CLIMATE CHANGE ADAPTATION TECHNOLOGY NEEDS ASSESSMENT in ENERGY, AGRICULTURE, WATER, FORESTRY, TRANSPORT, HEALTH sectors of the REPUBLIC of MOLDOVA

This publication is an output of the National Adaptation Plan and Agricultural Sectoral Plan Projects funded by the Green Climate Fund and implemented in collaboration with United Nation Development Programme (UNDP) and Food and Agriculture Programme (FAO).

Food and Agriculture Organization of the United Nations

GREEN CLIMATE FUND

UNDP Empowered lives. Resilient nations.

FOREWORD

The Republic of Moldova stands at a critical juncture in its development, where climate change adaptation is essential for safeguarding its economic, social, and environmental future. The country has aligned with the UNFCCC Parties in recognizing the significance of technology, following Article 10 of the Paris Agreement's Technology Framework, which emphasizes innovation, implementation, capacity building, enabling environments, collaboration, and stakeholder support.

As global weather patterns grow more erratic, Moldova adopted a strategic approach to climate adaptation, backed by technological innovation and coordinated policy efforts. Recognizing the technological needs for climate adaptation as a cornerstone of effective action, Moldova conducted a Technology Needs Assessment (TNA) in six priority sectors – Agriculture, Energy, Water, Forestry, Health, and Transport—during 2021-2023. In-depth sectoral assessments took an inclusive approach, guided by Sectoral Work Groups focused on enhancing resilience and promoting sustainable development in each area. The TNA was carried out as part of the second iteration of the National Adaptation Plan, funded by the Green Climate Fund and supported by UNDP and FAO UN Agencies.

The TNA process laid a robust foundation for integrating climate adaptation into sectoral planning, addressing existing adaptation gaps, and fostering systemic resilience in response to climate impacts. The identified and prioritised technological solutions aligned with Moldova's broader national and sectoral adaptation strategies, such as the *National Programme for Adaptation* (2023-2030), *Moldova 2030 Sustainable Development Strategy*, *Low Emission Development Programme* 2030 and *Nationally Determined Contribution 2.0 and 3.0* (under consultation). The outcomes of the TNA emphasised transformative adaptation, aiming to meet Moldova's adaptation needs by establishing resilient systems capable of responding to identified climate impacts, vulnerabilities, and risks in a timely manner, matching the anticipated pace of climate change.

The TNA process in Moldova followed a structured, three-stage approach to ensure a comprehensive understanding and prioritisation of adaptation technologies: Identification and *Prioritization of Adaptation Technologies; Barrier Analysis and Enabling Environment; Development of Technology Action Plans (TAPs)* followed by the identification of *Project Ideas* (Energy, Water, Forestry, Transport, Health and investment Concept Note (Agriculture). Sectoral TNA Reports offer a thorough exploration of the technological pathways that can facilitate effective climate adaptation across the prioritized sectors.

Climate adaptation TNA assessments form a vital component of Moldova's contributions to global adaptation efforts under the Paris Agreement, underscoring the country's commitment to strengthening resilience against climate-induced impacts.

Aliona Rusnac
State Secretary
Ministry of Environment of Moldova

Empowered lives.
Resilient nations.

GREEN CLIMATE FUND

CLIMATE CHANGE ADAPTATION TECHNOLOGY NEEDS ASSESSMENT

FORESTRY SECTOR

Integrated Report (TNA, BAEF, TAPs)

Ion Talmaci – Forestry Sector Leading Consultant
Dr. Ala Druta- TNA Team Leader
Pavel Gavrilita – Project Manager
Dr. Ion Comendant – Capacity Building Consultant
SWG of Forestry sector -16 members

Chisinau, 2023

Contents

Abbreviations

ADA	The Austrian Development Agency
AM	Agency „Moldsilva”
ASM	Academy of Sciences of Moldova
ATU	Administrative-Territorial Unit
EA	Environment Agency
CCA	Climate Change Adaptation
CDM	Clean Development Mechanism
CI	Climate impact
EFI	European Forest Institute
ENFIN	European National Forest Inventory Network
EU	European Union
FGR	Forest Genetic Resources
GCF	Green Climate Fund
GDP	Gross domestic product
GD	Government Decision
GEF	Global Environment Facility
GFMC	Global Fire Monitoring Centre
GIES	General Inspectorate for Emergency Situations
GIS	Geographic Information System Mapping
GHGs	Greenhouse gases
GPS	Global Positioning System
FRMI	Forest Research and Management Institute
IEG	Institute of Ecology and Geography
IGPPP	Institute of Genetics, Physiology and Plant Protection
IEP	Inspectorate for Environmental Protection
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
IZ	Institute of Zoology
LPA	Local public authorities
MAFI	Ministry of Agriculture and Food Industry
MTBF	Medium Term Budgetary Framework
MCA	Multicriterial assessment
MECR	Ministry of Education, Culture and Research
MIRD	Ministry of Infrastructure and Regional Development
MoEnv	Ministry of the Environment
MSU	Moldova State University
NAC	National Anti-corruption Centre
NAP	National Adaptation Plan
NARD	National Agency for Research and Development
NBG	National Botanical Garden (Institute) "Alexandru Ciubotaru"
NCFGS	National Center for Forest Genetics and Semiology
NDC	National Determined Contribution
NDS	National Development Strategy
NEF	National Environmental Fund
NFI	National Forest Inventory
NRLP	Nature Reserve Lower Prut
PFC	Protective forest curtains
PD	Parliamentary Decision
PI	Project Ideas
RCIBFRM	Regional Center for Industrial Breeding of Forest Reproductive Material
RCEFR	Regional Center for Ecological Forest Restoration

RM	Republic of Moldova
RWM	Railway of Moldova
SA	Sample Area
SAUM	State Agrarian University of Moldova
SB	State Budget
SDG	Sustainable Development Goals
SEF	Forest ecosystem's services
SME	Small and medium-sized enterprises
SRD	State Administration of Roads
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Plan
WB	World Bank

REPORT I. TNA FORESTRY SECTOR

Executive Summary

Climate change is already profoundly affecting resource availability conditions and activities within different sectors of the national economy in the Republic of Moldova, for example in forestry, agriculture, transport, energy, water resources, health, etc. Due to the still low index of afforestation of the territory, there is intensification of soil erosion and landslide processes, unfavorable change of hydrological regime, continuous aridisation of environmental conditions. Forests are the main element ensuring ecological balance in this geographical area. Thus, the problem of conservation and sustainable development of existing forests, as well as the expansion of forest lands through afforestation of new areas unsuitable for agricultural use, are matters of national interest. Climate change, manifested mainly in global warming and intensification of extreme natural disasters, greatly affects forest ecosystems and associated biological diversity.

The Government of Moldova considers that the National Adaptation Planning (NAP) process is one of the basic keys to achieving the adaptation objectives outlined in the 2014 Climate Change Adaptation Strategy, the 2020 National Determined Contribution (NDC), as well as for the continuous integration of climate change considerations into its policies and budgetary processes. The Government relaunched the NAP process in 2018 through consultations with national stakeholders and UNDP support.

The programmatic documents adopted by the Republic of Moldova in the field of climate change include, on the one hand, vulnerable sectors such as forestry and, on the other hand, sectors (including health, agriculture, water resources, etc.) that can make a significant contribution to mitigating the effects of climate change. For the forest-based sector, sectoral adaptation priorities are to promote the resilience and adaptability of forests to climate change. The analysis of the degree of implementation of policy documents until 2020 at the forestry department, based on the reports of agencies/institutions generalized by MoEnv, shows certain results that, for some actions, have largely reached the established indicators. However, these achievements are still insignificant in general and there is the sense of a poorly coordinated and promoted process at national, regional and local levels. The main risks, previously largely established, have materialized. For example, with regard to the change in the sensitivity of forest species to water scarcity and the increase in abiotic destruction caused by fires, wind storms, floods and drought, in particular, as a consequence of the decrease in water flow and the draining of several water basins, following the drought of recent years (aa. 2019-2020 etc.).

Due to the vulnerabilities recorded and forecasted, as well as the significant contribution to mitigating the effects of climate change, including for other sectors of the national economy, the forestry sector was selected among the key sectors for the TNA process. In the context of mitigating and/or anticipating climate change impacts, variability and climate extremes, a number of adaptation technologies/measures to help forest ecosystems meet the challenge of climate change have already been identified and proposed in various policy documents over the past two decades. In the previous period, certain measures/technologies were undertaken within the forestry sector aimed at adapting forest ecosystems to climate change. Due to the available technical and financial resources, but also to current visions, the efforts of institutions within the forestry sector (Moldsilva; forestry entities;

LPA, etc.) are focused primarily on maintaining a fragile balance, rather than on development and paradigm shift.

Digital and innovative technologies are understaffed in the forestry sector. The predominance of labor in forest cultivation and use/exploitation activities is an element that eloquently characterizes the technological situation in the forestry sector. The forestry sector needs to make substantial efforts in the area of the computerization and mechanization/technologization of certain activities, by using existing means or by creating new specific means. Also, in order to promote and implement sustainable forestry based on rational use of forest resources and efficient fulfilment of the assigned protection functions, long-term and applied fundamental scientific research is needed.

In the TNA project, stakeholder consultation has been an ongoing process throughout all phases. Their consultations and views in providing technological details about the current situation in sectors was of particular importance, including the use of new technologies. Stakeholders have an important contribution in developing the final set of criteria and indicators used to prioritize technology options. In order to give an active role to stakeholders in the TNA process, sectoral working groups (SWGs) have been set up, including on the forestry sector (17 members). Within the TNA process for the forestry sector, SWG was involved as a priority in the following actions/activities:

- Participation in identifying the long list of technologies/measures to adapt the forestry sector to climate change (21 technologies/measures).
- Primary selection/prioritization of efficient technologies/measures to adapt the forestry sector to climate change (12 technologies/measures; organization of the workshop on 06.08.2021).
- Participation in the MCA analysis for the final prioritization of technologies/measures for adaptation of the forestry sector to climate change (evaluation of 10 technologies/measures; selection of evaluation criteria; scoring; organization of the workshop on 02.12.2021; validation of results regarding the selection for the forestry sector of 2 technologies/measures for adaptation to climate change, etc.).

Identifying technologies/tools to mitigate the consequences of climate change, increasing the resilience and adaptability of the forestry sector is a complex process based on knowing the current state and forecasts for the short and medium terms of development. For the forestry sector, technology is more associated with the notion of measures and best practices. In the context of ensuring the adaptation of the forestry sector to climate change, the following general sectoral objective is set: ***Enhancing the capacity of the forestry sector in the Republic of Moldova to adapt to the consequences of climate change by maintaining and improving the capacities of forest ecosystems to provide services to society and maximizing the contribution to mitigation by strengthening and increasing carbon sequestration of volumes of carbon compared to the current situation***.

In order to strengthen both the capacities of forest ecosystems to adapt to climate change and increase their protective effect on agricultural land and crops, human localities, infrastructure, etc., a broad set of sectoral technologies/measures (21 technologies/measures) was identified at the first stage, classified into 8 subsectors. The cumulative budget of those options is estimated at 233.2 million EUR. Most of the identified sectoral technologies/measures have a medium and high degree of replicability and applicability. Activities include exchange of experience between national institutions involved in the process (MoEnv; Moldsilva; MECR; MIRD; MAFI; LPA; EA; IEP; GIES, etc.), and also with similar experts and institutions from neighbouring countries (Romania, Ukraine; Hungary, Bulgaria, Czech Republic, Poland, etc.).

The implementation of these technologies/measures will require, at the initial/preparatory stage, an extensive analysis of regulatory and policy barriers. Also required is a list of activities aimed at solving problems (development and/or strengthening of the institutional framework for afforestation and forest management activities; updating of technical norms and regulations; strengthening the planting subsector; contractual arrangements defining roles and responsibilities for stakeholders, etc.), which will partially change approaches and the situation in the forestry sector.

The adaptation options identified include the realization of a wide range of transfer and diffusion of existing and new technologies in the forestry sector in the Republic of Moldova. Among the main innovative aspects foreseen within the technologies selected and proposed for implementation are delineated:

a) The use of biotechnologies in the process of industrial growth of forest seedlings; conducting genetic research and in vitro breeding of forest species; automated irrigation systems in forest nurseries.
b) Industrial processing and conditioning of forest seeds; technical solutions for the care of seed source arboretums and those designated as forest genetic resources; quality assessment and certification of regeneration material.
c) Establishment and commissioning of basic elements of the subsector for the production of forest reproductive material: Creation of 2 regional centers for industrial breeding of forest reproductive material usable in the new climatic conditions (northern and southern areas), creation and appropriate technical endowment of the National Center for Forest Genetics and Seminology (Center area).
d) Establishment of climate thresholds corresponding to spatial distribution limits of forest types and/or forest species, with the development of bioclimatic models to predict future distributions of steady-state forests under a range of plausible climate change scenarios.
e) Calibration of biogeochemical models to forecast changes in productivity of arboretums and carbon stocks in the main forest types.
f) Remote sensing, digital photogrammetry, laboratory analysis and statistical processing of data on the evolution of forest status, in particular, interconnection with climate change (NFI, etc.).
g) New approaches in applying forest management, correlated with climate change and contemporary society requirements; promoting participatory management of public forest resources.

Among the main climate change adaptation benefits of technologies/measures identified for the national forestry sector, the following aspects are mentioned in particular:

a) Improvement of the management and conservation of natural forests, seed arboretums and forest genetic resources, particularly in terms of adaptation to climate change. Ensuring traceability of seed and planting forest material.
b) Production of forest material in the assortment necessary for forest regeneration, reconstruction and extension activities, qualitatively and in the required quantities, with direct consequences on increasing the success of forest crops and adapting regeneration, reconstruction and afforestation works to climate change.
c) Development and promotion of new approaches and technical regulations that will ensure the resilience of forest ecosystems to the effects of climate change, as well as the implementation of sustainable forest management principles. These documents and approaches will be based on a cycle of fundamental research cumulated with applied components on the adaptive

capacities of native forest ecosystems to climate change (bioclimatic models; resilience of species and arboretums; biogeochemical models; review of approaches in the process of applying forest treatments and works, forest regeneration works, etc.).

d) Diminishment of forest areas affected, weakened and/or degraded by fires or attacks of diseases and pests by creating viable systems for fire and phytosanitary monitoring of forests, connecting to international and spatial resources in the field, classification of forests and other types of forest vegetation in categories of incendiary danger, elaboration of measures for anti-fire planning of forests, adoption in forestry practice of new technologies and equipment for land and aviation combat, etc.
e) Adequate monitoring of the evolution of forest status through NBFIs, in particular, the interconnection with climate change. Preparation of studies/scenarios on the development of forest ecosystems to be used, in particular, in forest policy development processes focusing on adaptation to climate change, as well as for providing data for reporting sustainable forest management indicators, according to national needs, but also international commitments assumed by the country.

The process of prioritizing adaptation technologies/measures at forest sector level was carried out in two stages through a participatory process. At the first stage, SWG members prioritized, by means of a sectoral web questionnaire, 12 technologies from the long list (LLT) proposed for implementation for the forestry sector. Thus, according to the results of the sectoral web questionnaire, the maximum score (123 points) was accumulated by the technologies "1.1. Increasing the degree of afforestation of the territory per country by planting climate-resilient forestry crops" and "1.2. Afforestation of riparian strips, rivers and water basins". These are followed by technology "3.1. The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" with 121 points.

For the second stage prioritization of climate change adaptation technologies/measures on the forestry sector, 15 evaluation criteria were selected. These criteria were associated to 8 evaluation categories: Costs; economic; social; medium; climate; institutional/implementation; politics; gender. Also, for each evaluation criterion, the scoring scale (0-10) was awarded, and SWG members individually determined the weight of each evaluation criterion (score matrix). Taking into account the specificities of the forestry sector, the maximum score (179 points or 12.3% of the total) was awarded to the assessment criterion reflecting climate benefits: "Improving the sector's resilience to climate change (to what extent technology will contribute to reducing climate vulnerability)". In 2nd place was the evaluation criterion reflecting environmental benefits "The contribution of technology to the protection and sustainment of ecosystem services", which accumulated 155 points or 11.1%. The evaluation criterion reflecting investment aspects ("Investment cost of technology") accumulated the third score – 126 points or 9.0%.

In order to achieve the direct prioritization of climate change adaptation technologies/measures on the forestry sector, the multicriteria analysis (MCA) procedure was used. In this context, with the support of spreadsheets based on Excel, 3 interconnected matrices were built: Performance matrix, score matrix and decision matrix. The forms filled in by SWG members were submitted to the national sector consultant. In total, 14 forms were filled in, or 82.4% of the requirement. The gender aspect of the process was acceptable: B/F – 50%/50%.

The analysis of the results shows that SWG members in the forestry sector gave priority to technology aimed at restoring the Eco protective and bio productive potential of existing forests, especially degraded and inadequate ones: T/M-5 "**Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change**", which accumulated a final score of 22.45 points. The technology provides for the application of ecological restoration practices on a total area of 25.0 thousand ha for degraded and inappropriate arboretums (totally derived, brought, inappropriate to stationary conditions, poor productive, etc.), vulnerable to climate change, aiming at replacing arboretums with a single species with mixed and plurian arboretums, maximum use of the shelter of the degraded stand, etc. All silvitechnical interventions within this system will be carried out in full compliance with the place and role of each component element of the ecosystem (trees, shrubs, animal kingdom, etc.), applying the ecosystem based approach (EbA) and nature-based solutions (NBS). As intervention methods, substitutions and restorations will be applied as a priority.

The next technology/measure ranked in the hierarchy of the forestry sector is T/M-6: "**The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions".** According to MCA, that technology has accumulated a final score of 21.54 points. The technology provides for the adaptation of the subsector of production of forest reproductive material to the evolution of climate change through activities to strengthen and modernize the process throughout the production chain: Identification, legalization and care/maintenance of seed source arboretums (including forest genetic resources/FGR); harvesting, processing and certification of forest seed; industrial breeding and valorization of forest reproductive material, etc. The technology includes the establishment and commissioning of basic elements of the subsector for the production of forest reproductive material: Creation of 3 regional centers for industrial breeding of forest reproductive material (RCIBFRM) usable in new climatic conditions (north, center and south; appropriate technical equipment; primary operational activity; staff training; management of the seed base; production of seedlings with protected roots, etc.).

The third technology "Climate Change Impact Considerations, Forest Species, and Appropriate Forest Ecosystem Management Strategies" is designed to enhance the resilience of forest ecosystems in the face of climate change. It supports comprehensive research programs focused on understanding and improving the adaptive capacity of native forest species through an ecosystem-based approach (EbA) and nature-based solutions (NBS). Key elements of the technology include (i) Climate Thresholds and Bioclimatic Modelling: Development of bioclimatic models to predict forest distributions under various climate scenarios, assessing limits to spatial distribution for different forest species. (ii) Species Migration Analysis: Examining historical data to understand migration patterns of forests, predicting how forest boundaries may shift over time.(iii) Biogeochemical Modelling: Calibrating models to forecast productivity and carbon stocks within different forest types under increasing CO_2 conditions.(iv)Adaptive Capacity Assessment: Evaluating the inherent and socio-economic capacities of forest ecosystems to support adaptation strategies. The technology prioritizes the creation of sustainable forest management practices, including the use of climate-resilient species, and promotes innovative technical regulations and approaches for forest conservation and regeneration. The initiative is spearheaded by research institutions, national agencies, and regional stakeholders, focusing on adapting forest management to predicted climate impacts. Key benefits of this technology include enhanced environmental resilience, job creation in forest research and management, cost savings on forest restoration, and strengthened capacities for sustainable ecosystem management, benefiting both environmental and socio-economic sectors.

The results obtained in the first MCA were tested at robustness, i.e., how they are stable to changing factors that determine the position T/M in the list of priority levels. In this respect, according to SWG recommendations, robustness was also studied by changing the weight of evaluation criteria, especially those related to primary investment costs of implementation, but also maintenance/operating costs, etc. Also, as most adaptation technologies/measures in the forestry sector target rural areas characterized by shortages of jobs, incomes, etc., criteria characterizing these aspects have also been included in the robustness assessment process. Thus, the scoring values for cost criteria were increased by 50%, gender criteria by 30%, and economic and social criteria by 25% each. At the same time, environmental and climate criteria were lowered by 45%, while criteria referring to institutional/implementation aspects and the policy framework remained unchanged. The use of these approaches has partially changed the hierarchy of criteria for assessing technologies/measures in the forestry sector: 1. Investment cost of technology – 189 points or 13.5% of the total; 2. Technology maintenance/operation costs – 143 points or 10.2%; 3. Potential for transfer and diffusion of new technologies (Degree of innovation) – 136 points or 9.7%.

Those changes in MCAs note certain changes in the hierarchy of climate change adaptation technologies/measures in the forestry sector. At the same time, it is mentioned that the first two technologies remained the same, only changed with the place. The results obtained in the sensitivity analysis largely confirm the correctness of the MCA exercise carried out with SWG support. In this context, for the promotion and final analysis of adaptation technologies/measures in the forestry sector, it is considered optimal to apply the hierarchy made by SWG within the MCA.

Chapter 1. Introduction

1.1 About TNA project

Climate change is already profoundly affecting resource availability conditions and activities within different sectors of the national economy, in particular, forestry, agriculture, transport, energy, water resources, health, etc. Over the past decade, Moldova has experienced a number of extreme events, such as droughts and major floods, along with incremental effects caused by the increase in average temperature and uneven distribution of precipitation throughout the year, which have had negative consequences on the country's economy, well-being and health of the population, etc. Severe droughts recur more frequently, causing significant economic losses. The increasing incidence and intensity of extreme events has also led to an increase in the frequency of high-risk situations.

The Government of the Republic of Moldova considers that the National Adaptation Planning (NAP) process is one of the basic keys to achieving the adaptation objectives outlined in Moldova's 2014 Climate Change Adaptation Strategy, National Determined Contribution (NDC), as well as for the continued integration of climate change considerations into its policies and budgetary processes. The government launched the NAP process in 2014 through consultations with national stakeholders and with the support of the Austrian Development Agency (ADA) and UNDP.

The NDC contains a strong adaptation component that relies on the NAP process to inform the development and implementation of adaptation objectives. The interconnection of the NAP process with the setting of NDC targets provides a constructive response between national and international decision-making processes on climate change for better convergence between the implementation of the Paris Agreement, the Sendai Framework and the 2030 Agenda. At the same time, Moldova is a signatory to a series of agreements with the EU that provide much-needed support to improve its national policies, as well as a monitoring and reporting component, which leads many of the recent changes in the legal and regulatory framework. The Association Agreement is accompanied by an Action Programme for European integration: Freedom, democracy, welfare 2011-2014 (Government Decision 289/2012), which establishes the framework for convergence of Moldovan and European policies.

The main objective is to support the Government of the Republic of Moldova in advancing the second cycle of the iterative process of national adaptation planning. The project aims to address barriers to prioritizing national investments in climate change adaptation and to increase the availability of human and financial capacity to implement priority actions identified during NAP-1 and those that will occur under NAP-2. The objective of the project will be achieved through three outcomes that refer to strengthening national capacities to integrate CCA considerations:

- Outcome 1 focuses on strengthening national governance mechanisms for CCAs;
- Outcome 2 supports the improvement of the long-term CCA capacity to plan and implement adaptation actions;
- Outcome 3 focuses on continuous improvement of financing, implementation and monitoring systems related to adaptation.

The objectives of NAP-2 will be achieved within two parallel implementation tracks. The first path implemented by UNDP expands and deepens the national approach developed under NAP-1. It will also strengthen synergies both vertically at different levels of government and horizontally between sectors affected by climate change in order to reduce duplication of efforts, pool limited resources for efficient use and ensure a coherent and comprehensive approach to integrating CCA responses into development planning. The second path will focus on adaptation in the agricultural sector and will be implemented concurrently under the auspices of FAO.

The designated national authority coordinated with UNDP and FAO Country Offices to ensure complementarity and matching of activities and exchange, as appropriate. By its very nature, NAP-2 will facilitate the integration of SACs into existing strategies, policies and programs and establish a solid basis for integrating methods, tools and information systems into day-to-day planning activities to effectively inform decision-makers on climate risks and enable informed formulation of resilient projects and financing strategies.

The sub-result of the project on the adoption of adaptation technologies aims to expand the capacity of CCA activity with the development of a CCA technological framework. This would articulate the medium- and long-term objectives necessary to acquire technological knowledge to meet the needs of CCA and to achieve a large-scale and transformational technology transfer at subnational and sectoral level. Under TNA, technology assessments will provide information about technology needs and prioritized technologies will be included in the formulation of gender-sensitive CCA investment proposals for further mobilization of funding.

The TNA process will be implemented within the phased NAP-2 Project, namely:

1. Identifying and prioritizing adaptation technologies for key sectors: Energy, transport, forestry, water resources, health.
2. Identifying, analyzing and addressing barriers, including the enabling framework, hampering the diffusion and deployment of priority technologies for climate resilience and adaptation.
3. Development of the Technology Action Plan (TAP) for the implementation of priority technologies.

1.2 Existing national policies related to technological innovation, climate change adaptation and development priorities

1.2.1 National circumstances related to the forestry sector

According to current cadastral records (01.01.2021), the total area of the forest fund in the Republic of Moldova is 449.8 thousand ha (13.3%), including state property – 362.8 thousand ha (80.7%); public property of administrative-territorial units (ATU) – 84.3 thousand ha (18.7%), private property – 2.7 thousand ha (0.6%). Land covered with forests occupies 370.7 thousand ha (afforestation degree – 11.2%), including state property: 317.7 thousand ha (85.7%), of which 303.2 thousand ha Agency "Moldsilva" (95.4%); public property of ATU – 50.5 thousand ha (13.6%); 2.5 thousand ha in private ownership (0.7%).

The area covered with forests in the Republic of Moldova varied considerably over time, from 366.2 thousand ha in 1848 to 222.0 thousand ha in 1945, and to reach 370.7 thousand ha in 2020 or about 11.2% of the country's territory (Figure 1.1). These fluctuations were determined by national circumstances and priorities at certain periods, but also by the political/administrative context at certain stages:

- Radical changes in state order and structure (1812; 1918; 1944; 1991).
- Mass destruction of forests during World War I.
- Nationalization by redemption of private and religious forests after the union of Bessarabia with Romania (period 1918-2023).
- Forest extension programmes from 1950-1990, 2002-2009, 2014-2018.

At the same time, the Republic of Moldova has 50.9 thousand ha of forest vegetation outside the forest fund (30.5 thousand ha of protective forest curtains; 20.4 thousand ha of shrub vegetation). Forest protection belts (PFCs) constitute 1.22% of agricultural land area, while scientific norms for national phytogeographical conditions constitute on average about 4%.

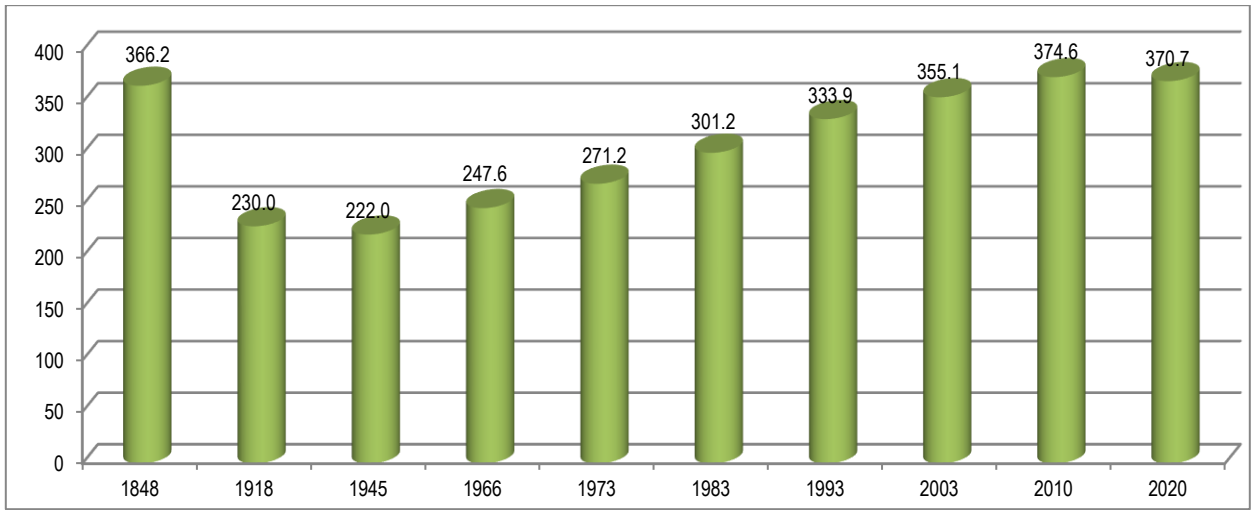


Figure 1.1. Evolution of forest areas in Moldova during 1848-2020, kha

Most of the forest vegetation outside the forest fund is in public property of ATU – 40.4 thousand ha (79.4%). Also, it is mentioned here that forest vegetation outside the forest fund includes 3.7 thousand ha of land for industry, transport, telecommunications managed by the Ministry of Infrastructure and Regional Development (RWM; SRA).

Compared to other countries in the region, the Republic of Moldova has very low indicators specific to forest resources. Thus, for each inhabitant there is 0.095 ha, 11.3 m^3 standing timber and only 0.16 m^3/year of harvested wood. The forests of the Republic of Moldova are dispersed in 3626 forest bodies with an average area from 5 ha to 5550 ha, being located in the area of activity of 920 administrative-territorial units (ATU)/mayoralties. From a territorial point of view, about 57.7% of the land area covered with forests and other types of forest vegetation belongs to the Central area of the Republic of Moldova, to the North area to 26.6% of these lands and only 15.7% to the South area.

Forests owned and managed by ATU (municipalities) represent a comparatively new subsector in terms of field, but with a great potential for expansion and management. The vast majority of forest land owned by ATU is created in the postwar period through various state programs or with international support. The forests under ATU management are mostly included in the category of forests for land and soil protection, as well as protection against climatic factors. According to the legislation in force, forest land owners are obliged to comply with the forestry regime, which represents a system of technical, economic, legal and forestry norms regarding the planning, use, regeneration, guard and protection of forests. The current state of forest resources owned by ATU is also influenced by limited institutional and human capacities at local level. Thus, the current general characteristic of forests owned by ATU represents:

- small bodies dispersed outside the built-up areas of rural and urban localities;
- predominance of acacia as a basic species;
- insufficient application/implementation of the forestry regime;
- a general lack of forest development projects;
- care and management measures applied on a case-by-case basis;
- degree of severe damage caused by grazing and illegal logging, waste pollution, etc.;
- management conducted with violations of forestry technologies and compliance with ecological and forestry requirements.

The share of private forests is small and constitutes 0.7% of the total in the Republic of Moldova or 2.5 thousand ha. An important aspect is that these lands are owned by about 4.5 thousand owners, which shows a high degree of dispersion and that the process of setting up the private forestry sector is still at its early stages. At the same time, the main reserves of land for the expansion of forest areas are privately owned. It is important to note that the area of forests located on private land in reality is larger. Case studies conducted by FRMII during 2015-2017 in the pilot districts of Nisporeni and Ungheni confirm the presence of important areas of forests/forest vegetation (500-800 ha) at district level, which, according to land records, can be found in other categories: Multiannual plantations, arable land, etc.

The state tries to capitalize on the potential of private property, including by creating/adjusting the appropriate regulatory framework. Thus, GD 1186/2016 approved the Regulation on carrying out afforestation works of degraded lands public property of administrative-territorial units and degraded lands owned privately. This document created conditions for the access of private persons to state programs for afforestation of new lands, provided they assume the implementation and observance of the forestry regime. The still unresolved issue is identifying the financial resources for these programmes.

The national forestry sector is subject to major challenges, such as poaching or illegal logging, which only worsen already vulnerable ecosystems, exposing many rare species to local extinction risks. The aspirations to increase the area of protected areas and to expand forest vegetation require adequate correlation with the institutional framework. Both the rich biological diversity and the cultural-traditional diversity of society are closely intertwined in this process.

Climate change, manifested mainly by global warming and intensification of extreme natural disasters, greatly affects forest ecosystems and associated biological diversity, because the Republic of Moldova is located in a region with a high degree of vulnerability and frequently faces heat waves, forest fires, droughts, etc. The period of the last 20 years has been manifested by a high intensity of

extreme phenomena, such as droughts, hail/frost, which are a stressful factor for the health of forest ecosystems. Forecasts for the next century on the evolution of forests of the Republic of Moldova (World Bank, 2015) assume that the longitudinal gradient will move northwards, and the health (phyto-sanitary) status of forest ecosystems will worsen. Various emission scenarios (MoEnv/Climate Change Office, etc.) for the period up to the end of the twenty-first century forecast variations in precipitation predicting a general and gradual downward trend in annual precipitation against the background of rising temperatures and sequential increase in potential evaporation, varying from one geographical area to another. Trends in changing thermal regime will continue and will most likely correlate with variations in emissions and other climatic phenomena. It is undeniable that forests will be directly or indirectly affected by climate change, and forest managers in vulnerable areas will be hit quite hard. The economic and financial activity of forest managers over the last decades shows the increasing trend of negative indicators (share of forestry branch in GDP; net profit in forestry; share of investments in forestry; share of research and technological development expenditures; number of employees in forestry; share of working wood, etc.), more as a result of reducing the quality of ecosystems (natural resources) than their management. At the same time, in the situation of growing interest in forest resources, the human factor will be decisive in ensuring continuity (sustainability), where the compromise between social-human/economic and ecological values can be expensive.

Under such conditions, forest management must be adjusted to the current situation and to a scenario influenced by climate change by optimizing all components of the system. The principles of sustainable management with the promotion of species and techniques/technologies that will cope, can ensure long-term development with the preservation of the resource for a longer period. On the other hand, "Moldsilva" Agency is really a structure with human resources (specialists, seasonal workers, users, etc.) involved in ensuring the forestry and conservation regime, which will largely decide the fate of tomorrow's forests.

The compromise can be identified at the dividing limit of forests intended for intensive management (but applying the respective technologies/techniques to obtain income) and forests with conservation character (aiming at carbon sequestration; protecting biological diversity in the long term; contributing to improving resilience to climate change for other sectors (agriculture, water, etc.). The Agency "Moldsilva" will be able to ensure the continuity of the forestry regime (including conservation) only under the conditions of support through strategically budgeted programs for this purpose, based on significant monetary estimates of the generated goods and services.

Climate change is the most important argument in promoting a green economy in forests. The authorities' statement regarding the lack or insufficiency of financial resources for budgeting the activities of the Agency "Moldsilva" is not relevant at all, because the loss of forests as generators of goods and services will endanger not only human lives, but also other economic activities (sectors) providing income. Strategic activities – regeneration, afforestation, extension, guarding/protection, etc. – must be budgeted through strategic sustainable programs that support the continuity and functionality of forests through climate change adaptation actions.

The problems identified in the forestry sector relate primarily to inadequate forest management, low bioproductive potential of forests, insufficient forest protection and protection, and slow expansion of forest areas. The activities undertaken by the competent authorities are still insufficient to stop the losses caused to forests by illegal logging, estimated at about 400-600 thousand m^3 annually, according to analytical studies conducted by local and international institutions. At the same time, the

sector faces problems related to the insufficiency of the institutional and management framework for the complexes of natural areas protected by the state and the lack of financing sources necessary to ensure the established regime and their sustainable management, insufficient dimensions of the areas of natural areas protected by the state, as well as of the areas covered with forests, insufficient provision and development of sustainable forest management, green spaces, meadows, wetlands, continuous degradation of protective forest curtains causing loss of habitats and ecosystems.

As a sector of the national economy, forestry is conditioned by the policy promoted by the state in the forestry and hunting field, by the quantitative and qualitative characteristics of the country's forest resources, by the capacity of the forestry sector to meet the needs of the national economy and population in forest products and services. The problems of the forest fund have a well-marked biological aspect, and forest management has an economic character, which is based on a certain type of human activity. It also has a social character, a character so strong that it can be said that the center of gravity of forest management falls precisely on its social aspect; on the relations between man and forest. In certain historical periods, economic realities require solving urgent problems, such as: Payment of salaries, their increase, maintenance of fixed funds, renovation of technologies, technology, payment of payments, necessity of carrying out works, which are not always in accordance with the needs of the forest, with the task of maintaining the continuity of forests, harvesting its products, expanding land with forest vegetation. It is in such cases that the position of the state, which ensures the national priorities in the field, is important.

Among the major factors, which over recent years have led to the marginalization of forest policy, is the lack of a scientifically substantiated conception of the use of natural resources, including forestry. After the collapse of the former USSR, there were no major changes regarding the rapid transition from socio-economic conditions established in time and based on huge natural and financial resources, to the imminent reality of a small state, with a very pronounced geo-political, demographic and ecological specificity. As a result, a number of sporadic and alert measures were adopted, without an economic argumentation adequate to the current situation, measures that later proved ineffective. In most cases, the concept of an administrative command regime was followed, based mainly on numerous contradictory legislative and normative acts. Frequent reshuffles related to the departmental affiliation of the forestry sector serve as proof of this: Since 1990, it has been reformed and assigned to different central authorities/ministries more than 5 times. The reshuffles (including territorial structures), in general, have not improved institutional capacities. On the contrary, they have blocked the activity of state forestry bodies for appreciable periods of time, with adverse consequences on the state and development of forests.

Another important aspect is that, given the compliance with the technical rules governing the forestry regime and which are very restrictive, the current possibilities for innovation in forest management are very limited. As the share of manual activities in forestry is very high, "Moldsilva" Agency will make more consistent efforts on computerization and mechanization of some activities, by using existing means or by creating specific means.

1.2.2 Forest ecosystem services in the Republic of Moldova

Forest ecosystems in the Republic of Moldova provide important supply services thanks to timber and non-wood forest products that are part of the forest economy. Thus, forest ecosystem services (SEF)

refers to a flow of resources or services from the natural environment that directly or indirectly benefit humans, falling into the following four categories[1]:

- Provisioning services refer to tangible products such as timber/timber, non-forest products, fish, pharmaceuticals, etc. provided by ecosystems (Table 1.1).
- Regulatory services refer to natural ecosystem processes, such as carbon sequestration and water regulation, that contribute to social well-being.
- Cultural services refer to non-material benefits derived from ecosystems, for example through tourism and education or aesthetic experiences.
- Support services are required for the production of all other SEFs (e.g. soil formation, nutrient circulation, photosynthesis, primary production, etc.). They differ from other services either in that their impact on people is either indirect (through provisioning, regulation or cultural services) or occurs over a very long time.

In addition to the important regulation of ecosystem services addressed to the water supply and disaster risk reduction sectors, their value of timber supply was estimated at 28.3 million. dollars.

Table 1.1: Forest ecosystem services and associated benefits

Types of services	Services	Benefits/results
Scoping	Food	Hunting, fish, fruits, berries, mushrooms, etc.
	Wood	Round wood, timber, firewood, etc.
	Water	Water, water supply services for industrial and agricultural purposes
	Natural medicine	Medically Natural (Medicinal herbs)
	Ornamental Resources	Saplings and ornamental plants, winter trees, etc.
	Energy sources (fuel, etc.)	Firewood, mining debris, etc.
Regulatory services	Regulatory services GES	Carbon seizing
	Microclimate stabilization	Air quality, temperature and evapotranspiration regulation
	Water regulation(accumulation and retention)	Protection against floods and storms
	Waste processing	Water detoxification, sediment/waste
	Nutrient retention	Improving water quality
Cultural services	Recreation and ecotourism	Admiring landscapes, birds and animals, hiking, etc.
	Education	A "natural field laboratory" for understanding biological processes
Cultural services	Spiritual, religious, natural heritage	Use of forestry issues in books, films, painting, folklore, national symbols, architecture, advertising

Currently, the forestry sector is affected by illegal logging and little attention to non-wood forest products. In the case of a sustainable ecosystem management scenario, with the reduction of illegal logging and the growing interest in the potential of non-wood forest products, the net present value for 25 years (rate of 10%) is estimated at EUR 578.8 million. dollars. Even if the contribution of forest

[1] Transylvania University of Brasov (UTB), Faculty of Forestry and Forestry (2015), Forest Ecosystem Services Assessment (SEF) of the Republic of Moldova. Technical Report under the ENPI FLEG II Program, 89 p.

supply services to Moldova's economy could decrease in the near future, the benefits will still outweigh the losses.

1.2.3 Forest-related climate change policies and actions

The Republic of Moldova has developed and adopted a series of policy documents comprising integrated measures to address the new conditions created by climate change for the forestry sector. Thus, the national policy framework in force with reference to technological innovations, climate change and forest sector development includes a comprehensive set of documents (Parliament and Government decisions) that refer, in whole or in part, to forestry, establish objectives and measures in terms of addressing climate change, in the light of international documents ratified or adopted by Moldova.

The programmatic documents adopted by the Republic of Moldova in the field of climate change include, on the one hand, vulnerable sectors such as forestry and, on the other hand, sectors (including health, agriculture, water resources, etc.) that can make a significant contribution to mitigating the effects of climate change. The list of these documents is presented below, including brief information about the provisions and their potential impact. Thus, the main national strategic documents in forestry, biodiversity conservation and climate change are the following:

- The Environmental Strategy for 2014-2023 and the Action Plan for its implementation, approved by GD nr. 301/2014.
- Climate Change Adaptation Strategy until 2020 and Action Plan for its implementation, GD nr. 1009/2014.
- The Strategy on Biological Diversity for 2015-2020 and the Action Plan for its implementation, approved by GD no. 274/2015.
- The low-emission development strategy until 2030 and the Action Plan for its implementation, approved by GD nr. 1470/2016.
- The strategy of sustainable development of the forestry sector, approved by Parliament Decision nr. 350/2001.

Although expired, the main policy document aimed at sectoral development is the Strategy for Sustainable Development of the Forestry Sector for the years 2001-2020. According to him, the main strategic directions of sustainable development of the forestry sector are:

- Restoring the ecoprotective and bioproductive potential of forests.
- Extension of areas with forest vegetation.

The following aspects were outlined as objectives, most of which are connected to climate change

- Enhancing the ecoprotective and bioproductive potential of natural forests.
- Conservation of biological diversity of forests.
- Extension of areas covered with forest vegetation.
- Increase in the efficiency of forest fund security and protection activities.
- Increase in the contribution of forestry sector to solving socio-economic problems.
- Conservation of the national countryside.

That document mentions very clearly the role of forests as an invaluable source of various benefits, through their products and contribution to the development of society, as well as a major importance

in maintaining ecological balance. The strategic framework favors the extension of areas covered with forest vegetation by afforestation of degraded lands, affected by landslides, afforestation of riparian strips for the protection of rivers and water basins, creation of green islands of trees and shrubs, corridors of interconnection between forested massifs, etc. In this context, it is necessary to cover with forest vegetation at least 130 thousand ha and to create new forest bodies, expanding the areas of existing ones.

The main impact of the implementation of this document is foreseen to increase forested areas up to 15% of the territory, reduce greenhouse gas emissions, reduce soil degradation; reducing and stopping landslides, etc. The implementation costs are estimated at 345.9 million lei (25.5 million USD) through GD 739/2003.

The Environmental Strategy for 2014-2023 specifies that forest resources are strategically important natural resources. Forests play a particular role in maintaining ecological balance, combating desertification and land and soil degradation, preserving biodiversity, protecting landscape, water and river basins, food and energy security, mitigating the impact of climate change, and last but not least, preventing and reducing the risk of natural disasters. Thus, through *Specific Objective 6.4:* Extension of forest areas up to 15% of the country's territory, of state-protected natural areas up to 8% of the territory and ensuring efficient and sustainable management of natural ecosystems. At the same time, it is foreseen to improve the quality of at least 50% of surface waters by implementing the river basin management system; restoration of about 150 thousand ha of degraded wetlands, with their inclusion in the economic circuit of the country. The forestry sector (riparian strips; water source protection strips, etc.) must also contribute to this process.

The Strategy on Biological Diversity for 2015-2020 and the Action Plan for its implementation (GD no. 274/2015), contains in the specific objective C. Implementation of measures to stop threats to biodiversity, Specific objective 1. Implement measures to halt soil degradation and mitigate the effects of climate change. In Section 3 Direct threats to biological diversity, 1. Climate change, it is stipulated that: "Climate change is a global phenomenon that endangers natural, social and economic systems through their sensitivity and vulnerability to climatic factors." For the purpose of assessing the problem of adaptation of biological resources to climate change. The strategy included actions to elaborate the study on the relationship between ecosystems, biodiversity and the aspect of climate change in the Republic of Moldova and technologies to ensure the adaptability of forest ecosystems to climate change.

The Climate Change Adaptation Strategy until 2020 and the Action Plan for its implementation (GD no. 1009/2014) provide for research on the impact of climate change on different fields and ecosystems, temporal and spatial assessment of the impact of climate change on them, identification of vulnerable areas and sectors and assessment of needs and possibilities of alternation of more resistant species, in response to climate change, etc. The strategy is intended to serve as an umbrella programming document that creates an enabling environment for specific sectors to integrate climate change adaptation activities and risk management into their existing and future strategies and action plans, or to develop their own climate change adaptation strategies or action plans. The document sets out six priority sectors assessed as most vulnerable to climate change, including forestry, subject to specific adaptation options and proposed in the Action Plan.

This strategy sets a general objective to develop and strengthen the capacity of the Republic of Moldova to adapt and respond to the actual or potential effects of climate change, with three specific objectives underlying the achievement of this objective:

- Create, by 2018, the institutional framework in the field of climate change to ensure the efficient implementation of adaptation measures at national, sectoral and local level.
- Create, by 2020, a mechanism to monitor the impact of climate change, related social and economic vulnerability and to manage/disseminate information on climate risks and disasters.
- Ensure the development of climate resilience by reducing climate-related risks by at least 50% and facilitating adaptation to climate change in six priority sectors by 2020.

Each specific objective is supported by the 'action strand'. Six horizontal and cross-cutting actions are identified for the first and second specific objectives (three per objective), while for the third one action strands are assigned by sector (six in total). Thus, 64 concrete measures (both horizontal and sectoral) are identified for implementation by 2020 and included in the Action Plan (PA) of the Strategy. Each measure detailed in the IP is associated with a concrete indicator, used to monitor the implementation and impact of an adaptation action. In order to provide viable sectoral solutions, climate change adaptation measures need to be integrated into the development planning of each vulnerable sector, by incorporating them into existing strategies and programs or by developing new sector-specific adaptation plans. As pilot measures for risk reduction and adaptation to climate change in the forestry sector, the following are foreseen:

- Intensifying the process of expanding the territories covered with forest vegetation and ecological reconstruction of forests, creating corridors of interconnection between forested massifs (indicator – 20 thousand ha of forested land).
- Creation/rehabilitation of forest curtains for the protection of agricultural land, roads and waters (indicator – restored/created 3 thousand ha of forest curtains).
- Creation of forest plantations for industrial and energy needs (planting energy forests to meet population needs, indicator – 5 thousand ha).
- Selection and growth in nurseries of tree species resistant to various climatic conditions.
- Creation of urban and rural green spaces (indicator – 2 thousand ha).

The costs of implementing the Adaptation Strategy are estimated at: 500 million. lei (for afforestation of land); 66 mil. MDL (for restoration/creation of forest curtains), 380 mil. lei (for the creation of energy plantations).

Low emission development strategy until 2030 and Action Plan for its implementation (GD no. 1470/2016). With reference to the forestry sector (within LULUCF), the document provides: Unconditional increase, by 2030, of carbon dioxide sequestration capacity up to 62% and conditional greenhouse gas sequestration up to 76% compared to 1990; promoting to a greater extent agroforestry and silvopastoral practices, supporting communities for sustainable and integrated forest management, etc. The main indicators necessary to achieve for the forestry sector: 3.8 thousand hectares forested annually (for afforestation of riparian areas and strips for protection of rivers and water basins); 5.9% of the total area (860 000 ha) of degraded land improved by afforestation; 3.6% of the total area (860 000 ha) of degraded land planted with forest vegetation (for the extension of areas covered with forest vegetation); 12.0 thousand ha of forest protection curtains planted, 10 thousand ha of energy forestry crops planted. Implementation costs are estimated at 2597 million. lei from the state budget, 1621,4 million. lei – external assistance.

An important aspect of the implementation process of national policy documents is their reflection in regional/local level documents. Most regional structures (districts) have strategic documents that establish medium and long-term socio-economic and development priorities/particularities. These documents largely apply the same approaches to assessing the current situation, as well as defining strategic directions for development. At district level, we want these development programs/strategies to also represent an opportunity to open the way to possible new directions of action, capable of leading to progress and local, district/regional development. At the same time, the analysis of these regional policy documents shows that aspects related to sustainable forest management, conservation of biological diversity and climate change are poorly reflected and developed, targets and parameters necessary/possible to achieve in the result of implementation are missing. This is due to the ambiguity of the process of elaboration and adoption of such documents at regional/local level, which does not have the obligation to reflect national and/or sectoral documents at regional level, through concrete parameters. Also, these strategies do not examine forests owned by LPAs both as local investment objectives and as means of production intended to obtain own revenues in local budgets. What the development and expansion of forest resources at local level lacks is a viable financial and administrative mechanism.

The analysis of the degree of implementation of the mentioned policy documents until 2020 at the forestry department, based on the reports of the agencies/institutions generalized by MoEnv, shows certain results that, for some actions, have largely reached the established indicators. However, these achievements are still insignificant, in general, and there is the sense of a poorly coordinated and promoted process at national, regional and local levels. Thus, among the main findings on the forestry sector are mentioned the following aspects:

1. Overall, the insignificant result of the implementation at the forest department is due to the fact that their implementation period (2014-2020) coincided with the political instability in the Republic of Moldova. The government(s) and competent agencies were not able to take tangible actions to adapt the forestry sector to climate change, especially by developing new policy documents and legislative acts, allocating funds for afforestation of new lands, to ensure the reduction of the impact of climate change on sectors of the national economy and increase the resilience of these sectors to climate change.
2. During 2014-2020, the Government did not provide essential support for creating a consolidated institutional framework to ensure measures to reduce the adaptation impact of the forestry sector to climate change, in particular. The institutional adjustments in 2015-2018, which included the transition of the "Moldsilva" Agency from the direct subordination of the Government to the subordination of the Ministry of Environment, and then the unification and creation of MADRM distanced the forestry sector from the real decision-making points, with the necessary consequences on the process of obtaining financing domestically and internationally.
3. In the period 2014-2020, there was no decisive intensification of the process of expansion of territories covered with forest vegetation and ecological restoration of forests. Of the afforestation task of 20.0 thousand ha of new land, only 1.9 thousand ha or 9.5% were realized. The national program for ecological restoration of forests remains an unfulfilled desideratum, and the actions and initiatives of the Agency "Moldsilva" in this compartment cover very little of the necessary.
4. The process of allocating land under afforestation activities of degraded land and riparian areas is slow and poorly coordinated. The procedural aspects provided by the legislation are

complicated and require the involvement of a large number of authorities and institutions at local and regional level (local councils, district councils, cadastral services, forestry entities, district ecological inspections, etc.) by creating specialized joint commissions. The situation of land available for these purposes is more generalist, without concrete reflection at local level. MoEnv and "Moldsilva" Agency have insufficiently taken measures/actions/campaigns to identify the real reserve of land that owners (LPAs, private etc.) are ready to allocate for afforestation. LPA's refusals have a formal priority in nature, especially with reference to the shortage of public land for grazing animals. Also, the private sector is practically out of process, although according to cadastral records the main reserve of land for afforestation is privately owned.

5. In the last decade, there has been an alarming increase in damage and destruction caused to forests by fires, disease and pest attacks, wind storms, floods, droughts, etc. In this context, it is necessary to consolidate/reconfigure the registration/signalling systems and/or records, as well as anticipate/liquidate forest fires, disease and pest attacks, forest drying, etc.
6. Within research and university institutions are elaborated an insufficient number of scientific and practical studies on the relationship between forest ecosystems, biodiversity and the aspect of climate change in the Republic of Moldova.
7. The process of assessing and amending legislative and regulatory acts relating to the forestry sector from a climate point of view is in a profound process of delay. The normative basis regulating the application of the forestry regime in forests in the Republic of Moldova needs amendments with important aspects that would ensure the adaptation process without substantial loss of forest areas and related functions.
8. The development of international cooperation and with donor bodies, in order to ensure the necessary assistance for the implementation of climate change adaptation measures, has a fluctuating character, for some important periods being abandoned or blocked, including for administrative and financial reasons (frequent change of administrations/decision-making staff; non-payment of membership fees, etc.), which undermines, in particular, the initiation and implementation of joint activities.
9. Training forestry staff for capacity building on integrating climate and disaster risks into sectoral policies and sustainable practices associated with climate change adaptation modalities achieved certain results during 2015-2017, with 25-30 events organized annually. Since 2018, this activity has been practically suspended for administrative and financial reasons (organizational problems, lack of funds, etc.), completion of international projects, etc., although due to the quality and major fluctuations of staff in the sector, the action is stringent and very necessary.
10. The communication process by "Moldsilva" Agency and its subordinated structures was not coordinated and permanent, having more of a fluctuating character, the main activities being organized on the occasion of professional or international events (International Day of Forests; Forestry Worker's Day, etc.). This is also due to the fact that the process was not supported by a sector-specific general communication plan, and since 2018 annual plans have also been largely suspended.

1.3 Vulnerability assessments in the country

1.3.1 Impacts, risks and vulnerabilities associated with climate change in the Republic of Moldova

According to national communications 2-4 submitted to UNFCCC, Moldova is particularly affected by three types of climate impacts: Temperature increase, changes in precipitation regimes and increased climate aridity, which are associated with the frequency and intensity of amplification of extreme weather events, such as heat waves and frost, floods, storms with heavy rains and hail, severe droughts. These conclusions are drawn on the basis of projected climate change scenarios, assessments undertaken in national communications 2 to 4 to UNFCCC, together with various other assessments carried out at project level, covering national, sub-national and geographical scale. Those documents shall define the basis for setting medium and long-term priorities for planning, actions and investments in adaptation, together with monitoring the effectiveness of planned and implemented adaptation.

The analysis of national climate data reveals that the frequency of droughts in the Republic of Moldova over a period of 10 years is about 1-2 droughts in the northern part of the country; 2-3 droughts in the central part and 5-6 droughts in the south. It is also mentioned that 7 out of 10 warmest years in Moldova's history were in the last two decades. Historically, Moldova has experienced episodes of drought once every 3-10 years, depending on the geographical location in the country. During 1990-2015, droughts of varying intensity were recorded in Moldova during 12 years (1990, 1992, 1994, 1996, 1999, 2000, 2001, 2003, 2007, 2011, 2012, 2015). It is necessary to note that in 1990, 1992 and 2003, droughts continued throughout the growing season (April to September). The most severe and disastrous droughts during the mentioned period were in 2007 and 2012, affecting over 70% of the country's territory. This dangerous trend continued in the following period, and in 2020, Moldova was hit by one of the most severe drought episodes in the last two decades, which caused a decrease of almost 30 percent in agricultural production, with significant spillover effects throughout the economy, including the compression of household income and consumption. contributed to the general recession and imposed additional tensions on Moldova's budget.

Floods affect Moldova repeatedly. In the last 70 years, 10 major floods of the Dniester and Prut rivers have been reported, three of which occurred in the XXI century (in 2006, 2008 and 2010). Flooding caused by smaller rivers in the country is also quite common. The socio-economic costs of climate change associated with natural disasters such as droughts and floods are significant. Between 1984 and 2006, they amounted to about 61 million US dollars. Droughts in 2007 and 2012 caused an estimated economic loss of about $1.0 billion and $0.4 billion, respectively.

Projected temperature increases, volatility of precipitation and incidence and severity of drought episodes due to climate change could worsen the impact of hydrometeorological disasters in the medium term. Natural hazard events could have a significant impact on Moldova's development trajectory and disproportionately affect poor and vulnerable income groups. Thus, climate change is expected to further intensify the severity and impact of hydrometeorological hazards in Moldova. In line with global climate trends, the likelihood of multi-year droughts is expected to increase and, without proper management, the repercussions could be disastrous for the economy.

The negative impacts of climate change pose challenges to the country's economic growth, directly and indirectly affecting sectors that rely on natural resources (agriculture, water and forestry), but also industrial sectors such as energy, transport, along with the impact on population health. The exacerbating impact of climate change can have repercussions on social and gender equality.

The national policy framework on climate resilience should comprise a range of short- and medium-term reform and investment programmes, including to improve risk identification in Moldova, invest in better risk reduction – both structural and non-structural interventions, improve disaster preparedness and ensure stronger financial protection mechanisms; and updating recovery and resilient reconstruction policies. This framework should gradually shift the focus from 'reactive', ex-post responses to 'proactive', ex-ante risk management. Given the limited financial resources, Moldova should ensure that risk mitigation priorities are properly systematized in existing national programmes (agriculture, forestry, infrastructure, urban planning, flood risk management, etc.), also include financial protection measures in case of climate risks that cannot be fully mitigated.

The draft action plan for 2018-2023 on the implementation of the Sustainable Development Strategy of the forest-based sector refers to objectives and specific actions aimed at adapting to climate change, which includes scientifically justified adaptation measures with clear mitigation co-benefits and approaches to sustainable development, maintenance and adequate monitoring of forest condition, with intensification of afforestation/reforestation process through climate-resistant species. The new version of the Forest Code, aligned with European and international standards, addresses the urgent problems of the forestry sector in the Republic of Moldova: Promoting new practices of sustainable forest management to stop the reduction of forest areas, halting the degradation of forest biodiversity by promoting nature-based forest types with adequate biological diversity; reducing forest land fragmentation processes, stopping unauthorized works and ensuring the integrity of the forest fund; combating illegal logging of forests and related trade by implementing advanced methods of monitoring timber use and forest certification, etc.

For the forest-based sector, sectoral adaptation priorities are to promote the resilience and adaptability of forests to climate change. The following main activities and actions are identified in support of adaptation priorities:

- Implementing the planting of new forest areas resilient to the impact of climate change and capable of efficient carbon capture and biodiversity conservation.
- Planting forest curtains for the protection of agricultural land and water, together with those for anti-erosion purposes.
- Promoting the protection and conservation of existing natural-fundamental forests.
- Application of monitoring of invasive species and phytosanitary regulations to imports or domestic products.
- Facilitating ecological adaptation of forests through ecosystem-based approach.
- Development of methodologies/technologies to ensure the adaptability of forest ecosystems to climate change.
- Modifying forest regeneration practices to climate change adaptation needs.
- Promoting incentives for private sector involvement in forest-based adaptation practices.
- Adapting wood use to the impacts of climate change.
- Promoting cross-sectoral collaboration of the forestry sector with regulators in agriculture, water, local authorities, etc.

- Promoting the restoration of degraded grasslands.
- Promoting awareness and a good understanding of climate change and how the forest-based sector can make a positive contribution.

The prioritization of investment directions in climate change adaptation was carried out as part of the development of the Republic of Moldova's Program for engagement with the Green Climate Fund (GCF), using the methodology of Multi-Criteria Analysis (MCA). The list of adaptation options for each of the key sectors: Agriculture, water resources, human health, forestry, energy and transport was made on the basis of the review of national and sectoral development planning documents, policies and documents related to climate adaptation and sustainable development, studies on climate impacts, risks and vulnerabilities, sectoral adaptation needs and opportunities, and development partners' reports. The consultation process on investment priorities was extensive, using the multi-stakeholder approach, using the experience and perspectives of national experts, generating a common understanding of investment priorities. The consultation allowed negotiation within groups of participants, supporting participatory decision-making and ensuring transparency at each stage of the evaluation process. The prioritisation criteria for adaptation investments include national interests and priorities and have been defined as:

1. Alignment with national climate change adaptation strategies and plans, as well as with national legislation.
2. Contributing to reducing vulnerability at national level and increasing climate-resilient sustainable development.
3. Total number of direct and indirect beneficiaries (women and men).
4. Contribution to transformational adaptation.
5. Contributing to improved economic performance with a high level of environmental, social and gender benefits.
6. Financing needs of vulnerable groups, target population, sectors, development regions, country.
7. Financial and economic feasibility on the basis of which sectoral investment options were prioritized.

Consequently, for the forestry sector, the following financing priorities in climate change adaptation have been established, which provide for the promotion of sustainable management of natural resources through:

- Afforestation/reforestation practices, applying the ecosystem approach;
- Sustainable management of forests and ecosystem services;
- Organic restoration of degraded pastures.

1.3.2 General aspects of forests in the Republic of Moldova and climate change

Current studies and results show that the most promising management practices in terms of adapting to climate change, but also increasing carbon stocks are reforestation and the application of agroforestry practices in tropical latitudes, and in temperate zones – afforestation and reforestation activities. Reforestation and afforestation activities may be feasible as a possible component of an overall carbon management strategy, but to be effective they need to be practiced globally. For the European continent, forest management should be changed more than today if the aim of influencing carbon sequestration is to become paramount. The main emphasis should be shifted towards

expanding forested areas, and for existing forests – more nature-oriented management (reduction of wood harvests, natural regeneration, conservation of fundamental natural arboretums, etc.). The Republic of Moldova has set similar objectives already, in 2001, in the Strategy for Sustainable Development of the Forestry Sector, as well as in other policy documents subsequently approved, and most of the notable achievements focus on the activities of expanding forest vegetation carried out during 2002-2010. At the same time, the forestry sector is an important economic area of the Republic of Moldova, and the expansion of forest areas and forest conservation is an important indicator of the conservation of biological diversity. Currently, at regional and local level, there is a need to address specific actions for different types of forests, taking into account the wide range of natural, social, economic and cultural conditions of forests in the European space: Both the restocking of these forests with trees and reforestation require sustainable forest management in relation to the Forest Strategy for the European Union (2013/2014) and in accordance with the Council of Europe Resolution of 15 December, 1998.

Due to the still low index of afforestation of the territory, in the Republic of Moldova there is intensification of soil erosion and landslide processes, unfavorable change of hydrological regime, continuous aridisation of environmental conditions. Forests are the main element in ensuring ecological balance in this geographical area. Thus, the problem of conservation and sustainable development of existing forests, as well as the expansion of forest lands through afforestation of new areas unsuitable for agricultural use, is a matter of national interest.

The establishment and management of stable and diversified forests that can adapt to climate change are important challenges and will require the implementation of actions to reduce the vulnerability of the forestry sector. Also, capitalizing on the opportunities offered by the forestry sector to mitigate the effects of climate change in other sectors of activity, requires a series of measures applied in the forestry sector, with significant impact on reducing greenhouse gas emissions and a better management of climate change effects in agriculture, water management, infrastructure/communications, prevention of natural disasters, etc.

According to a number of national and international policy documents and reports, the rapid pace of climate change due to human activity exceeds the natural capacity of forest ecosystems to adapt. Thus, some territories within the Republic of Moldova may no longer be favorable to the development of certain types of forests, which will cause changes in the natural distribution of forest species and changes in the growth of existing arboretums. Extreme events such as storms, forest fires, droughts and heat waves are expected to become more frequent and/or severe, thus increasing pressure on forests.

Increasing forest cover contributes to meeting global environmental targets with regard to reducing CO2 emissions to mitigate climate change and increasing the use of renewable energy sources. Through their ecological, social and economic functions, forests provide various goods and services to society, such as wood and non-wood products, recreational areas, landscape beautification, etc., which complement the rationale for intervention through this measure.

Climate change could pose a threat to the biodiversity of Moldova's forests in the following ways:

- Changes in species behavior as a result of stress induced by their ability to adapt;
- Change in habitat distribution and composition, as a result of changes in species structure;

- The rise of exotic (introduced) species in current natural habitats and increasing their potential to become invasive;
- Changing the distribution of wetland ecosystems, with their possible limitation and eventual disappearance;
- Changes in natural ecosystems and their species caused by heating and fires, etc.;
- Tthe disappearance of certain species of flora and fauna.

Changes in climate patterns – including temperature rise, changes in precipitation and reduction in ice and snow – have caused a wide range of adverse effects, causing risks and vulnerability, including:

1. Biodiversity loss: The survival of certain species will be threatened or they will disappear due to habitat loss, ecosystem modification and increased acidity of waters;
2. Extreme weather events: More frequent extreme weather events, causing heat waves, large wildfires, intensifying floods and droughts, stronger hurricanes;
3. Threats to human health: Spread of disease and poor air quality, as well as possible deaths from devastating heat waves.

1.3.3 Risks and vulnerabilities highlighted in the forestry sector

The Strategy for Adaptation to Climate Change until 2020 (NCCAS) and the Action Plan (AP) for its implementation was adopted by Government Decision nr. 1009/2014, in accordance with the Government Program for 2013-2014 "European integration: Freedom, democracy, welfare" (chapter "Environment") and in accordance with the provisions of the Association Agreement of the Republic of Moldova with the European Union (chapter "Climate change"). The strategy is intended to serve as an umbrella programming document that creates an enabling environment for specific sectors to integrate climate change adaptation activities and risk management into their existing and future strategies and action plans, or to develop their own climate change adaptation strategies or action plans. The document establishes the forestry sector as one of those six priority sectors assessed as most vulnerable to climate change.

From the outset, for the forestry sector, the risks highlighted in the NCCAS and their evolution were examined. Thus, according to the data from NCCAS, the main risks and advantages identified at that stage for the forestry sector were established, which are exposed in Table 1.2.

Table 1.2: Risks to the forest-based sector due to climate change

Details on the size of the risks/benefits		NORTH	CENTER	SOUTH
Risks	Change in forest species composition	LOW	MEDIUM	HIGH
	Possible increase in tree mortality	LOW	MEDIUM	HIGH
	Modification of species competition	MEDIUM	MEDIUM	HIGH
	Negative consequences for temperature-sensitive species	LOW	MEDIUM	HIGH
	Change in regeneration rate	MEDIUM	HIGH	HIGH
	Changing the sensitivity of forest species to water scarcity	MEDIUM	HIGH	HIGH

Details on the size of the risks/benefits		NORTH	CENTER	SOUTH
	Change in individual tree density	MEDIUM	HIGH	HIGH
	Increased abiotic destruction caused by fires, windstorms, floods and droughts	LOW	MEDIUM	MEDIUM
	Change of phytosanitary conditions	MEDIUM	HIGH	HIGH
Advantages	Change in biomass production	HIGH	MEDIUM	LOW

According to the analysis, the results of the implementation of NCCAS it is mentioned that the main risks, previously largely established, have materialized. In particular, regarding the change in the sensitivity of forest species to water scarcity and the increase in abiotic destruction caused by fires, wind storms, floods and drought (especially as a consequence of the decrease in water flow and the draining of several water basins, as a result of drought in recent years (in particular, AA. 2019-2020). In support of these conclusions are the following statistical data recorded in the evolution of the state of forests during the period 2015-2020:

- The Area of arboretums affected by forest diseases and pests (Lymantria disappear; Stereonychus fraxini; Tortrix viridana, etc.) – on average about 78.9 thousand ha/year or 21.8% of the total area of forests of the Republic of Moldova.
- The area of arboretums affected by fires – on average about 185 ha/year, cumulative over the period – 1.11 thousand ha or 0.3% of the total area of forests of the Republic of Moldova.
- The area of arboretums affected by drying – on average about 11.0 thousand ha/year or 3.7% of the total area of RM forests; cumulative period – 65.7 thousand ha.

At the same time, it is necessary to mention that the real area of forest fires is much higher, especially on land managed by LPAs, because an important part of wildfires are not registered due to the faulty system of registration and liquidation at local level. Also, the system for detecting and recording outbreaks of forest diseases and pests has many gaps, which generate the delay of control measures in the primary phases, when it would be possible to solve it with minimal technical and financial resources, but also with non-essential consequences on the biological resistance of arboretums to damaging climatic factors. Another important aspect is that about 64% of the total area of forests affected by dryness (pedunculate oak, holm, fluffy oak). Among the main causes of this situation is the origin from shoots of most oak arboretums (pedunculate oak (Quercus robur) – 55%, sessile oak (Quercus petraea) – 86%, downy oak (Quercus pubescens) – 98%).

1.4 Selection of priority sectors for climate change adaptation

In the last 127 years (1887-2014), changes in average temperatures and precipitation have occurred in the Republic of Moldova. RM became warmer, with an average increase in temperatures greater than 1.0°C, while the increase in precipitation was only about 54.7 mm. The early 1980s is generally considered a "turning point" in the long-term air temperature curve, where human influence on the atmosphere is most distinctly expressed (IPCC, 2007); this has been statistically confirmed by both international studies (Gil-Alana, 2008) and national studies (Corobov et al., 2013; Taranu, 2014). The temperature increase is evident (from an average annual value of 8.5°C in the north to 10.3°C in the south), followed by a decrease in the amount of annual precipitation, respectively, from 622 mm to

508 mm. The increase in temperatures on the territory of the Republic of Moldova during 1981-2010 no longer offers any room for doubt and is very evident during the warm period, especially in summer, when the average T increases by 0.9-1.0°C and Tmax - by 0.9-1.3°C/decade with a very high degree of certainty.

According to available studies and information, Moldova is very vulnerable to climate variability and change. For the period ahead, the impact of climate change is expected to intensify as changes in temperature and precipitation affect economic activity, and socio-economic vulnerability to these changes is extremely high. The socio-economic costs of climate-related natural disasters such as droughts, floods and hail are significant and both their intensity and frequency are expected to increase further as climate change has resulted. Adaptation is relevant for many sectors of Moldova's economy, but when it comes to operationalizing it, at district or country level, institutions may be overburdened by coordination, integration and monitoring requirements.

The existing policy framework is usually not designed to promote the integration of future climate projections and their uncertainties with sectoral priorities and measures at different levels and within different organizational structures and stakeholders. Communities operate at different spatial and time scales, have different priorities, and may need different incentives to increase their capacities to respond to climate change. Climate change is increasingly recognized as a fact of national importance, but so far the national strategic framework lacks integrated climate change adaptation measures. Therefore, a strategic framework is needed at national level to ensure that a qualitative, efficient and coherent process of adaptation to climate change takes place.

Regarding the forestry sector, it is mentioned that forest ecosystems (represented by forests and other forest vegetations) cover about 499 thousand ha or about 14.7% of the territory of the Republic of Moldova, having an extremely important role in the protection of river basins, soils, land, infrastructure, etc. At the same time, forest ecosystems provide a wide range of direct and indirect economic and environmental benefits to rural communities: Firewood, non-wood products, stabilization of landforms, landscape improvement, and many other benefits. Fuel wood is particularly important for poorer rural households, who cannot afford high energy costs for gas and electricity.

The researchers expect that even small changes in temperature and precipitation could greatly affect the growth and survival of forests in the future, especially such as forests in Moldova. Climate change would impact future moisture conditions in forests through changes in both temperature and precipitation. As the temperature rises, water losses through evapotranspiration increase, resulting in drier conditions. Higher temperatures also tend to decrease the efficiency of water use by plants. In some areas of the RM, future decreases in precipitation will accentuate the moisture stress caused by warming. There will also be important changes in precipitation seasonality and the occurrence/accentuation of extreme events, such as droughts and heavy rainfall.

For the forestry sector in the Republic of Moldova, the following are among the main risks considered to be priorities:

- Negative consequences for species sensitive to temperature changes.
- Changes in the rate of regeneration.
- Changes in species sensitivity to lack of water.
- Changes in individual tree density.
- Changes in phytosanitary conditions.

- Changes in species composition.
- Possible increase in tree mortality.

Measures to adapt forests in the continental-temperate bioclimatic zone, which also includes the Republic of Moldova, are very versatile. Current and planned research includes adapted planting material, biotic and abiotic damage, biodiversity, in particular genetic diversity, forestry treatments and protective functions of forests. Measures at stand level (regeneration of arboretums; care and management of arboretums; harvesting/harvesting of wood, etc.) aim to reduce the risks of abiotic disturbances, i.e. fire, wind, drought, as well as biotic disturbances, i.e. pests and pathogens. The construction of stable and diversified forests is an ongoing measure and is planned to improve stand stability by selecting appropriate species, provenances and genotypes.

The process of prioritizing sectors was based on the following aspects:

- Data from previous vulnerability assessments of countries and sectors showing climate vulnerabilities changing each sector.
- Adaptation potential of sectors.
- How improvements (technologies potentially deployed) in selected sectors can contribute to achieving the country's development priorities.

This process used data on the country's vulnerability to climate change, long-term impact on the country, social, economic and environmental development, data collected from vulnerability assessments in national communications (I-IV), as well as various thematic evaluation reports carried out in the previous period. As a result, the following sectors were selected as key sectors: Transport; energy; health; water resources; forestry.

Chapter 2. Institutional arrangements for TNA and stakeholder involvement

Moldova's institutional arrangements on climate change and adaptation need significant improvement. Given the complexity and multidisciplinary nature of climate change, a number of institutions each focus on different aspects of this issue and the challenges associated with it. However, in order to address climate change effectively and systematically, formal coordination structures between relevant ministries are needed to ensure a better overview of climate policy. The Ministry of Finance would also be an important actor in setting up and supervising such a structure, given its critical stance on resource allocation.

In the Republic of Moldova, the Ministry of Environment (MoE) is responsible for developing and promoting public policies in the field of environment and climate change, management and use of natural resources and waste management. Apart from the ministry, its subordinated institutions (Moldsilva Agency, Environment Agency, Apele Moldovei Agency, Inspectorate for Environmental Protection, State Hydrometeorological Service, etc.) are directly involved in the implementation of policies and legal framework related to environmental protection and climate change. MoEnv will be involved in the dialogue with the Ministry of Infrastructure and Regional Development on the full integration of climate change issues in the transport and energy sectors, as well as in conducting

regular dialogues with local public administrations (LPAs), private sector, academia and NGOs to ensure their awareness and involvement in the implementation of project activities.

The existing national institutional framework lacks a clear separation of functions on forest and climate change management issues. Institutional instability is felt at all levels, and human resources in the field are insufficient to develop and promote the regulatory and policy framework. The existing institutional framework, as well as the institutions and organizations directly involved in the activity of the forestry sector in the Republic of Moldova are: The central public authority responsible for forestry (Ministry of Environment), the administrative authority for forestry (Agency "Moldsilva" with subordinated entities), administrative authorities responsible for issuing permissive acts and state control (Environment Agency/MA; Inspectorate for Environmental Protection/IEP), local public authorities (LPAs) that own land with forest vegetation, other institutions that own small areas of forest land (e.g. the central public authority responsible for road and rail transport infrastructure), etc. The main tasks of authorities responsible for forest management and climate change are set out in Table 1.3.

Table 1.3: Analysis of the main tasks of authorities responsible for forestry and climate change

Nr. d/o	Categories of institutions/authorities	Basic tasks and parameters, including climate change adaptation/mitigation
1.	Ministry of Environment (MoEnv)	The central public authority responsible for developing, promoting and implementing state policy in the fields of environmental protection and climate change, biodiversity conservation, rational use of natural resources, etc., including forestry and hunting. Operates according to the Operating Regulation approved by GD nr. 145/2021. Within the MoEnv there are two directorates with responsibilities to the forestry sector and climate change: Biodiversity Policy Directorate (5 units); Air Policy and Climate Change Directorate (5 units). Currently, 4 people are employed in both directions, which is insufficient to cover the entire spectrum of environmental issues, including forests, protected areas, biological diversity, climate change, etc.
2.	Agency „Moldsilva" (Moldsilva)	Institution subordinated to MM, operates on the basis of the Organization and Functioning Regulation approved by GD nr. 150/2010. Subordinated to the Agency "Moldsilva" are 24 state enterprises and two public institutions (Orhei National Park, Lower Prut Biosphere Reserve), including the Institute for Forest Research and Management (FRMI), with 2 subdivisions: Center for Forest Management and Center for Development and Technology Transfer. The forestry enterprises consist of 80 forest districts with 187 foreman sectors and 1068 forestry cantons. Moldsilva carries out the direct management of the state-owned forest fund (337.7 thousand ha or 75.3% of the total) and an important part of the natural areas protected by the state; participation in forest-related policy-making; implementation of forestry policies; developing and implementing measures to ensure forest conservation and development, including adaptation to climate change. Within the central apparatus of the Agency "Moldsilva" are the responsible directorates: Forest Fund Department, Protected Areas and Forest Regeneration; Forest Protection and Forest Guard Section; Service of valorization of forest products and forestry tourism.
3.	Environment Agency (MA)	Institution subordinated to MoEnv operating according to GD no. 549/2018, is responsible for implementing the provisions of policy documents and international environmental treaties to which the Republic of Moldova is a party in the field of quality and protection of atmospheric air and ozone layer, in the field of reducing greenhouse gas emissions and adapting to climate change, develops and submits information on their achievement. The MA is invested with functions of environmental authorization, implementation of environmental legislation, harmonized to European Union legislation and new environmental instruments established therein such as environmental impact assessment from economic activities, strategic environmental assessment, integrated environmental monitoring, etc. Performs the issuance of permissive documents for the practice of entrepreneurial activities with an impact on the environment (authorizations, environmental agreements, permits, certificates, notifications, notices and coordination); carrying out quality monitoring of environmental

Nr. d/o	Categories of institutions/authorities	Basic tasks and parameters, including climate change adaptation/mitigation
		factors (monitoring of forests and natural areas protected by the state; monitoring of the plant and animal kingdoms, etc.); creation and administration of cadastre and special registers, administration of the information and data system for its fields of activity and ensuring public access to environmental information. The MA is subordinated to 2 territorial subdivisions: The North Environment Agency and the South Environment Agency, with the status of directorate and the responsible directorates/sections in the field concerned: Environmental Quality Monitoring Directorate; Natural Resources Monitoring Directorate; Integrated Environmental Information Management Directorate; Environmental reference laboratory (Directorate-General); Air quality laboratory.
4.	Inspectorate for Environmental Protection (IEP)	Institution subordinated to MoEnv, which operates according to GD nr. 548/2018 as an administrative authority empowered to carry out exclusively state supervision and control in the field of environmental protection and use of natural resources, preventing and counteracting violations in the areas of competence. IEP is subordinated to 35 territorial subdivisions: (inspections) and directorates of the central apparatus responsible in the field concerned: Control Directorate for water resources management and atmospheric air; Directorate for forest fund control, protected natural areas and green spaces.
5.	Local public authorities of level I and II (LPAs)	Operates according to the Law on Local Public Administration, nr. 436 of 28.12.2006. Performs direct management of forest vegetation (forests, protective forest curtains, green spaces) owned by ATU (82.7 thousand ha forest fund or 18.5% of the total); regulation of the process of using forest vegetation (carrying out forestry uses; cadastral records, etc.).
6.	Ministry of Infrastructure and Regional Development/MIDR (Moldovan Railways/RWM; State Administration of Roads/SRD)	MIDR, through subordinated institutions (RWM and SRD) ensures the management of forest vegetation with functions of protection of road and railway infrastructure (3.6 thousand ha); performing forestry uses; guarding and protecting forest vegetation, etc. These activities are carried out in accordance with the Railway Transport Code, no. 309/2003; Road Law. No. 509/1995; GD nr. 678/2001 – SRD, etc.
7.	Ministry of Education and Research (MECR)	Research and education institutions with biological/environmental profile subordinated to MECR (National Botanical Garden (Institute)/NBG; Institute of Ecology and Geography/IEG; Institute of Genetics, Physiology and Plant Protection/IGPPP; State University of Moldova/SUM; State Agrarian University of Moldova/SAUM; Free University of Moldova/ULIM etc.) carries out fundamental education and research for the forestry sector.
8.	Forestry/ecological non-governmental organizations (NGOs)	NGOs make an essential contribution to solving problems of forest protection and biodiversity conservation (about 200 environmental NGOs), which actively participate in the implementation of projects in the targeted areas; promoting public awareness actions; conducting applied research with reference to the state and development of forest ecosystems, etc.

2.1 TNA national team

The TNA National Team includes a TNA Coordinator as well as a wide range of stakeholders to constitute the NAP2/TNA Coordination Board and national consultants/experts organized in working groups. The NAP2/TNA Coordination Council is envisaged as the highest decision-making body of the TNA Project, comprising decision-makers from relevant key ministries. As shown in Figure 2.2, as well as in the detailed description provided below, each element of the institutional set-up in the country is designed to play an important role in the process of implementing and promoting the NAP2/TNA project.

The TNA National Team is the main decision-making body for the project, with the TNA Coordinator acting as a national focal point. The TNA national team is composed of a small core group (project manager, assistant, etc.) as well as a broader group of stakeholders and experts, who help the core group. This broader group includes national consultants and sectoral/technology working groups. The TNA coordinator will play a key role and coordinate between the different groups to ensure they work together as a team.

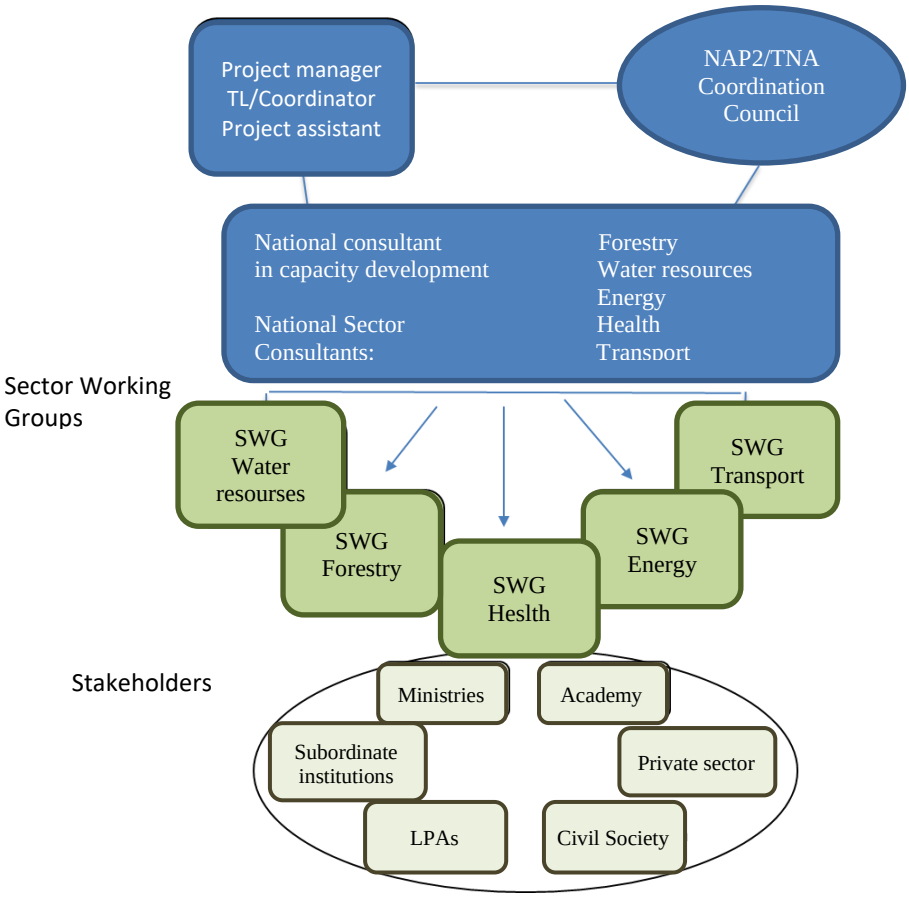


Figure 2.2: Institutional arrangements of the TNA component

The appointment of the TNA Coordinator was made by the Ministry of Environment (representation of MoEnv, performs functions of UNFCCC focal point, etc.). The TNA coordinator is the focal point for the effort and management of the entire TNA process. This involves providing vision and leadership for the overall effort, facilitating communication tasks with NAP2/TNA Coordination Board members, national consultants and stakeholder groups, networking, information acquisition, and coordination and communication of all work products.

The NAP2/TNA Coordination Council is the core group of decision-makers and includes policy implementation representatives from the ministries involved, members familiar with national development goals, sectoral policies, climate change science, potential impacts of climate change for the country and adaptation needs. The NAP2/TNA Coordination Board is to provide project leadership in association with the TNA Coordinator. The specific responsibilities of the NAP2/TNA Coordination Board shall include the following:

- Identification of national development priorities and priority sectors.
- Decision on setting up sectoral/technological working groups.
- Approval of adaptation technologies and strategies that are recommended by sectoral working groups.
- Endorse the Technology Sector Action Plan (a roadmap of policies that will be needed to remove barriers and create an enabling environment) and develop the Technology Action Plan for Adaptation.

The Technology Needs Assessment (TNA) is central to the work of the Parties to the UNFCCC and represents an opportunity to track the evolving need for new equipment, techniques, practical knowledge and skills that are needed to reduce the vulnerability of sectors and livelihoods to the adverse impacts of climate change. In this context, UNDP Moldova has recruited a team of five national experts to support the participatory adaptation process at national level in the water, health, transport, energy and forestry sectors. The results of their mission will contribute to achieving Moldova's adaptation goals declared in the updated NDC (2020), while meeting national targets for a number of SDGs: 13, 7, 9, 3, 15, 6. The experts employed under the TNA project have in-depth knowledge and extensive experience in the field of climate change. Most experts have participated in other climate change projects, especially in national communications, which is of great benefit for the TNA assessment. The involvement in TNA evaluation of high-level professionals from different sectors ensures a multidisciplinary team, led by the TNA National Coordinator.

The role of national consultants is to lead and undertake activities such as research, analysis and synthesis in support of the TNA exercise. The leadership of the national working group of consultants/experts on the TNA component was ensured by Dr. Druta Ala. The national consultants worked closely with the NAP2/TNA Coordination Council and other working groups involved in the NAP2 project.

National consultants applied a participatory approach in TNA to the CCA of assigned sectors, involving a wide range of stakeholders and ensuring a multisectoral and multidisciplinary scope. In close cooperation with the TNA working group leader, national consultants supported and facilitated the activities of sectoral working groups (SWGs), ensuring communication with stakeholders on working products, etc. The core tasks assigned to the TNA Expert/Consultant Group shall include the following:

- Identify priority technologies for climate adaptation of assigned sectors (water, health, transport, energy, forestry) by providing an overview of possible adaptation technological options, highlighting their adaptation potential based on identification of sectoral vulnerabilities and currently applied technologies.
- Preparation of the TNA Report according to the established technological prioritization steps.
- Elaboration of the Report on conducting the analysis of barriers and proposing the framework of activity for the implementation and dissemination of the first three priority technologies in the sector (including market and barrier analysis for the development, implementation and dissemination of priority technologies; production of market maps and problem trees for each prioritized technology; identification of measures to overcome barriers, etc.).
- Perfecting action plans for each prioritized technology (TAP).
- Elaboration of sectoral reports on TAPs and compilation of sectoral technology roadmaps on SACs.

- Formulating, based on TAPs, project ideas (IP) for prioritized technologies.

The tasks and areas of activity of the national consultants employed in the TNA Working Group are generalized in Table 2.4.

Table 2.4: Context of national consultants contracted under the adaptation component of the TNA project

National consultants	Title, position, institution	Area of competence
Druta Ala	PhD in Biology, Team Leader	National adaptation team leader in TNA project
Comendant Ion	PhD technical sciences, coordinating scientific researcher, Energy Efficiency and Renewable Energy Sources Laboratory, Institute of Power Engineering	National capacity development consultant within the TNA component
Șalaru Ion	Deputy Director, National Agency for Public Health	National consultant on the health sector
Lupu Mihai	Head of Energy Efficiency and Renewable Energy Sources Laboratory, Institute of Power Engineering	National consultant on the energy sector
Bejenaru Gherman	PhD in Geography, associate professor, Tiraspol State University	National consultant on water resources sector
Soloviov Nicolae	Coordinating scientific researcher, Energy Efficiency and Renewable Energy Sources Laboratory, Institute of Power Engineering	National consultant on the transport sector
Talmaci Ion	Technical Deputy Director, Institute for Forest Research and Management	National consultant on forestry sector

2.2 Stakeholder engagement process followed in TNA – overall assessment

Forests are one of the main renewable natural riches and are of particular strategic importance for the Republic of Moldova. Forests have profoundly influenced the lives of our people through the ages. In the beginning, serving as a source of food and shelter, throughout history society's needs have evolved from wood production to more complex activities with multiple goals – ecological, social and economic. The involvement of a large number of actors and beneficiaries of forest products and services requires the presence of an institutional framework capable of managing the situation and challenges. The vision of the Environmental Strategy for 2014-2023 (adopted by GD 301/2014) is to create a functional system (institutional, administrative, management) adjusted to EU policies and to ensure a sustainable environment. Figure 2.3 shows the multitude of users of forest products and services.

Figure 2.3: Structure of actors involved in the ownership and use of forest and hunting resources

An important element in assessing technological needs in the field of climate change adaptation is to carry out stakeholder mapping for the forest-based sector. This action started with the identification of parties/institutions interested/involved in the activity of the forestry sector in the Republic of Moldova. The current overall organizational chart of the stakeholders involved in the forestry sector in the Republic of Moldova is shown in Figure 2.4.

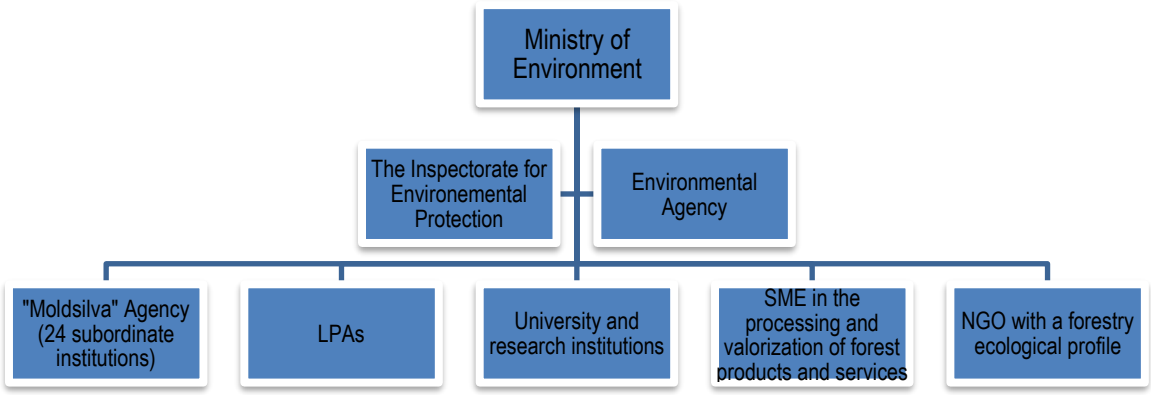


Figure 2.4: Current overall organizational chart of stakeholders in the forestry sector in the Republic of Moldova

As a result of the analysis of the existing institutional framework, as well as of the beneficiaries of forest services/products, the institutions and organizations directly involved in the activity of the forestry sector in the Republic of Moldova are: The central authority responsible for environmental protection (MoEnv), the Agency "Moldsilva" with subordinated entities, administrative authorities responsible for issuing permissive acts and state control (Environment Agency; Environmental Protection Inspectorate), local public authorities owning land with forest vegetation, other institutions owning small areas of forest land, etc. Finally, stakeholders for the forestry sector were identified

from 7 categories of institutions/authorities, which in turn are divided into different specialized entities/subdivisions:

1. Ministry of Environment (MoM).
2. Agency "Moldsilva" (forestry enterprises; nature reserves; FRMII).
3. Environment Agency.
4. Environmental Protection Inspectorate.
5. Universities and research institutions.
6. Local public authorities/Congress of Local Authorities of Moldova (district councils; local councils; mayoralties).
7. Non-governmental organizations with forest/ecological profile.

Stakeholder consultation was an ongoing process throughout all phases of the project. Their consultations and views in providing technological details about the current situation in sectors was of particular importance, including the use of new technologies. Stakeholders have an important contribution in developing the final set of criteria and indicators used to prioritize technology options. Extensive discussions have been developed to consider different technology options in adapting the forestry sector to climate change. Also, important arguments were raised during the exercise of awarding the weighting of criteria, as the members of the working group judged according to their knowledge, interests, other considerations. During these discussions, stakeholders' views and arguments were considered decisive in establishing the short list of adaptation technologies.

Stakeholders are essential in the TNA process. Therefore, in order to give an active role to stakeholders in the TNA process, sectoral working groups (SWGs) have been set up, including on the forestry sector. On a sector-by-sector basis, working groups decide on appropriate technologies for the sector, carry out market/barrier analyses and recommend an enabling framework for the sector.

For the forestry sector, SWG consisted of 17 members, including the NAP2 national consultant on the forestry sector. The composition of SWG, as well as the authorities/institutions it represents, is set out in Annex no. 3 to this Report. Within the TNA process for the forestry sector, SWG was involved as a priority in the following actions/activities:

- Participation in identifying the long list of technologies/measures to adapt the forestry sector to climate change (21 technologies/measures).
- Primary selection/prioritization of efficient technologies/measures to adapt the forestry sector to climate change (12 technologies/measures; organization of the workshop on 06.08.2021).
- Participation in the MCA analysis for the final prioritization of technologies/measures for adaptation of the forestry sector to climate change (evaluation of 10 technologies/measures; selection of evaluation criteria; scoring; organization of the workshop on 02.12.2021; validation of results regarding the selection for the forestry sector of 2 technologies/measures for adaptation to climate change, etc.).

2.3 Taking gender aspects into account in the TNA process

Forests make a significant contribution to the development of humanity, providing it with livelihood resources. Currently, it is estimated that about 1.2 billion people depend on agroforestry systems. Identifying and addressing the needs of women and men is critical to ensuring the success of forestry policy. Respectively, gender mainstreaming in forestry-related policies can increase their

effectiveness. In this context, an important element in the TNA process is the gender aspect. Because effective gender mainstreaming in climate change adaptation requires planning and resources to ensure that the overarching principles are translated into action. Thus, the TNA process included the following gender-sensitive approaches:

- Analysis of differentiated impacts of proposed interventions on women and men.
- Full recognition of the different needs of women and men, based on consultations that intentionally seek advice from both women and men.
- Recognizing the respective potential of women and men to play an active role in contributing to adaptation to climate change.
- Recognizing the need to address institutional barriers that limit women's participation in planning and implementing climate change adaptation.
- Recognizing the potential of women and men to participate in technology transfers.
- A focus on context-based gender mainstreaming that is anchored in local systems.

Overall, the Sustainable Development Goals (SDGs) launched at the UN Sustainable Development Summit in New York (September 2015) contain two elements that are relevant and explicit to the gender aspect. One is SDG 13, which requires urgent action to combat climate change and its impacts. It is, therefore, at the heart of TNA's mission. Secondly, and central to the gender aspect, is SDG 5, which focuses on achieving gender equality and empowering all women and girls. SDG 5 calls for women and girls everywhere to have equal rights and opportunities, to be able to live free from violence and discrimination. SDG 5 has a number of key objectives, which include the following:

- End all forms of discrimination against all women and girls everywhere.
- Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual exploitation and other types of exploitation.
- Eliminate all harmful practices such as child, early and forced marriage and female genital mutilation.
- Recognize and value unpaid care and domestic work by providing public services, infrastructure and social protection policies and promoting shared responsibility within the household and family, where appropriate, at national level.
- Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.
- Ensure universal access to sexual and reproductive health, reproductive rights, as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences.
- Undertake reforms to grant women equal rights to economic resources, as well as access to ownership and control over land and other forms of ownership, financial services, inheritance and natural resources, in accordance with national laws.
- Improve the use of enabling technologies, in particular information and communication technology, to promote women's empowerment.
- Adopt and strengthen applicable policies and legislation to promote gender equality and empower all women and girls at all levels.

Due to sectoral specificities (harsh working conditions; living and working in the forest away from localities, etc.), gender aspects are less reflected in forest policy and management documents. The share of women in the structure of forestry, technical and engineering personnel is below 20%. Gender

balance is relatively normal in functions ancillary to the forestry sector: Economists, accountants, human resources inspectors, etc. This situation materializes starting with the enrolment in college, largely keeping the trend at the stages of employment and activity in the sector.

For activities in forest ecosystems, women work especially in forest seed harvesting, nursery, planting works and care/maintenance of forestry crops, on these compartments women have a share of over 70%. Within the state forestry sector there are certain incentives related to the temporary or permanent employment in the sector of spouses of technical personnel (forest foremen, foresters, etc.). The main challenges with regard to gender equality in the forestry sector relate to the following aspects:

a) Rural women and men often have dispersed knowledge of forest resources and play different roles in forest management and plantations.
b) Women follow the traditional practice of using agroforestry production systems, such as growing fruit and vegetables in the garden, harvesting and selling wood and fruit, individually or in small businesses. They are primarily responsible for collecting firewood, for home use, as well as plants/berries for food and treatment.
c) Men are much more involved in more expensive and large-scale activities, such as logging and woodworking. However, gender roles are changing, for example, with more and more men making brooms out of sorghum and weaving baskets out of twigs, engaging with women in craft activities.
d) Vulnerable groups, such as poor women, especially older women in rural areas, often face energy-related obstacles (wood collection, which also requires time and labor; fuel scarcity) and health problems caused by burning and collecting wood – they are primary energy producers and its users in the household.
e) The predominance of neo traditionalist ideas, which treat women only in the context of domestic roles, motherhood, limit their life opportunities, etc. The lack of gender impact assessment on forest policy leads to incomplete assessments of the situation and underestimation of risks, impact of actions on women and men, etc.

Incorporating the gender dimension into policies and planning in the forest-based sector is essential in ensuring the effectiveness of development programs and all development activities involving the consumption of forest-related benefits (Figure 2.5). Gender-based constraints related to access to forest services and products, training, employment and entrepreneurship need to be better studied and addressed. Women are often responsible for collecting small wood, fodder and raising livestock. Improving the process of providing firewood and fodder can reduce the amount of time women spend collecting feed and feeding animals, it also helps reduce women's daily household tasks, giving them more time for other activities, improving health and strengthening livelihoods.

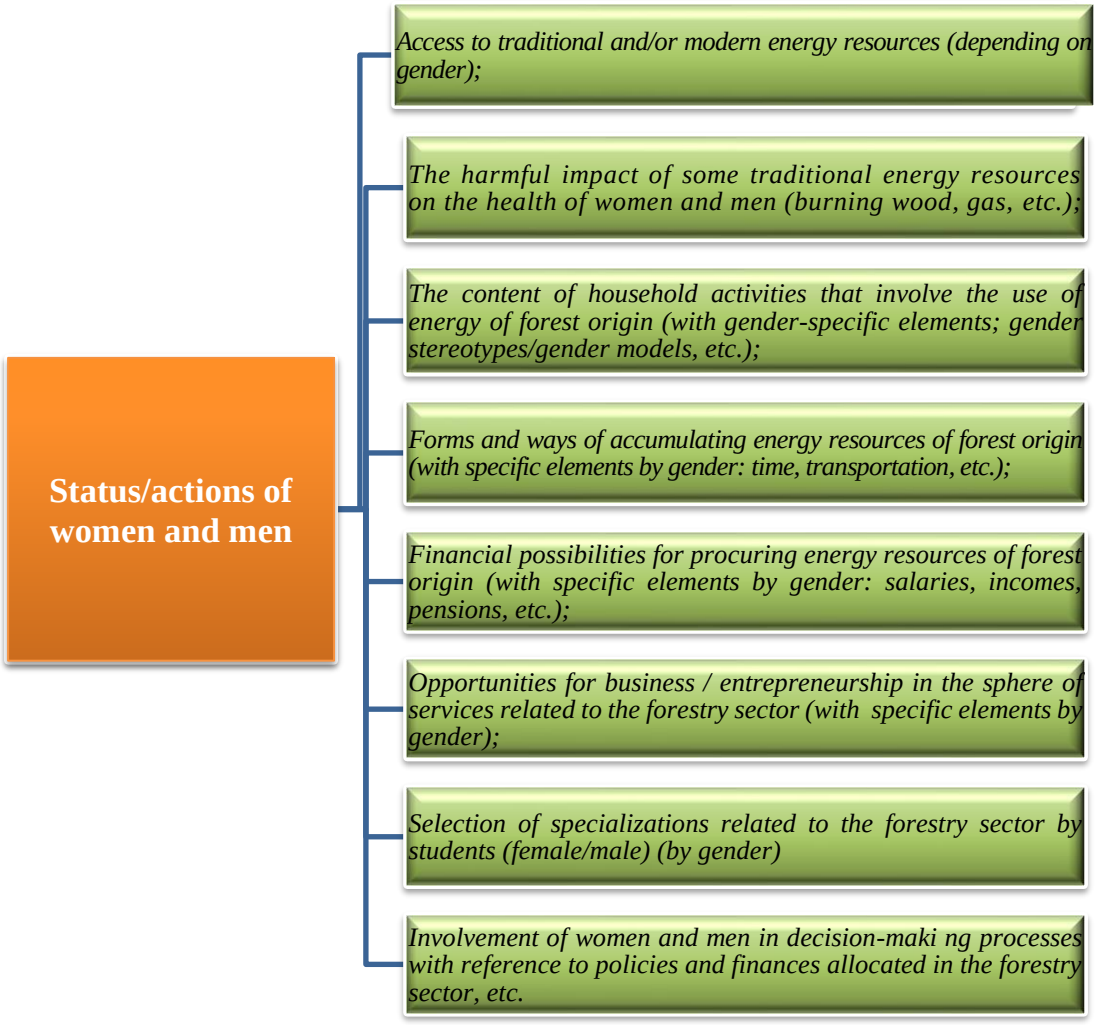


Figure 2.5: Gender elements in the forestry sector in the Republic of Moldova[2]

In the process of prioritizing technologies/measures for adaptation of the forestry sector to climate change, the gender aspect was also pursued. Thus, in the structure of the criteria for assessing technologies/measures for adaptation of the forestry sector to climate change (15 criteria) is included a criterion dedicated to this field – Criterion P. Impact on gender equality. Also, 61.5% male and 38.5% female respondents participated in the sectoral prioritization of adaptation technologies/measures (Figure 2.6). It can be considered an acceptable ratio, taking into account the specificities of the forestry sector in this compartment.

[2] Valentina Bodrug-Lungu (2015), *Guide on gender mainstreaming in forestry in the context of climate change.* Climate Change Office, Ministry of Environment, 16 p.

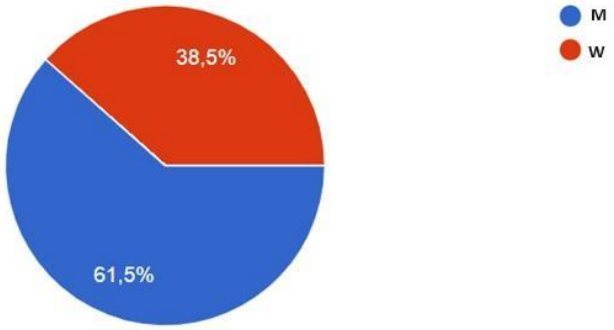


Figure 2.6: Results of the forestry sector questionnaire on the gender of respondents

The proposed technological options for adapting the forest-based sector to climate change do not affect gender equality. Women, along with men, will be widely involved in the implementation process in most stages and activities: Harvesting seeds of trees and shrubs; growing seedlings in forestry nurseries; planting seedlings; care and maintenance of forestry crops; harvesting non-wood products (fruits, berries, medicinal plants), etc. Also, wood production harvested as a secondary result of sustainable management of newly created and/or rehabilitated forests contributes to improving living conditions and domestic comfort in neighboring localities.

Chapter 3 Prioritizing technology for the forestry sector

3.1 Key climate change vulnerabilities in the forest-based sector

3.1.1 State of play of the forestry sector in terms of climate change

Forests in the Republic of Moldova have suffered a series of damages due to biotic and abiotic causes. Moreover, the impact of climate change, which has a clear latitudinal effect through rising temperatures and drought, especially in the south of the republic, is already observable. The flora species of the southern zone already suffers as a result of decreasing precipitation and increasing temperature. Climate change certainly leads to increased biotic damage, tree species becoming more susceptible to pest attacks (oak stands, ash, willow, elm, etc.). The development and maintenance of compositionally diverse and climate-adapted forests is a significant challenge and will require urgent research into species selection, adaptive provenances and genotypic studies of native species.

The analysis of the current horizontal structure of forests in the Republic of Moldova (Figure 3.7) shows that the species with a higher surface than the others is acacia, with a share of 33.1%. The cvercinee (oak stands) account for 28.7% (pedunculate oak – 14.8%, oak – 12.0% and downy oak – 1.9%). The species with a share of over 3% are: ash – 7.8%, hornbeam – 5.3%, linden – 3.5% and walnut – 3.1%.

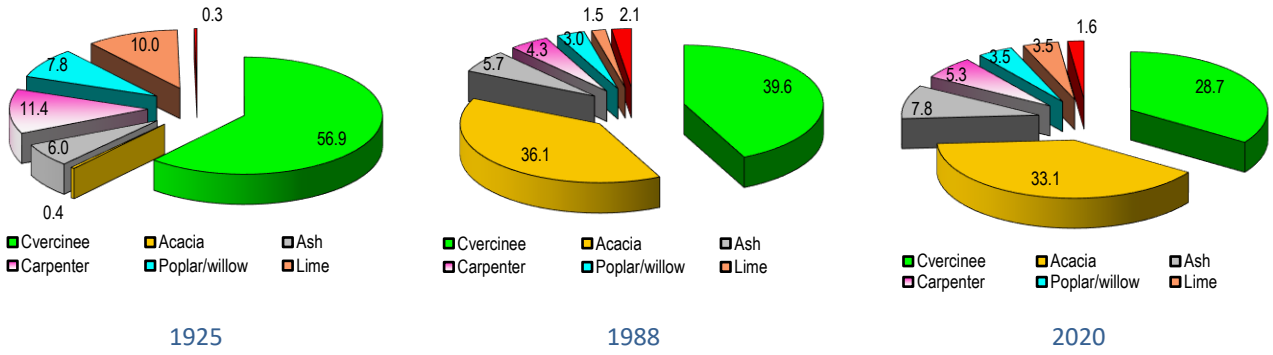


Figure 3.7: Evolution of forest composition on the territory of the Republic of Moldova[3]

According to Figure 3.7, about one third of the arboretums in the forest fund managed by state forestry bodies are made up of artificially introduced species, which do not fit into the natural ecosystems of Moldova. During 1989-2020, the total area of cvercinee (oak stands), although increased by about 20 thousand ha, their participation in the forest structure was LOW by 10.9%. At the same time, it is mentioned that this is a general trend in the structure of Moldova's forests recorded during the last 90 years. Thus, the total forest area increased from 234.2 thousand ha in 1925 to 370.7 thousand ha in 2020 or +136.5 thousand ha (+58%). Against the background of this increase, the share of oak stands halved, with a considerable increase in the share of acacias and softwoods. These changes were partially influenced by the events of 1944-1945, when the territory on which the Republic of Moldova is located today also underwent some administrative changes.

Other indicators characterizing the current forests in the Republic of Moldova:

- General average production class – 3.9 (including oak – 2.8, fluffy oak – 3.0, linden, white poplar – 3.1, ash – 3.4, oak/hornbeam – 3.6, etc.).
- Overall mean consistency – 0.76.
- Total standing timber volume – 45407.8 thousand m3, equivalent to an average volume per hectare of 118 m3, achieved at the average age of 45 years. The current average growth of forests is 3.8 m3/year/hectare, and the total average growth is about 1418.2 thousand m3/year. According to the volume stored on stilts, the oak stands hold about half of the total volume (49.0%). An average volume per foot higher than the general average registers the following species: linden – 238 m^3/ha, oak – 234 m3/ha, ash – 195 m^3/ha, oak – 184 m^3/ha, hornbeam – 152 m^3/ha.

Another aspect necessary to mention is that according to the main characterization indicators (current average growth; average standing timber volume, etc.), forests in the Republic of Moldova achieve lower values compared to forests in neighboring countries, Romania (current average growth: -23.9%; average standing timber: -65.3%) and Ukraine (current average growth: -5.0%; average standing timber volume: -45,9%).

The comparative analysis of creditworthiness of forest stations, productivity of forest types, as well as current productivity of stand elements, reveals some deviations with negative trends for forests in

[3] Demetrescu Ilie C. (1926), *From forest statistics*. Editor "Progresul Silvic" Society, Magazine Pădurelor nr. 3, Bucharest, pp. 147-150; Украинское лесоустроительное предприятие (1988), *Лесной фонд Молдавской ССР по учету на 01.01.1988*. Ирпень, 345 p.; Ion Talmaci, Erii Prosii, Ala Mardari, Alexandru Varzari, Alexandru Galupa (2018), *Forests of the Republic of Moldova, current state, qualitative and quantitative indicators*. Magazine Pădurelor, nr. 3/2018, SC Magic Print SRL, Onesti. pp. 7–20. ISSN 1583-7890.

the Republic of Moldova (Table 3.5). Thus, the current average production class is about 13% below the potential indicator (CLP – 3.4). This will only be achieved through profound improvement of forest management, including gradual substitution (including ecological restoration) of degraded, inadequate arboretums, etc. These activities require substantial institutional and financial efforts, which are currently insufficient and difficult to identify. The development and promotion of internationally funded projects is a sure way to solve problems related to finance and transfer of new technologies.

Table 3.5: Comparative analysis of the capitalization of the station potential by current forests[4]

Indicators	Categories of lower Creditworthiness/productivity		
	Superior	**Medium**	Inferior
Creditworthiness of resorts (%)	15,5	42,6	41,9
Productivity of forest types (%)	13,7	43,6	42,7
Current productivity of species/arboretums (%)	9,4	33,8	56,8
Current average production class	3,9		
Potential average production class	3,4		

The establishment of stable and diversified forests is a continuous measure and is planned to improve the stability of arboretums by selecting appropriate species, origin and genotypes. The current requirements to increase forest productivity and the development of the forest economy in terms of CCA in the Republic of Moldova require ensuring the production of high-quality planting material. In fact, according to the data of various activity reports of the national forestry sector, it is confirmed that forest nurseries currently grow forest reproductive material, without relying on the requirements of EU standards and international treaty data on adaptation to climate change. The generalized analysis of vulnerabilities associated with climate change for forest ecosystems in Moldova is presented in Table 3.6.

Table 3.6: Vulnerabilities found/predicted for forest ecosystems in Moldova associated with climate change

Impact category	Impact on forestry sector	Social/economic impact
High temperatures, heat waves	Longer growing season; Negative consequences for species sensitive to temperature changes; Increasing vulnerability to forest fires.	Reducing the volume of wood production; Transition to other forms of energy; Additional costs for the population.
Change in precipitation indices	Change in phytosanitary status of forests; Change of species composition in forests; Changing types and incidence of forest pests and diseases.	Changing the capacity of forest habitat to maintain biological diversity, protect the environment and ensure specific socio-economic functions.
Extreme phenomena: droughts, fires, windstorms and floods	Reduced growth and/or production of biomass;	Economic losses in forestry.

[4] Ion Talmaci, Erii Prosii, Ala Mardari, Alexandru Varzari, Alexandru Galupa (2016), *Report on updating the basic indicators of forests and other types of forest vegetation in the Republic of Moldova*. Climate Change Office, 98 p.

Impact category	Impact on forestry sector	Social/economic impact
	Increasing the number of forest fires; Increased mortality rate of forest seeds.	

Some phenomena/impacts associated with climate change for forest ecosystems in the Republic of Moldova will also generate certain opportunities, which can partially compensate for possible losses:

- Extension of forested areas, as well as forest protection curtains, which will significantly contribute to reducing soil erosion processes, landslides, will lead to reducing torrent flows, protection of agricultural crops and other social and economic objectives, improvement of the general living environment.
- Strengthening the communal and private sector in forest management and increasing transparency throughout the wood flow, creating a competitive forestry market, increasing the valorization of wood and non-wood products, correct use of wood according to quality.
- The planting of species that will benefit from the new environmental conditions and achieve superior biomass accumulations throughout the production cycle, depending on the region and species, can reach 20-40% in addition to the accumulation that would be achieved under normal environmental conditions.

An eloquent example of the effect of climate change on the development of Moldova's forests became the drought in spring-summer 2007, which affected over 70% of the country's territory. This phenomenon has considerably damaged forests on an area of about 19 thousand ha or 6.3% of the forest area owned by the "Moldsilva" Agency, especially in the south and centre of the country. This drought affected about 20 forest species, both native and alien, including: pedunculate oak (*Quercus robur*), oak (*Quercus petraea*), ash (*Fraxinus exelsior*), sycamore (*Acer platanoides*), sycamore (*Acer pseudoplatanus*), acacia (*Robinia pseudoacacia*), birch (*Betula verrucosa*), pine (*Pinus sylvestris)*), Crimean black pine (*Pinus pallasiana Holmboe*). The most affected were acacias, constituting 71.3% (13 thousand ha) of the total area of forests affected by drying. The drought of 2007 had long-lasting consequences, with consequences visible over several subsequent years. Thus, according to forestry-pathological research data conducted by FRMI specialists, the total area of degraded and dry arboretums of different intensity constituted over 33 thousand ha or 11.0% of the forest area of the Agency "Moldsilva" during 2008-2011.

Approximately the same destructive effect on forests in Moldova had the drought of 2012. As a result, during 2012-2015 about 41 thousand ha of forests were affected to varying degrees of drying, most of them being attested in the southern and central areas. The process of drying forests has been a constant phenomenon in the Republic of Moldova over the past decades. According to FRMII data, during the last decade (including the forecast for 2021), the area of forests affected by drying was 119.1 thousand ha[5] (Figure 3.8).

[5] Materials of the Scientific-Practical Symposium "Ensuring sustainable forest management by implementing forestry treatments and promoting natural regeneration, afforestation", "Moldsilva" Agency, 2020, 61 p.

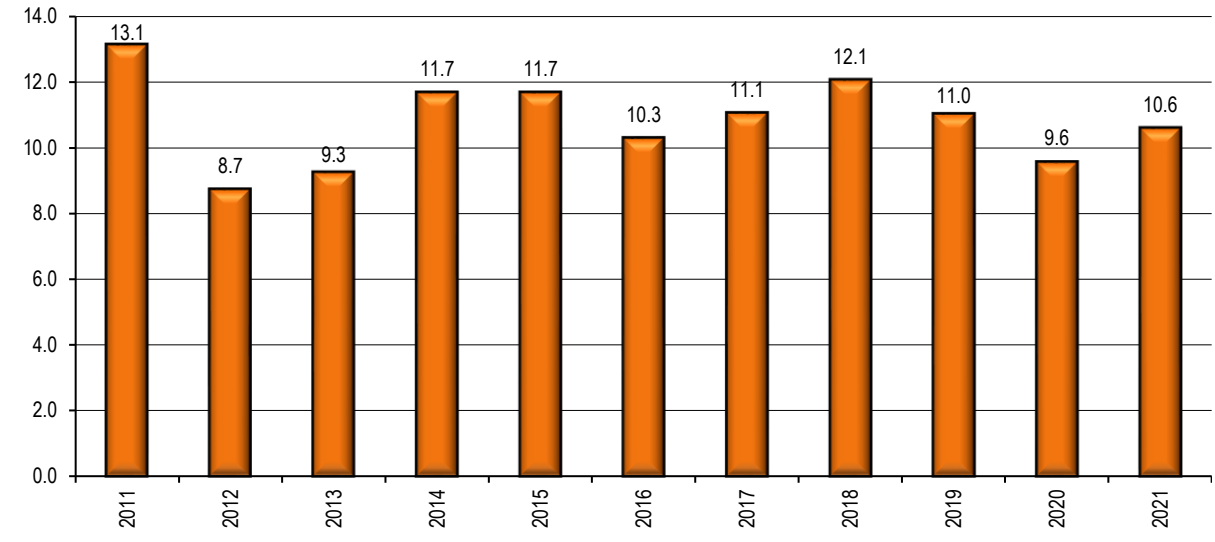


Figure 3.8: Dynamics of forest drying processes in the Republic of Moldova, kha

The vulnerability of forests in Moldova to climate change is confirmed by the current phytosanitary status of forest ecosystems. Thus, as a result of droughts that occurred in 2007, 2011, 2012, 2015, 2019, 2020, there was a sharp weakening of forest ecosystems, reduction of biological resistance of trees to the action of negative factors, which led to the degradation of arboretums, intensification of drying processes on large areas and creation of favorable conditions for mass spread of phytophagous and xylophagous pests. The dynamics of outbreaks of defoliating pests in arboretums managed by "Moldsilva" Agency during 2010-2020 is presented in Table 3.7.

Table 3.7: Dynamics of outbreaks of defoliating pests in arboretums managed by "Moldsilva" Agency

Indicators and main pests	Area of outbreaks at the end of the year, thousand ha											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Media
I. Area of phytophagous pest outbreaks, total, including by species of defoliating pests:	56,0	61,0	85,3	79,8	63,5	43,8	45,9	69,9	101,3	83,8	70,6	69,2
- Green oak moth	3,9	2,7	75,9	59,2	37,2	14,5	13,2	20,0	25,5	24,0	27,1	27,6
- Green cotar and brown cotar	48,4	50,2	6,1	10,9	18,0	25,6	23,5	35,9	53,7	50,5	15,0	30,7
- Hairy caterpillar of oak	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,6	7,3	1,2	19,5	2,9
- Thrombus of ash leaves	3,4	3,0	3,3	9,5	8,3	3,7	9,2	10,4	14,4	7,9	0,0	6,6
- Other pest species (elm leaf wasp, etc.)	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,3	9,0	0,9
II. Area of outbreaks requiring aerial control measures	31,0	33,2	35,7	52,9	39,2	10,9	20,2	34,5	54,8	16,2	0,0	29,9

Source: Materials of the Scientific-Practical Symposium "Ensuring sustainable forest management by implementing forestry treatments and promoting natural regeneration, afforestation", "Moldsilva" Agency, 2020, 61 p.

According to data from Table 3.7, the average area of phytophagous pest outbreaks was about 69 thousand ha during 2010-2020, of which about 30 thousand ha or 43.5% required control measures. The main defoliating pests in arboretums managed by "Moldsilva" Agency are:

- Totricidae – Green oak moth (Tortrix viridana).
- Geomitrides – Green cotar (Operopthera brumata).
- Brown cotar (Erannis defoliaria).
- Cotar (Agriopis leucophaeria).

- Hairy caterpillar of oak (Lymantria dispar).
- Elm leaf wasp (Aprocerus leucopoda Takeuchi).
- Noctuide (Noctuidae).
- Thrombus leaves of ash (*Stereonychus fraxini*).

Among the defoliating pests, the highest share and destructive effect had the green oak moth (Figure 3.9). Although all these species are known in forestry practice in the Republic of Moldova, during the last decades their outbreaks had a cyclical development, being largely influenced by climatic conditions during critical periods of development (larvae, etc.), but also by the intervention capacities of central and territorial forestry structures.

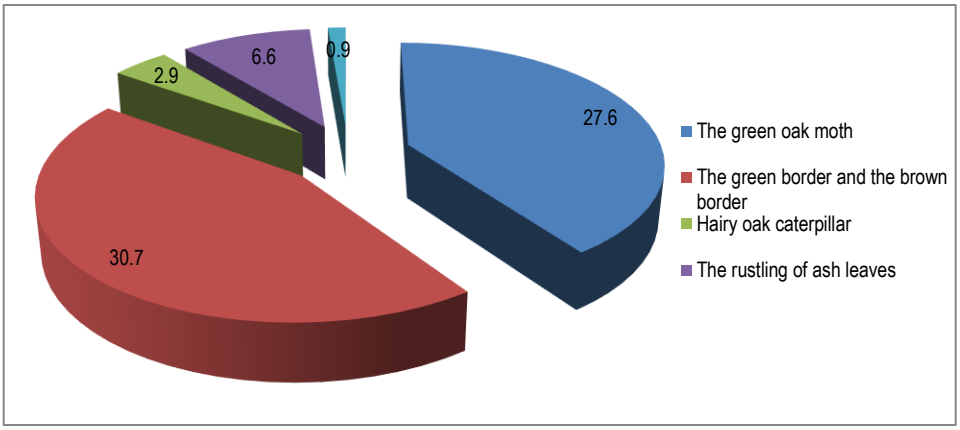


Figure 3.9: Distribution of outbreaks by pest species, kha[6]

Herd eruptions that occur in some years deviate from the projections known/applied in the activity of forest services for recording and monitoring forest diseases and pests. At the same time, existing management technologies (outbreak detection and monitoring; operational signaling, etc.) and combating are still ineffective and require substantial improvement.

Climate change influences moisture conditions in forests through changes in both thermal and rainfall regime. In some areas of Moldova, the reduction in rainfall in the future will accentuate the moisture stress caused by warming. Changes in the seasonality of rainfall and extreme events, such as drought and heavy rainfall, will also matter. The potential lack of summer rainfall, with prolonged droughts, is the main limiting factor of forest growth and productivity. Rising temperatures and changing rainfall patterns are the main factors that expose forests to various insect pests and fungal diseases. During 2021-2039, it is expected that the phytosanitary status of forests will change significantly in the northern part of the country, where areas with arboretums affected by drying will expand by about 15-25%. During 2040-2069, the change in phytosanitary status determined by the level of drying of trees in the northern part of the country will strongly stimulate the expansion to the south and southeast. There will be significant changes in this between 2070 and 2099.

This process is already in full swing in the south and partly in the central part of the country, being confirmed by the magnitude of forest drying phenomena and the share of hygiene cuts in the structure

[6] Materials of the Scientific-Practical Symposium "Ensuring sustainable forest management by implementing forestry treatments and promoting natural regeneration, afforestation", "Moldsilva" Agency, 2020, 61 p.

of forest treatments carried out in the forest fund managed by the "Moldsilva" Agency. Thus, according to the analysis of data for the period 2005-2019, it is found that selective hygiene cuts are applied annually on average on 8.2 thousand ha of forests affected by drying phenomena with the harvesting of a total volume of 106.8 thousand m^3/year. In the general structure of forestry treatments, selective hygiene cuts have an average share of 37.1% by area and 20.9% – by volume. It is also mentioned here that some arboretums affected by drying are included in regeneration emergencies through forestry treatments attributed to the main products or through ecological restoration.

Measures to adapt to changes in the continental-temperate bioclimatic zone, which includes forests in the Republic of Moldova, are very diverse. The research, currently taking place and planned, includes topics related to sapling adaptation, biotic and abiotic damage, biological diversity, especially genetic diversity, adaptation of forest-specific operations and techniques, as well as forest protection functions. Measures at stand level (regeneration, cultural operations, harvesting, etc.) aim to reduce the risks of negative effects of an abiotic nature (fires, winds, drought) or biotic.

The impact on individual species can be negative or positive depending on stationary conditions and climate change at regional level. Hornbeam and ash are the most vulnerable species, with ash showing a 20-40% decrease in biomass accumulation. The linden tree is expected to achieve higher growth by 2040, followed by a steady decline. Beech, located at the lower limit of its natural range, will show a decrease in biomass production of up to 50% by 2050, but in the short term it has the capacity to participate in the realization of stable forest structures in terms of ecosystem and productivity. Oak seems to be less affected by new climatic conditions, with increases in volume forecast until 2090, followed by steady decreases. The pedunculate oak is less scientifically documented internationally, but being of particular importance at the level of the Republic of Moldova.

The fluffy oak, also less documented, seems to prove a high ability to adapt to climate change, having the ability to maintain its growths and especially its vitality even in conditions of higher temperatures and drought. The most vulnerable regions in the Republic of Moldova will be: The south and, partly, the center (where currently there is the largest area covered by forests 209.4 thousand ha, or about 14.5% of the total territory of the geographical area).

Most forests in the process of drying are oak stands (69.3%), followed by acacia arboretums with a share of 13.4% and ash arboretums with 4.0% (Figure 3.10). The rest of the species have smaller shares, including based on the degree of participation in the composition of forests in the Republic of Moldova.

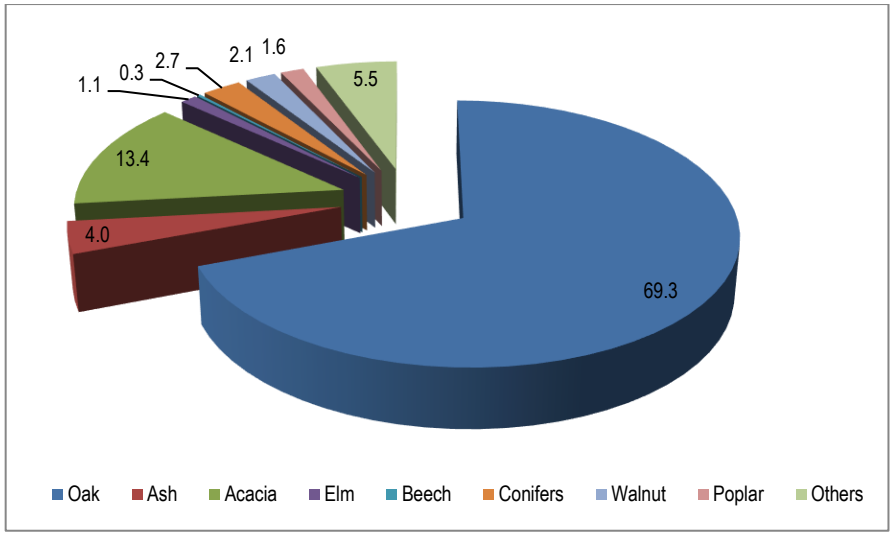


Figure 3.10: Species distribution of the drying process of forests in the Republic of Moldova, %[7]

Climate variability, with all its components, extreme temperature values and lack of precipitation during periods of drought favor the exposure to fires of agricultural crops, feed deposits, areas with forest vegetation, housing, etc. The effects on soil depend on the type and moisture content of the soil. On dry and coarse-textured soils, fires leave a hydrophobic layer in the soil (by accumulating chemicals, resulting from burning vegetation, in the lower layer of the litter box).

Following a fire, through the disappearance of vegetation, swarming, erosion intensifies, especially in areas naturally susceptible to erosion. It also increases flood hazard. After a fire, river basins have a higher potential for erosion and flooding. At high rainfall or storms, mineral compounds are removed and deposited in reservoirs designed to ensure water supply to humans.

Fires are classified by the layer of fuel that allows the fire to spread. Thus, they are distinguished as: Basic fires (crawl exactly below the surface of the land with glowing combustion), surface fires (move along the topographic surface) and canopy fires (by burning in flames, produced by strong winds and helped by very large slopes). Forest fires are an integral part of forest ecosystem dynamics in many ecosystems, as they are an essential element of forest renewal. They help control insect and disease damage and remove litter that has accumulated in the "basement" of the forest. At the same time, forest fires are a significant disturbance agent in many forested landscapes. Fire risk depends on many factors such as weather, vegetation, topography, forest management practices, socio-economic context, etc. Extreme fire episodes and fire seasons in recent decades in Moldova were, in most cases, determined by severe weather conditions. Although most fires are ignited by humans (either accidentally or intentionally), it is widely recognized that weather conditions and fuel buildup play a dominant role in altering fire risk over time. In this context, climate change is expected to have a strong impact on forest fire regimes in Moldova. This is confirmed by statistical data at the respective compartment for the previous period. Thus, the forest area covered by fires in the Republic of Moldova increased significantly from 2000 to 2020 with strong interannual variability (Figure 3.11). Significant annual fluctuations/increases are cumulated with major drought events recorded in the Republic of Moldova (2007, 2012, 2020, etc.).

[7] Materials of the Scientific-Practical Symposium "Ensuring sustainable forest management by implementing forestry treatments and promoting natural regeneration, afforestation", "Moldsilva" Agency, 2020, 61 p.

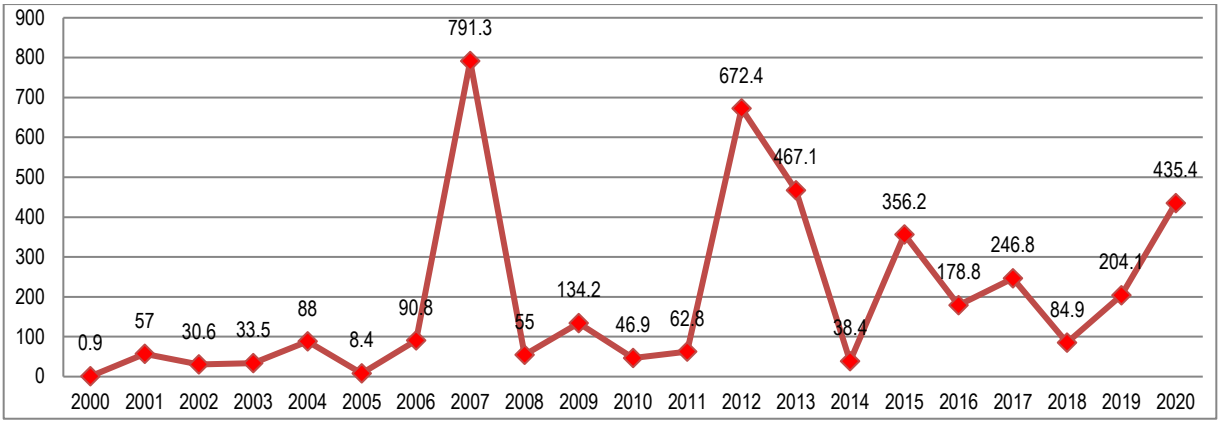
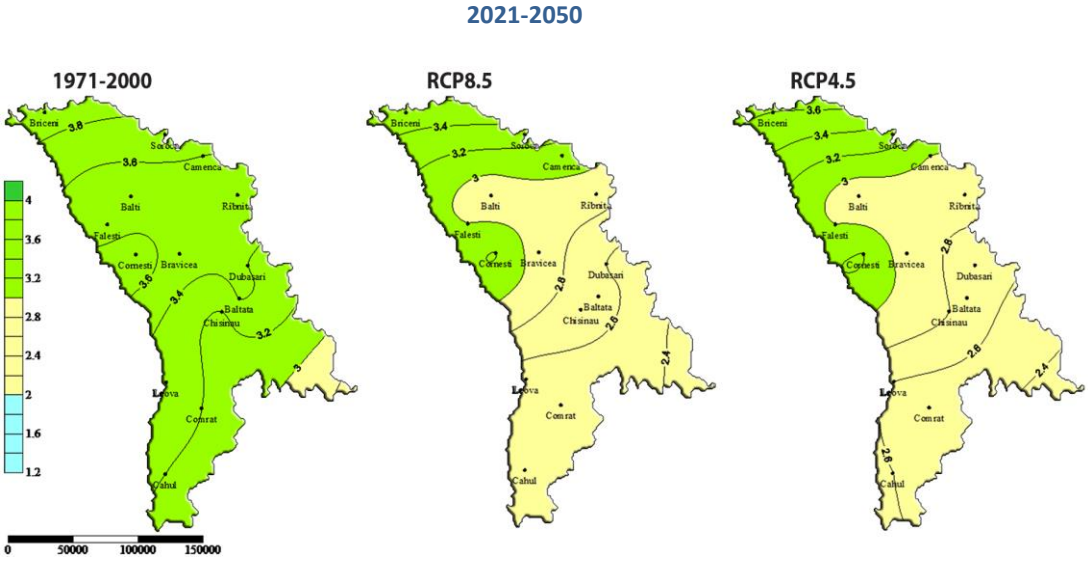


Figure 3.11: Dynamics of forest fires in the Republic of Moldova during 2000-2021, ha[8]

In order to estimate possible changes in forest fire risk conditions over the Republic of Moldova, the projections of the Angstrom Index (I) for two 30-year periods are modelled: 2021-2050 and 2071-2100, according to the EURO-CORDEX RCM assembly for the representative concentration pathways RCP8.5 and RCP4.5 in the XXI century (Taranu L., Deveatii D., Trescilo L., 2018). In this context, a set of maps was developed for a better spatial and temporal visualization of forest fire risk in the Republic of Moldova during the base period 1971-2000 and the 30-year periods: 2021-2050 and 2071-2100, according to the EURO-CORDEX RCM assembly for RCP8.5 and RCP4.5 scenarios[9] (Figure 3.12 – Figure 3.13). As a result, there was a significant correlation between meteorological parameters and the occurrence of forest fires, which opens a possibility of further investigation and analysis of geophysical and anthropogenic factors that can influence the occurrence of disasters.



[8] Talmaci I., Miron A., Ţpitoc L. (2021), *Chapter 6: Land use, land use category change and forestry. National Inventory Report: Sources of sequestration and greenhouse gas emissions in the Republic of Moldova: 1990-2019*. Prepared for reporting to UNFCCC. – Chisinau: Public Institution "Environmental Project Implementation Unit" (IP "UIPM"), Environment Agency, United Nations Environment Programme, 2021 (Tipogr. "Bons Offices"). – 715 p.

[9] Lilia Taranu, Dumitru Deveatii, Lidia Trescilo et al. (2018), *Vulnerability Assessment and Climate Change Impacts in the Republic of Moldova: Researches, Studies, Solutions*/Led.: Scorpan V., Ţaranu M.; Climate Change Office, Min. of Agriculture, Regional Development and Environment of the Rep. of Moldova, UNEP. – Chisinau: S.n., (Tipogr. "Bons Offices"). – 352 p.

2071-2100

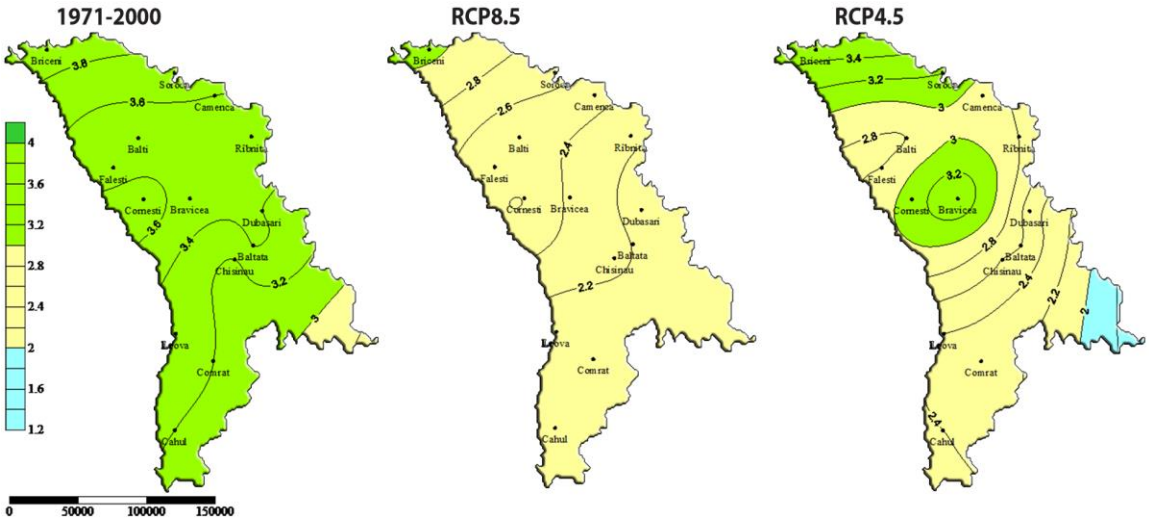
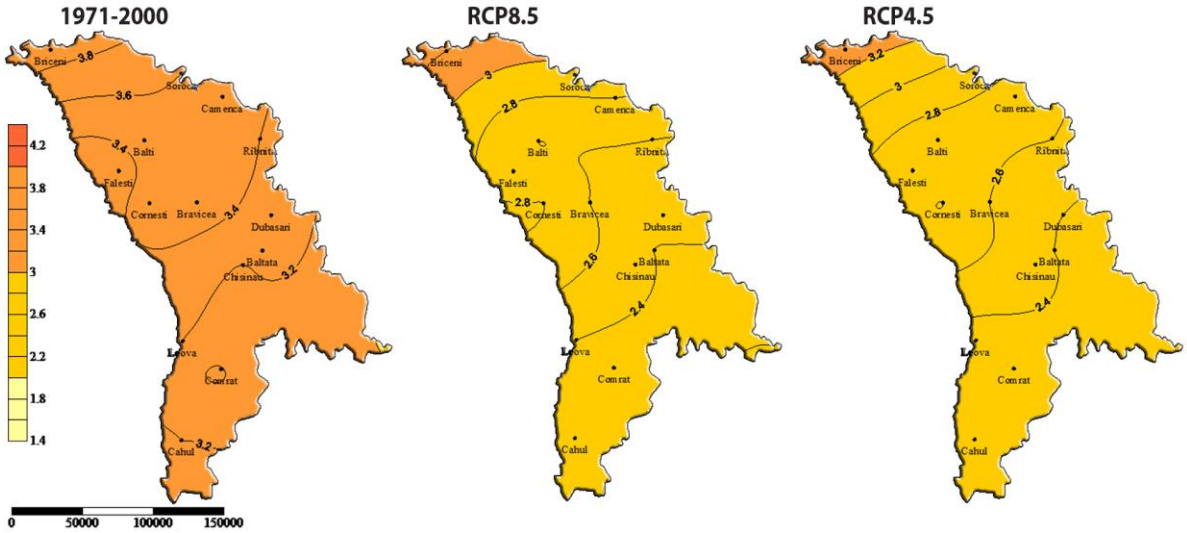


Figure 3.12: Angstrom Index Development of EURO-CORDEX RCM projected for July throughout the Republic of Moldova

In the period 2021-2050, according to the EURO-CORDEX RCM assembly for both scenarios, during the warm period of the year, forest fire risk conditions are described as "favorable fire conditions" (I = 3.0<I<2.5) and "more favorable fire conditions" (A = 2.5<I<2.0). Depending on the greenhouse gas emissions scenario and the eventual increase in average temperature, the Angstrom Index, in both scenarios, will range from 3.6 to 2.5 (July) and from 3.3 to 2.3 (August), while in the base period 1971-2000, the values of the Angstrom Index in summer fall within the limits when fire conditions are unfavorable (I = 4.0 <I <3.0). For the period 2071-2100, the trend of increasing forest fire risk conditions during the warm period (July/August) will be maintained and will be much higher for RCP8.5 with strong greenhouse gas emissions.

2021-2050



2071-2100

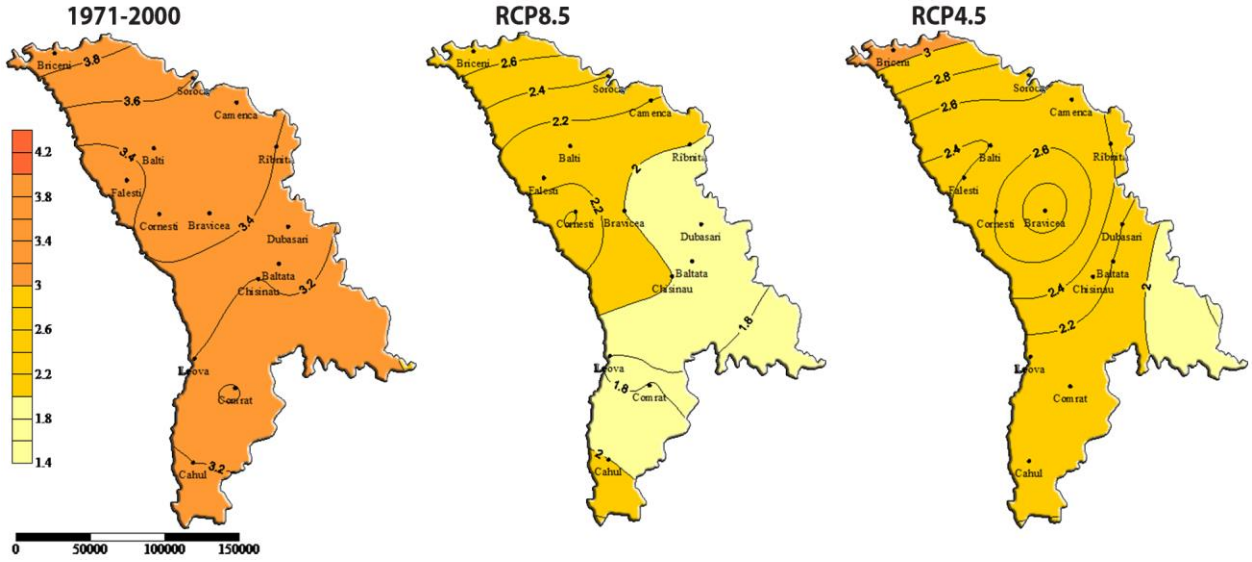


Figure 3.13: Angstrom Index Development of EURO-CORDEX RCM projected for August throughout the Republic of Moldova

Also, weather conditions of fire risk will be possible from June in Ribnita, Dubasari, Balta, Leova, Comrat and Cahul and will continue until September, covering almost the entire territory of the Republic of Moldova, except Briceni, Soroca, Camenca, Bravicea and Cornesti.

3.1.2 Assessment of the main risks and opportunities arising from climate change for the forestry sector

The most important risks associated with forest ecosystems in the Republic of Moldova identified during the last decades by specialists in the field are:

- Change in the composition of arboretums;
- Changes in the competitive behavior of species;
- Changing the rate of forest regeneration;
- Increased sensitivity to pest attacks;
- Change in phytosanitary conditions.

The analysis of the main biological and meteorological risks threatening the forestry sector in the Republic of Moldova is presented in Table 3.8.

Table 3.8: Analysis of the main biological and meteorological risks threatening the forestry sector in the Republic of Moldova

Risk	Control	Action
Change in forest composition due to different sensitivity of species to temperature and precipitation	Monitoring of species structure of arboretums	Boosting research on the adaptive capacity of native tree species to climate change. Review forestry practices in order to adapt them to new climatic conditions.

Risk	Control	Action
Changes in the competitive behavior of species (including increased competition between species and individuals with an effect on increased tree mortality)	Monitoring of species structure of arboretums	Boosting research on the adaptive capacity of native tree species to climate change. Review forestry practices in order to adapt them to new climatic conditions.
Changes in stand structure (including density)	Monitoring the structure of arboretums	Review forestry practices to adapt them to new climatic conditions.
Changing species peculiarities in the process of regeneration	Monitoring of species structure of arboretums	Adapting forest regeneration practices to the needs of climate change.
Spread of invasive plant species, new or existing	Maintaining and improving the pest monitoring system through forest managers or research institutions	Through ongoing research, identifying climate change-related interactions, alternative species and appropriate attack management strategies.
Spread of pathogenic pest species from other geographical regions adapting to climate change	Maintaining and improving the pest monitoring system through forest managers or research institutions	Taking immediate action in case of relevant alerts. Holding regular meetings with specialists, amending, if necessary, import or domestic phytosanitary regulations.
Increasing the survivability and fecundity of game species that may affect forest plantations	Permanent monitoring through hunting fund managers.	Adopting local strategies for staff management.
Spread of invasive plant species, new or existing	Identification of species susceptible to spread under climate change conditions; Monitoring by field staff of the incidence of the phenomenon	Collaboration with regulatory, agricultural, forestry, local public authorities, etc. Planning collaborative control and eradication strategies where the impact shows signs of being significant.
Windbreaks	Although it is not a common phenomenon, it can grow; Monitoring through field personnel; Research on sensitive forest areas and types;	Immediate elimination of effects through wood harvesting, promotion of species with swivel rooting.
Mass drying phenomena	Monitoring through sample markets and field staff of the emergence and extent of the phenomenon	Adopt management measures to eliminate severely affected arboretums without compromising regeneration capacity. Adoption of appropriate regeneration compositions. Continue research into species adaptation to climate change.
Increasing incidence of forest fires	Strengthening the fire alarm and signaling system	Strengthening collaboration with specialized fire extinguishing bodies. Adoption of preventive measures. Adoption of a rapid intervention regulation, including the revision of firefighting facilities and fittings.
Reduction of biomass production	Carrying out the National Forest Inventory and forest management plans	Modification of the assortment of species for afforestation/regeneration/reconstruction depending on biomass production capacities in new climatic conditions.

Risk	Control	Action
		Review of technical rules covering the periodicity and intensity of care and management work. Transition to other types of biomass and forms of energy.

At the same time, the role of forest ecosystems in mitigating the effects of climate change through carbon sequestration in biomass and other associated protective functions is recognized. Concerns about forest land expansion are a constant in the sectoral priorities outlined in various programmatic documents already adopted or in the process of adoption, and there is significant experience in this regard within the sector – implementation and monitoring of carbon projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol. This experience can help the Republic of Moldova in attracting and implementing projects in this area of activity, which can support efforts to reduce greenhouse gas emissions, but also to create new forests with increased capacities to adapt to climate change.

Another important component in mitigating the effects of climate change are forest protection curtains (PFCs), which in the Republic of Moldova have a tradition of over two centuries. The first works to create forest belt systems on the territory of Bessarabia started at the beginning of the XIX century, when 535 ha of protection plantations were created, including PFC in the context of afforestation of ravines and neighboring lands, with the construction of various hydrotechnical installations. In plantings, acacia and ailanthus were used as a priority. Since 1947, the process of creating PFC has intensified, focusing on the protection of agricultural land, watershed banks, infrastructure and transport routes, as well as reducing soil erosion. Currently, the total area of PFC is 30.6 thousand ha. The main species are acacia (36%) and common walnut (38%), but 12 other native species and 8 exotic species are also present[10]. Centralized data on the current state of PFCs does not exist, although according to some sources[11], many areas are affected by illegal logging, abusive/uncontrolled grazing, waste pollution or other destructive factors.

Most land covered by PFC is owned by local public administrations (some small areas are managed by public authorities responsible for transport and road infrastructure, etc.). This is a positive factor in relation to any rehabilitation initiative at national or local level. Forest protection curtains are positively appreciated by farmers and communities, especially for the fact that they can contribute to the revitalization of agroforestry practices in the future, in addition to making an important contribution to mitigating and adapting the agricultural and forestry sectors to climate change.

After clearing forests with native species, over the years certain areas of industrial forest plantations were created, grown rapidly and with the purpose of being cut down at an age of 25-30 years. This phenomenon has again produced negative effects on natural ecosystems. Thus, the task was set to create forests only from reproductive seedlings of species – genetic resources, adapted to natural conditions in the area and climate change. For those reasons, Council of Europe Directive 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material with direct reference to the subject concerned is being implemented at European level. In this context, it is worth

[10] Postolache Gh. (2008): On the creation of the forest shell. Rev. Bot., nr. 1, vol. 1, Chisinau.
[11] EU/UNDP Project "Climate East Moldova: Mitigation of effects and adaptation of ecosystems to climate change in Orhei National Park" to demonstrate to local communities the benefits and advantages of climate change adaptation measures. 2013, project document.

noting that, with the establishment of legal instruments at European level, the quality of breeding seedlings has significantly increased, which allowed zoning and assessment of genetic resources by selecting the most resistant trees and shrubs to the negative effects of climate change and stationary conditions. As a result of the efforts made, by implementing the mentioned EU Directive, reproductive propagating material has become more resistant to ecological conditions and to diseases and pests and as a result is an increase in the volume of production and the quality of wood. These EU rules are important for the Republic of Moldova both for forestry and environmental protection, as well as for the development of the economic field by creating/renovating forest nurseries and obtaining benefits from the marketing/export of forest material resistant to ecological conditions and climate change.

3.1.3 Main focus areas of analysis in TNA for forestry sector

Forests play a particular role in maintaining ecological balance, combating desertification and degradation of land and soils, waters and river basins, preserving biodiversity, mitigating the impact of climate change, and, last but not least, preventing and reducing the risk of natural disasters. It is extremely important that the minimum afforestation rate of 15% is achieved, especially by planting native species and/or creating pastoral plantations, where conditions allow and pressure on natural forests is high. This target afforestation rate would solve several economic, social and environmental problems. At the same time, it is necessary to develop new provisions in the legislative and normative acts in the forestry field, which will establish measures to protect soils and lands from the degradation process and requirements for adaptation to climate change.

Following the analysis of the current state and needs related to the national forestry sector in the Republic of Moldova, objectives and measures are established to address climate change. That approach shall be based on sustainable forest management, which shall be ensured by the following:

- Long-term forestry policies.
- Prioritization of ecological objectives of forestry.
- Ensuring the integrity of the forest fund and the permanence of forests.
- Increasing the area of land occupied by forests and/or forest vegetation.
- Increasing the role of forestry in the development of society.
- Harmonization of relations between forestry and other fields of activity.
- Supporting all forest owners/holders and stimulating their association.
- Maintaining, conserving and enhancing biological diversity in forests.
- Maintaining the health and vitality of forests.
- Maintaining and enhancing forest protection functions.
- Maintaining and strengthening the productive capacity of forest resources (wood and non-wood products), their contribution to global carbon cycles.
- Mitigating the consequences of climate change on forests and adapting forests to climate change.

In addition to reviewing forest use/management and afforestation/reforestation/regeneration practices, it is necessary to anticipate the consequences of climate change projections/projections in the forest-based sector, including within the main sectoral areas:

a) Forest management, use and planning.
b) Detection and protection against forest fires.
c) Forestry operations in vulnerable and inadequate arboretums.

d) Forest protection practices that take into account changes in the key pest profile and associated hazards.
e) Specific measures to optimize compositions to improve the overall sustainability of forests.
f) Forestry and regeneration operations to replace arboretums of a single species with mixed and plurian arboretums.
g) Maintaining and restoring wetlands within forest massifs to preserve biodiversity and protect against climate change.
h) Training and improvement of forestry specialists, including in the field of anticipation and management of developments in the state of forests related to climate change.

3.2 Background to the decision

3.2.1 Existing efforts to reduce identified climate change vulnerabilities and adaptation needs for the forest-based sector

Over the past two decades, the Republic of Moldova has implemented a number of actions and activities aimed at reducing the vulnerability of the forestry sector to climate change. The generalizing analysis of the degree of implementation of the main policy/program documents containing measures in the forest and forest-pastoral field, shows that during 2002-2020 were implemented 16 programs/plans and pilot projects (Table 3.9) targeting the forestry sector (extension of forest areas in different categories of ownership (state, ATU, private); improving the condition and management of forests and communal meadows, etc.) in correlation with changes climate (adaptation, mitigation). Most of these programs/plans and pilot projects had a relatively high degree of finality/implementation, exceeding the index of 50%. The cumulative budget of these programs/plans and pilot projects is about 85 million US dollars, and the funding sources were both internal – 92.6% (78.7 million US dollars) and external – 7.4% (6.1 million US dollars).

Table 3.9: Ongoing forest-related and climate change programs, plans and projects

Name of program, plan, project	Implementing institution	Implementation period, related budget	Main objective/activities
Project "Soil conservation in Moldova" (PSCM)	World Bank, Agency "Moldsilva", FRMI	2002-2022; 19 Million US dollars;	● Creation of new, communal/state forests on 20.3 thousand ha through: i. Afforestation of eroded and unproductive lands. ● Reduce erosion by: i. Stabilization of landslides and improvement of hydrological regime; ii. increasing access to wood resources and non-wood forest products; iii. creating a basis for sustainable development at local and regional level. ● The cost per tonne of emission reduction in CO2 equivalent is USD 7.4. ● The resulting total GHG emission reductions will amount to 3.6 million tonnes CO2.
Project "Development of communal forestry	World Bank, Agency "Moldsilva", FRMI	2006-2035; 28,2 Million US dollars;	● Creation of communal forests on 8.5 thousand ha through: i. Afforestation of eroded and unproductive lands;

Name of program, plan, project	Implementing institution	Implementation period, related budget	Main objective/activities
sector in Moldova" (PDCFSM)			ii. application of agroforestry practices, carbon sequestration and reduction of greenhouse gas emissions. ● Reduce erosion by: i. Stabilization of landslides and improvement of hydrological regime; ii. increasing access to resources such as timber, firewood and non-wood forest products; iii. creating a basis for sustainable development at local and regional level. ● Introduction of participatory forest and grassland management practices. ● The resulting total GHG emission reductions will amount to 1.2 million tonnes CO^2.
Preserving diversity biological in the Lower Nistru region	World Bank/Global Environment Facility (GEF)	2002-2005; 975 thousand US dollars	● Improve efforts to conserve biological diversity along the Lower Nistru River. ● Create a national park in the basin of the Lower Nistru River. ● Developing local capacities to manage the national park and promoting sustainable management of forests and pastures in the protected area. ● Support the protection of transboundary wetlands in the Dniester Delta region by improving cooperation with Ukraine. ● Include afforestation and reforestation efforts, such as creating ecological corridors between fragmented forests and pilot land, through community resource management. ● Facilitate community involvement in decision-making and include sustainable use of resources in project activities (micro-loans for small green businesses).
Program for regeneration and afforestation of forest lands: regeneration and afforestation works in the forest fund, GD 737/2003	Agency „Moldsilva”	2003-2020; Budget: 588,1 million. lei	● Regeneration/afforestation of 95.1 thousand ha in the managed/fulfilled forest fund – 73.3 thousand ha or 77.1%;
Project "Development of communal forests”	World Bank, Agency ”Moldsilva”, FRMI	2004-2007; Grant from The Government of Japan: 919.9 thousand US dollars	● Contributing to ensuring the sustainability of forest planting activities. ● Improving population welfare in rural areas through better management of community forests and pastures in 50 participating communities. ● Improving the productivity of 2000 ha of pastures owned by local communities. ● Reconstruction and/or restoration of 340 ha of forests and other forest vegetation owned by local communities. ● Forest management of 5900 ha of forests and other types of forest vegetation owned by local communities.

Name of program, plan, project	Implementing institution	Implementation period, related budget	Main objective/activities
National programme on the establishment of the national ecological network for 2011-2018; GD 593/2011	ME, LPA, Agency „Moldsilva", ASM	2011-2018; 38427,0 thousand lei	● Afforestation of areas and strips of water protection of rivers and water basins on an area of 30.4 thousand ha/fulfilled – planting 60 ha (2018/1020) or 0.2%. ● It is in the process of identifying land and financial means.
Program for conservation and enhancement of soil fertility, GD 626/2011	Agency Land Relations and Cadastre	2011-2020; 33,29 million. lei	● Stabilization of landslides and ravines through afforestation and grassing – 50 ha. ● Establishment of 20 ha of forest protection curtains. ● Drainage and drainage of 270 ha of soils with excess moisture located on the slopes. ● Reducing erosion processes and stopping landslides through hydrotechnical and forestry improvement. ● Deforestation and set-aside of 1500 ha of degraded orchards and vineyards.
Project "Promoting good management of forest land managed by parties other than state institutions through capacity building for rational management of local natural resources" (ENPI-FLEG II)	European Commission through the European Neighbourhood and Partnership Instrument (ENPI), World Bank, FRMI	2014-2017; 75 thousand US dollars	● Elaboration by FRMI of management plans for 5030.2 ha of communal forests (forests, forest curtains, green spaces, etc.; 20 mayoralties from 10 administrative districts). ● Capacity building for the National Forestry Advisory Office (ONCS) within FRMI. ● Providing consultancy and guidance services for owners of communal (municipal) and private forests – beneficiaries 260 mayoralties/institutions/organizations/private individuals from 26 administrative districts, municipalities and ATU Gagauzia. ● Conducting 3 workshops entitled "Sustainable management of forest and pastoral resources in the Republic of Moldova" in the North, Centre and South areas with the participation of 111 people (LPAs, private; Agency "Moldsilva", Ministry of Environment, IEP, etc.).
Support Program local communities for sustainable and integrated forest management and carbon sequestration through afforestation	World Bank, Agency „Moldsilva", FRMI	2009-2014, Grant from The Government of Japan, 975,9 thousand US dollars	● Ensuring the sustainability of communal forests by: (i) Capacity building for forest management and reforestation activities at local level; (ii) special integrated forest management programme and intervention aimed at afforestation of degraded agricultural land, planting forest belts for environmental protection and creation of a local environmental network; (iii) program worth 600.0 thousand US dollars to support local communities in achieving the sustainability of newly planted forests and improving the management of communal grasslands. ● Ensuring global benefits through: (i) Carbon sequestration and reduction of greenhouse gas emissions; (ii) generating income for local communities from forest products to help reduce poverty in rural areas. ● The total reductions in GHG emissions obtained as a result will be 102 thousand tons CO2. The cost per ton of CO2 reduction is 9.6 US dollars.

Name of program, plan, project	Implementing institution	Implementation period, related budget	Main objective/activities
Ecological restoration of inadequate arboretums	Agency „Moldsilva", FRMI	2012-2015	• Research in acacia trees related to climate change: (i) Carrying out research in acacia trees of different ages, structure and composition and in different types of resorts in order to establish resistance and productivity. (ii) Mirroring the peculiarities of forest crops of pure acacia trees and in mixture, special attention will be paid to artificial acacia forests vegetatively regenerated by 2-3 generations. (iii) Elaboration of recommendations on bioecological properties and multiplication of more resistant species (Celtis, Sofora, Pyrrhus, etc.) to be implemented in resorts inappropriate for acacia. • Reconstruction of arboretums affected by American maple (Acer negundo L.) in R.N "Royal Forest": (i) Highlighting and researching the current state of productivity and resistance of arboretums affected by 100% American maple (completely derived). (ii) Research on the current state, productivity and resistance of arboretums affected by American maple where the basic species pedunculate oak persists (partially derived). • Research on the current state, productivity and resistance of arboretums affected by American maple trees where the basic species does not persist (derived and degraded).
Project "Climate East Moldova: Mitigation of effects and adaptation of ecosystems to climate change in Orhei National Park" (ONP)	UNDP Moldova, Agency „Moldsilva", FRMI	2013-2016; 535,0 thousand Euro	• Development of innovative management systems for community forests and pastures on the territory of PNO. • Improvement of 500 ha of pastures and afforestation of 150 ha of eroded and non-productive land. • Avoiding further deterioration of natural resources (biodiversity, land, forests), absorbing carbon and reducing greenhouse gas emissions. • Development of management plans for 5.9 thousand ha of grasslands owned by 18 municipalities within PNO. • Development of management plans for 1.5 thousand ha of communal forests within PNO; • Promote a better understanding of issues related to the effects of climate change on grasslands and forest ecosystems and contribute to local/regional sustainable development.
National plan for the extension of areas with forest vegetation, GD 101/2014	Agency „Moldsilva", MoEnv, FRMI	2014-2018; budget: 195,4 million. lei	• Afforestation of degraded lands – 12.0 thousand ha and creation of 1.0 thousand ha curtains/fulfilled – 2.1 thousand ha or 17.5%.
Moldova Agriculture Competitiveness Project (MAC-P), Phase I	World Bank, Ministry Environment Agency	2014-2017; Grant: US$2.3 million; 23 million.	• Rehabilitation of 2241 ha forest curtains for the protection of agricultural fields within the Sustainable Land Management component (23 million MDL). • Procurement and transmission to "Moldsilva" Agency of 23 forestry technical units (deforesters, tractors,

Name of program, plan, project	Implementing institution	Implementation period, related budget	Main objective/activities
	„Moldsilva", FRMI	MDL – contribution of the Government of Moldova	etc.) and 51 units of aggregates/technical equipment (planters, plows, scarifies, milling cutters, etc.) worth a total of 2.3 million US dollars.
Rural Programme for Inclusive Economic and Climate Resilience implemented by the Consolidated Unit for Project Implementation (IFAD VI))	UCIP-IFAD, Agency „Moldsilva", FRMI	2015-2020; 100 thousand US dollars	• Elaboration by FRMI during 2015-2020 of 58 execution projects with the corresponding technical and scientific argumentation for the creation of 348.35 ha of forest protection plantations in anti-erosion complexes. • Technical supervision of the implementation process of execution projects.
Project "Strengthening the institutional framework in the water and sanitation sector in the Republic of Moldova". Component 2: Improvement of water protection strips along water bodies	Austrian Development Agency, "Apele Moldovei" Agency, "Moldsilva", FRMI	2018-2021; 3,3 million. lei	• Inventory and delimitation of riparian strips by categories of use for the rivers Ciuhur, Nirnova, Cahul, Cainar, Ciuluc and Botna (700 thousand lei). • Elaboration of execution projects for 60.2 ha of forest belts for shore protection for the rivers Ciuhur, Nirnova, Cahul, Cainar, Ciuluc and Botna. • Planting 60.2 ha of forest crops for bank protection for the six rivers included in the project (total cost of carrying out technical projects - 2,618,926.5 lei).
Project "Improving the state of natural ecosystems affected by fires in RN Lower Prut"	ME, Agency „Moldsilva", NRLP, FRMI	2020-2021, 1,8 Million Lei; financier – NEF	• Restoration through ecological reconstruction works of arboretums fully affected by fire (25.0 ha). • Selective hygiene cuts of arboretums partially affected by fire (12.1 ha). • Elaboration of an anti-fire planning project for the territory of RN Lower Prut. • Improving access to the territory of the NRLP by improving the system of roads and paths and improving their quality. • Creating a network of mineralized anti-fire strips on the perimeter of forest bodies and in places with increased fire danger. • Strengthening the capacity to monitor the occurrence and evolution of wildfires. • Technical equipment of NRLP for limiting and combating wildfires.

One of the main mechanisms for implementing the forestry regime is the forest management plan. The forest management activity is carried out in accordance with the provisions of Articles 71-73 of the Forestry Code, as well as the technical norms in force. In this context, during the period 2011-2020, the area of land managed by the Agency "Moldsilva" covered by forest management works (FRMI Chisinau) was 336.9 thousand ha, of which 85.7 thousand ha within the fund of state protected natural areas with forestry profile (FANPS). The total cost of these works is estimated at 28.6 million lei (2.9 million lei/year) or about 1.6 million US dollars.

Another important indicator in forest management is the rational use of current wood increases through forestry operations. According to forestry records, annually, by applying the integrated complex of forest treatments and works, about 40% of the current average increase (about 1.4 million m^3/year) of wood generated by forests in the Republic of Moldova is capitalized. At the same time, by categories of holders, this percentage is very different and disproportionate: "Moldsilva" Agency – about 44%; municipalities and other holders – about 13%.

The lack or major deficit of forest management capacities within ATU structures is probably one of the most serious problems at the moment. Its magnitude is largely confirmed by the current state of most forests in public property of ATU, as well as by the results of revisions carried out in 2011 by specialists of territorial forestry enterprises jointly with employees of the Environmental Protection Inspectorate. This event is a milestone, as it is the last complex revision of ATU forests carried out in the Republic of Moldova. After this, only sporadic/one-off revisions and operative controls (raids/raids) were carried out, which do not fully reflect the seriousness of the problem. Thus, these revisions found a volume of 181.5 m³ per 1000 ha area covered with forests, forest protection curtains and other forest vegetation in public property of ATU or more than 14 times more compared to the index recorded in the same period on the forest fund managed by the Agency "Moldsilva". Also, it was found that out of the total of 866 mayoralties subject to revisions, only 63 had forest employees, 45 had guards, 47 mayoralties – forest fund security was partially ensured, and 597 mayoralties did not ensure forest/forest vegetation security.

3.2.2 Interconnection of identified focus areas by forestry sector and existing development efforts

The overall analysis of forest plans and programmes shows a relatively LOW degree of implementation. It is mentioned that an important part of indicators (extension of forested lands; planting of protective forest curtains; afforestation of riparian strips; increase of forest material in the necessary assortment, etc.) migrate from one document to another, have not assigned/identified real financial and material resources, nor being the object of annual planning of the state budget, MTBF, competent institutions (MoEnv; Moldsilva; LPA, etc.). At the same time, an important part of the provisions of forest policy/programme documents are implemented through pilot projects containing sectoral mechanisms and practical actions, are financially and technically supported by international institutions (World Bank; UNDP; GEF; AAD, etc.).

Based on the foregoing chapters, a number of problems related to the management and adaptation of the forestry sector to climate change are outlined, which require resolution in the following period:

1. Climate change, manifested mainly by global warming and intensification of extreme natural disasters, greatly affects forest ecosystems and associated biological diversity, as the Republic of Moldova is located in a region with a high degree of vulnerability and frequently faces heat waves, droughts, forest fires, attacks of diseases and pests, etc. The period of the last 20 years has been manifested by an increased intensity of extreme phenomena, such as droughts, hail/frost, which are a stressful factor for the health of forest ecosystems. Forecasts for the next period on the evolution of Moldova's forests assume that the longitudinal gradient will move northwards and the health (phytosanitary) status of forest ecosystems will worsen.
2. Various emission scenarios for the period up to the end of the twenty-first century forecast variations in precipitation that predict a general and gradual downward trend in annual

precipitation, varying from one geographical area to another. Trends in changing thermal regime will continue and will most likely correlate with variations in emissions and other climatic phenomena. It is undeniable that forests will be directly or indirectly affected by climate change, and forest managers in vulnerable areas will be hit quite hard.

3. The economic and financial activity of forest managers over the last decades shows the tendency to increase negative indicators, more as a result of reducing the quality of ecosystems (natural resources) than their management. At the same time, in the situation of growing interest in forest resources, the human factor will be decisive in ensuring continuity (sustainability), where the compromise between social-human and ecological values can be expensive.
4. Improving forestry legislation is a necessity based on socio-economic changes in society, ratification of international treaties, signing of the Agreement with the EU with direct or indirect reference to environment and forests. The revision of the normative framework is also dictated by the need to conserve forests and manage them sustainably, by increasing the areas covered with forest vegetation by creating plantations on the lands of administrative-territorial units, planting new forests on private lands, organizing forest auctions for selling standing timber, etc.
5. The policy documents of the Republic of Moldova (strategies, programs, action plans, etc.) are mostly outdated, expired, and the actions set out therein, even being insufficient, were important for the development of the forestry sector in terms of climate change, but most of them were not implemented or partially implemented due to lack of political will, financial resources and adequate institutional framework.
6. In the Republic of Moldova, insufficient management of the forestry sector is visible at various levels (from Government to local), especially the efficiency of measures to adapt the forestry sector to climate change. There is a lack/insufficiency of institutional capacities to address climate change adaptation problems from the Ministry of Environment to subordinated institutions, LPAs, etc.
7. In the forestry sector, there are limited technical and personnel capacities, especially for afforestation design works, ecological reconstruction of inadequate arboretums, rehabilitation of forest curtain systems, etc.
8. There are a limited number of experts in the field of climate change related to forestry issues, as well as scientists in scientific institutions. which has led to a lack of in-depth studies related to forest ecosystems in relation to climate change (genetic variability of edifying species of valuable forest habitats; climatic thresholds corresponding to the spatial distribution limits of forest types and/or forest species; development of bioclimatic models; calibration of biogeochemical models for forecasting changes in the productivity of arboretums and carbon stocks in the main forest types, etc.).
9. There is insufficient supervision of the production process and quality of forest material in forest nurseries to be planted in new and existing arboretums, without establishing its origin or provenance, without authenticating identity and quality and resilience to climate change. In general, there is insufficient endowment with modern technologies, equipment and technique of forestry nurseries.
10. In the autochthonous forestry practice, insufficient volumes of ecological regeneration and reconstruction works are carried out, which aim to improve the composition of arboretums by promoting biotypes more resistant to climate change, substitution of compromised introducers in forest culture, restoration of fundamental phytocenosis, etc.

11. During the last decade, there has been a significant decrease in the expansion rates of forested areas due to degraded land or other types of land unsuitable for agricultural use. A policy document is not yet developed for the massive expansion of land with forest vegetation, including to mitigate land degradation and climate change.
12. In the Republic of Moldova, there is too high a share of forest arboretums regenerated from shoots, with low capacity for resilience and adaptation to climate change.

3.3 Overview of existing technologies in the forest-based sector

In the context of mitigating and/or anticipating climate change impacts, variability and climate extremes, a number of adaptation technologies/measures to help forest ecosystems meet the challenge of climate change have already been identified and proposed in various policy documents over the past two decades. The most important of these are summarized in Table 3.10. These options have been implemented to varying degrees and levels of success, but their systematic application has been notably lacking over the last 5 years.

Table 3.10: Existing/deployed adaptation technologies/measures in the forestry sector

Policy documents	Proposed adaptation options
Climate Change Adaptation Strategy of the Republic of Moldova until 2020 (NSACC) and Action Plan (PA) for its implementation (GD 1009/2014).	Intensification of the process of expansion of territories covered with forest vegetation and ecological restoration of forests, creation of interconnection corridors between forested massifs (indicator – 20.0 thousand ha of forested land).
	Creation of forest curtains for the protection of agricultural land, roads and waters (indicator – restored/created 3.0 thousand ha of forest curtains).
	Creation of forest plantations for industrial and energy needs (planting of energy forests to meet the needs of the population, indicator – 5 thousand ha).
	Selection and growth in nurseries of tree species resistant to various climatic conditions.
	Creation of urban and rural green spaces (indicator – 2 thousand ha).
Sustainable Development Strategy of the Forestry Sector in the Republic of Moldova, PD nr. 350/2001; General Action Plan on Strategy Implementation, GD 739/2003.	Development and implementation of the ecological restoration program of forests (24.5 thousand ha).
	Elaboration and implementation of the State Program on regeneration and afforestation of forest fund lands (95.1 thousand ha).
	Implementation of the Complex Program for capitalization of new lands and increase of soil fertility (planting of 128 thousand ha).
	Creation of forestry crops from fast-growing species (5 thousand ha).
	Creation of rural and urban green spaces (5 thousand ha).
	Development of ways to mitigate negative influences on forests due to climate change.
	Development of land afforestation technologies based on forest reproductive material with protected roots.

Policy documents	Proposed adaptation options
	Research and monitoring of arboretums degraded by various unfavourable factors and improvement of existing treatments for proper application of ecological restoration works.
	Research on establishing the optimal intensity of intervention in forestry operations and forestry treatments depending on the type and condition of the forest ecosystem.
	Carrying out the study and elaboration of measures for conservation and restoration of degraded and fragmented habitats and vulnerable forest ecosystems.
	Assessment of genetic diversity of the main forest species in order to assess the status and trends of the genetic background, highlighting standard arboretums, delimitation of harvesting areas.
State Program on Regeneration and Afforestation of Forest Fund Lands for 2003-2020 (95.1 thousand ha), GD nr. 737/2003	Planting forestry crops on 24.7 thousand ha.
	Helping the natural regeneration of existing forests on an area of 39.0 thousand ha.
	Natural regeneration of existing forests on the area of 31.4 thousand ha.

The pressure from humans and diverse interests on forest ecosystems is enormous, and their sustainable future depends much on adopting a balanced system between conservation and management. In the previous period, certain measures/technologies were undertaken within the forestry sector aimed at adapting forest ecosystems to climate change. Due to the available technical and financial resources, but also to current visions, the efforts of institutions within the forestry sector (Moldsilva; forestry entities; LPA, etc.) They are focused primarily on maintaining a fragile balance, rather than on development and paradigm shift.

Digital and innovative technologies are understaffed in the forestry sector. The predominance of labor in forest cultivation and use/exploitation activities is an element that eloquently characterizes the technological situation in the forestry sector. The forestry sector is to make substantial efforts in the field of computerization and mechanization of some activities, by using existing means or by creating new specific means. Another important aspect is that, given the compliance with the technical rules governing the forestry regime and which are very restrictive, the current possibilities for innovation in forest management are very limited.

The decline of forestry science and education in the last decade, caused by the shortage of forestry scientific and teaching staff, insufficient funding of scientific research and education in the field, weakening of Moldova's traditional ties with educational and training institutions of forestry staff in the country and abroad, have created a difficult situation for the future of forestry research and education. In order to promote and implement sustainable forestry based on rational use of forest resources and efficient performance of assigned protection functions, long-term and applied fundamental scientific research is required.

The Republic of Moldova does not have a National Forest Inventory (NFI), and the process of collecting forest data does not exactly meet international requirements. Accurate and up-to-date information on the volume, distribution, composition and general condition of forests (both public

and private forests) is extremely important for formulating development and monitoring policies, providing assistance and support for sustainable management, as well as complying with national and international reporting commitments. For the next period, the optimal set of instruments needed to ensure improved management and adaptation of forests to climate change should include the following aspects:

1) Boosting research on the adaptive capacity of native tree species to climate change.
2) Reconsidering forestry practices in terms of adapting them to climate change.
3) Adapting forest regeneration practices to the needs of climate change.
4) Through continuous research, identification of interactions related to climate change, alternative forest species and appropriate strategies to manage disease and pest attacks.
5) Ecological restoration of arboretums inadequate and vulnerable to climate change.
6) Improving forest management (capacity building; reviewing regulatory and regulatory acts; developing and implementing new technologies; promoting digitalization of processes and activities, etc.).
7) Extension of forested areas, as well as forest protection curtains, which will significantly contribute to reducing soil erosion processes, landslides, will lead to reducing torrent flows, protection of agricultural crops and other social and economic objectives, improvement of the general living environment.
8) Strengthening the communal and private sector in forest management and increasing transparency throughout the wood flow, creating a competitive forestry market, increasing the valorization of wood and non-wood products, the correct use of wood according to its quality.
9) The planting of species that will benefit from the new environmental conditions and will achieve higher accumulations of total biomass throughout the production cycle, depending on the region and species, can reach 20-40% in addition to the accumulation that would be achieved under normal environmental conditions.
10) Taking immediate action in case of relevant alerts on the spread of forest pest species, holding regular meetings with specialists, amending if necessary import or domestic phytosanitary regulations.
11) Collaboration with regulatory, agricultural, forestry, local public authorities in the context of diminishing the spread of invasive plant species, planning collaborative control and eradication strategies where the impact shows signs of being significant.
12) Creation of edges and thickets of shrub species in the process of land afforestation, which will serve as habitat for wild animals.
13) Adopt management measures to eliminate arboretums severely affected by windfall without compromising regeneration capacity, adopt appropriate regeneration compositions, continue research into the adaptation of forest species to climate change.

3.4 Adaptation technology options for the forest-based sector and their main adaptation benefits

Identifying technologies/tools to mitigate the consequences of climate change, increasing the resilience and adaptability of the forestry sector is a complex process based on knowing the current state and forecasts for the short and medium period of development. In this context, it is mentioned that technology is a synthesis of equipment, techniques, practical knowledge or skills for performing a particular activity (IPCC, 2000). For the forestry sector, technology is more associated with the

notion of measures and best practices. In the context of ensuring the adaptation of the forestry sector to climate change, the following general sectoral objective is set: *Enhancing the capacity of the forestry sector in the Republic of Moldova to adapt to the consequences of climate change by maintaining and improving the capacities of forest ecosystems to provide services to society and maximizing the contribution to mitigation by strengthening and increasing carbon sequestration volumes. carbon compared to the current situation.*

At the initial stage, in order to ensure the development of relevant measures/technologies based on concrete goals and targets, the potential climate impacts (CI) on forest ecosystems described in the previous chapters of this Report were aggregated into the following categories:

- Climate impact 1: Diminishing production of biomass, other forest products and services.
- Climate impact 2: Changing the rate of forest regeneration, degradation and reduction of forest areas.
- Climate impact 3: Worsening phytosanitary status of forest ecosystems and increasing incidence of forest fires.

In order to strengthen both the capacities of forest ecosystems to adapt to climate change and increase their protective effect on agricultural land and crops, human localities, infrastructure, etc., a broad set of sectoral technologies/measures (21 technologies/measures) was identified at the first stage, classified into 8 subsectors. The cumulative budget of those options is estimated at EUR 233,2 million.

Most of the identified sectoral technologies/measures have a medium and high degree of replicability and applicability. Activities include exchange of experience between national institutions involved in the process (MoEnv; Moldsilva; MECR; MIDR; MAFI; LPA; EA; IEP; GIES, etc.), but also with similar experts and institutions from neighboring countries (Romania, Ukraine; Hungary, Bulgaria, Poland, etc.). Also, the proposed technologies will facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within LPAs and privately (tillage; care of forestry crops; logging; wood processing; harvesting/processing of berries; crafts; creation of forest infrastructure; logistics, etc.).

The implementation of these technologies/measures will require at the initial/preparatory stage an extensive analysis of regulatory and policy barriers, but also a list of activities aimed at solving (development and/or strengthening of the institutional framework for afforestation and forest management activities; updating of technical norms and regulations; strengthening the planting subsector; contractual arrangements defining roles and responsibilities for stakeholders, etc.), which will partially change approaches and the situation in the forestry sector.

The detailed description of the sectoral technologies/measures was made on the basis of a technical sheet form (Annex no. 1) containing basic information about the technological options, including brief description of the technology, application potential, costs (capital and exploitation), technical aspects (range of geographical applicability, maturity, etc.), impacts/benefits from their application (environmental, social, economic, etc.). The long list of identified technological options for the forestry sector is set out in Table 3.11.

Table 3.11: Long list of identified technological options for the forestry sector

Climate impact	Subsectors	Adaptation technologies/measures
Climate impact 1: Diminishing production of biomass, other forest products and services	1.1. Extension of new areas with forests and other forest vegetation	Increasing the degree of afforestation of the territory in the country by planting forest crops resilient to climate change (30 thousand ha; 75 million euros).
		Afforestation of riparian strips of rivers and water basins (15 thousand ha; 37.5 million euros).
		Creation and consolidation of forest curtain systems for the protection of agricultural fields and communication routes (12 thousand ha; 21.6 million euros).
		Implementation of practical activities for the creation and rehabilitation of silvopastoral and agroforestry systems (5 thousand ha; 3.8 million euros).
		Extension of green areas in urban and rural localities (3.0 thousand ha; 10.5 million euros).
		Planting and promotion of forestry crops with industrial and energy profile (3.0 thousand ha; 10.5 million euros).
	1.2. Regulation of forest management	Ensuring the implementation of the forestry regime in all forests and forest vegetation, regardless of departmental affiliation and nature of ownership (137 thousand ha; 2.1 million euros).
		Adapting forest regeneration norms and practices to the needs imposed by climate change (0.2 million euros).
		Regulatory regulation of carbon stock conservation practices in forests and their incorporation into forest management (0.1 million euros).
	1.3. Valuing forest products and services	Encouraging the development of small wood processing enterprises in rural areas to reduce the carbon footprint and increase the use of wood in products with a long period of use (3.0 million euros).
		Adaptation of timber harvesting practices in Moldovan forests to climate change (2.5 million euros).
		Increasing the contribution of wood from sustainable forest management, as a renewable energy source, to the country's energy balance (EUR 1.5 million).
Climate impact 2: Changing forest regeneration rate, forest degradation and depletion	2.1. Rehabilitation of degraded and inadequate arboretums	Ecological restoration of inadequate arboretums vulnerable to climate change (25 thousand ha; 50 million euros).
	2.2. Breeding forest reproductive material	The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions (7.8 million euros).
	2.3. Research and technological development	Considerations on climate change impacts, forest species and appropriate forest ecosystem management strategies (0.8 million euros).
		Strengthening the information system about the state and evolution of forests in the Republic of Moldova by carrying out the National Forest Inventory (499 thousand ha; 1.6 million euros).
	2.4. Capacity building, awareness and communication	Improving the capacity of public advisory services in forestry and relations with climate change (0.4 million euros).
		Strengthening institutional capacities of the forestry sector in forest management regarding the necessity and opportunity of implementing climate change adaptation and mitigation measures (0.3 million euros).
		Public awareness about forests and climate change, contribution to the management and consumption of services and wood products at individual and community level (0.2 million euros).
Climate impact 3: Worsening	3.1. Monitoring forest condition	Strengthening the system of detection, monitoring and liquidation of forest fires (2.2 million euros).

Climate impact	Subsectors	Adaptation technologies/measures
phytosanitary status of forest ecosystems and increasing incidence of forest fires		Strengthening the system of detection, monitoring and liquidation of outbreaks of forest diseases and pests (1.2 million euros).

The normative, national and international policy framework supporting climate change adaptation technologies/measures identified for the national forestry sector is mainly the following:

- Sustainable Development Strategy of the Forestry Sector in the Republic of Moldova, PD 350/2001.
- Strategy of the Republic of Moldova for adaptation to climate change and Action Plan for its implementation, GD 1009/2014.
- Environmental Strategy of the Republic of Moldova for 2014-2023 and Action Plan for its implementation, GD 301/2014.
- Energy Strategy of the Republic of Moldova until 2030, GD 102/2013.
- EU forest strategy (2013/2014).
- European Parliament resolution on the EU Forest Strategy – The Way Forward (2019/2157(INI).
- EU Directive 2018/2001 on the promotion of the use of energy from renewable sources.
- United Nations Strategic Plan for Forests 2017-2030.
- Forestry Code, 887/1996.
- Law on improvement through afforestation of degraded lands, nr. 1041/2000.
- Law on protection zones and strips of rivers and water basins, nr. 440/1995.
- Water Law, 272/2011.
- Law on Green Spaces of Urban and Rural Localities, 591/1999.
- GD 32/2001 on measures to establish riparian zones and strips for the protection of rivers and water basins.

The adaptation options identified include the realization of a wide range of transfer and diffusion of existing and new technologies in the forestry sector in the Republic of Moldova. Among the main **innovative aspects** foreseen within the technologies selected and proposed for implementation are:

- The use of biotechnologies in the process of industrial growth of forest seedlings; conducting genetic research and in vitro breeding of forest species; automated irrigation systems in forest nurseries.
- Industrial processing and conditioning of forest seeds; technical solutions for the care of seed source arboretums and those designated as forest genetic resources; quality assessment and certification of regeneration material.
- Establishment and commissioning of basic elements of the subsector for the production of forest reproductive material: Creation of 2 regional centers for industrial breeding of forest reproductive material usable in the new climatic conditions (northern and southern areas), creation and appropriate technical endowment of the National Center for Forest Genetics and Semiology (Centre area).
- Establishing climate thresholds corresponding to the spatial distribution limits of forest types and/or forest species, with the development of bioclimatic models to predict future distributions of steady-state forests, in a range of plausible climate change scenarios.

- Calibration of biogeochemical models for forecasting changes in the productivity of arboretums and carbon stocks in the main forest types.
- Assessment of adaptive capacity, including inherent adaptive capacity of forest species and ecosystems, as well as socio-economic factors determining the capacity to implement planned adaptation measures.
- Digital forest record keeping technologies (works, land, etc.), monitoring of basic parameters of forests, carbon sequestrations, etc.
- Remote sensing, digital photogrammetry, laboratory analysis and statistical processing of data on the evolution of forest status, in particular interconnection with climate change (NFI, etc.).
- Use of climate projections in forest design and influence on the evolution of forest vegetation status.
- Conservative tillage technologies; growing and planting seedlings with protected roots.
- Use in afforestation activities only flexible and long-lived tree and shrub species capable of adapting to climate change.
- Approaches and technologies for strengthening river banks and water basins in the afforestation process.
- Innovative technical solutions for substitution of inappropriate species and arboretums.
- Silvopastoral arrangements as grassland and land management plans.
- New approaches in applying forest management, correlated with climate change and contemporary society requirements; promoting participatory management of public forest resources.
- Testing and improving the mechanisms for carrying out PFC extension/rehabilitation works within all types of properties (state; ATU; private) through the interconnection of central public authorities (MoEnv; Moldsilva; MECR; MIDR; MAFI, etc.), local public authorities (local councils, mayoralties, district councils), companies and private individuals.

Among **the main climate change adaptation benefits** of technologies/measures identified for the national forestry sector, the following aspects are mentioned:

a) Paradigm shift in the afforestation process of new lands by using only flexible and long-lived tree and shrub species, corresponding to stationary conditions, as well as able to adapt to climate change. During planting activities, seedlings with protected roots will be widely used, which has an increased capacity to accommodate on land with difficult pedogeological tails.
b) Creating new forests resilient to adverse factors (disease and pest attacks; weather and climate change, etc.). New forests will also partially compensate for inevitable losses from diminished production of biomass, other forest products and services caused by climate change.
c) The contribution of newly created forests to increasing the resilience of related sectors of the national economy (agriculture, animal husbandry, communications/infrastructure, etc.), by protecting agricultural land, water bodies, infrastructure and human localities, improving microclimatic conditions (changing albedo, decreasing the amplitude of diurnal and annual air temperature, reducing wind speed, snow retention, reducing evapotranspiration, increasing air humidity, etc.), increasing soil fertility and conservation, reducing erosion and runoff on slopes, reducing deflation to a total halt, increasing soil moisture increasing moisture in riparian and wet areas (especially during summer), increasing soil moisture resources, as well as regulating river flows, minimizing risks related to water scarcity and flooding.
d) Enhancing the Eco protective and bio productive potential of natural forests, preserving the biological diversity of forests, as well as ensuring the resilience of these forests to climate

change. The conversion from the grove regime to the Codru regime, based on the ecosystem approach (EA) and nature-based solutions (NBS), ensuring regeneration from seed, creating long-lasting arboretums capable of adapting to climate change.

e) Improve the management and conservation process of seed source arboretums as well as forest genetic resources, with the application of nature-based solutions (NBS), in particular in terms of adaptation to climate change. Ensuring traceability of seed and planting forest material.
f) Production of forest material in the assortment necessary for forest regeneration, reconstruction and extension activities, qualitatively and in the required quantities, with direct consequences on increasing the success of forest crops and adapting regeneration, reconstruction and afforestation works to climate change.
g) Develop and promote new approaches and technical regulations that will ensure the resilience of forest ecosystems to the effects of climate change, as well as the implementation of sustainable forest management principles. These documents and approaches will be based on a cycle of fundamental research cumulated with applied components on the adaptive capacities of native forest ecosystems to climate change (bioclimatic models; resilience of species and arboretums; biogeochemical models; review of approaches in the process of applying forest treatments and works, forest regeneration works, etc.).
h) Promoting new practices of sustainable forest management to stop the processes of reducing forest areas, degradation of forest biodiversity by promoting natural types of forests, reducing fragmentation of forest massifs, increasing the efficiency of forest fund guard and protection activities (including combating illegal logging of forests and related trade), etc. The forest management plans will contribute to substantially improving the management of forests and forest vegetation owned by LPAs, MIDR, companies and private individuals in terms of adaptation to climate change.
i) Diminishing forest areas affected by fires by creating a viable digital fire monitoring system of forests with connection to international and spatial resources in the field, classification of forests and other types of forest vegetation in categories of incendiary danger, elaboration of measures for anti-fire arrangement of forests, etc. Elaboration of a set of fire detection and intervention protocols, including in terms of coordination and unification of efforts/resources of forestry staff and GIES.
j) Diminishing the area of arboretums weakened and degraded as a result of disease and pest attacks, timely detection and identification of control measures for new species of forest pests migrating to Moldova, including due to climate change. Adoption in forestry practice of new technologies and equipment for land and aviation control, amendment of import or domestic phytosanitary regulations for forestry, as well as elaboration/testing/implementation of a set of detection and intervention protocols in the field of protection of forests and other categories of forest vegetation.
k) Adequate monitoring of the evolution of forest status through NBFIs, in particular, the interconnection with climate change. Preparation of studies/scenarios on the development of forest ecosystems to be used, in particular, in forest policy development processes focusing on adaptation to climate change, as well as for providing data for reporting sustainable forest management indicators, according to the international commitments assumed by the country.
l) Strengthening the capacities of institutions and staff of the forestry sector to implement effective activities to ensure forest resilience to climate change, adequate monitoring of forest status, adoption of new practices of sustainable forest management, stopping the process of reducing forest areas and degradation of forest biodiversity, promoting natural types of forests, etc.

m) Diminishing anthropogenic pressing on forests and other types of forest vegetation, with the necessary consequences regarding the condition, volume and quality of products/services delivered, as well as their capacities to adapt to climate change. Increasing the contribution of forestry sector to solving socio-economic problems (jobs, combating poverty in rural areas, etc.).

3.5 Evaluation criteria and process for prioritizing adaptation technologies on the forestry sector

3.5.1 Primary prioritization of adaptation technologies in the forestry sector

In accordance with the provisions of the TNA process, the technology prioritization exercise at forest sector level was carried out through a participatory process. In this context, the project manager sent in advance (on 28.07.2021) an e-mail message to SWG members in the forestry sector requesting participation in the preliminary selection exercise of technologies presented in the long list of technologies (LLT). The direct event was organized during a webinar on August 6, 2021. It is also mentioned the activism of SWG members, who in anticipation of the workshop came up with certain proposals to concretize and improve the list of climate change adaptation technologies for the forestry sector.

The workshop on 06 August 2021 was attended by 13 SWG members or 76% of the total. The preliminary selection of technologies for the forestry sector by SWG members was carried out on the basis of a virtual platform through the questionnaire "Prioritization of forest TNA_2021_sectorul" (reference – https://forms.gle/zDcJCiGsD88WwtJ36) developed with the support of the application "Google forms".

The questionnaire for the forestry sector was completed by 13 people. Regarding the institutional affiliation of respondents, there is a dominance of representatives of specialized administrative authorities (Agency Moldsilva; Environmental Protection Inspectorate, etc.) with 38.5%, followed by representatives of central public authorities with 23.1% and public associations (NGOs) with 15.4% (Figure 3.14).

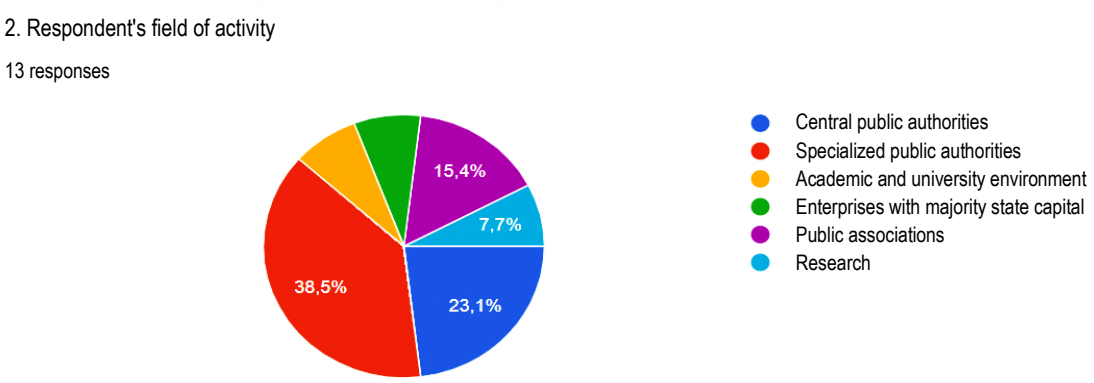


Figure 3.14: Results of forestry sector questionnaire on respondents' field of activity

The direct selection and/or prioritization of technologies was achieved by awarding points (1-10 points) by the responding SWG members. The application recorded all responses, displaying the results in graphical format (Figure 3.15). That data was then generalized, calculated and attributed to each technology.

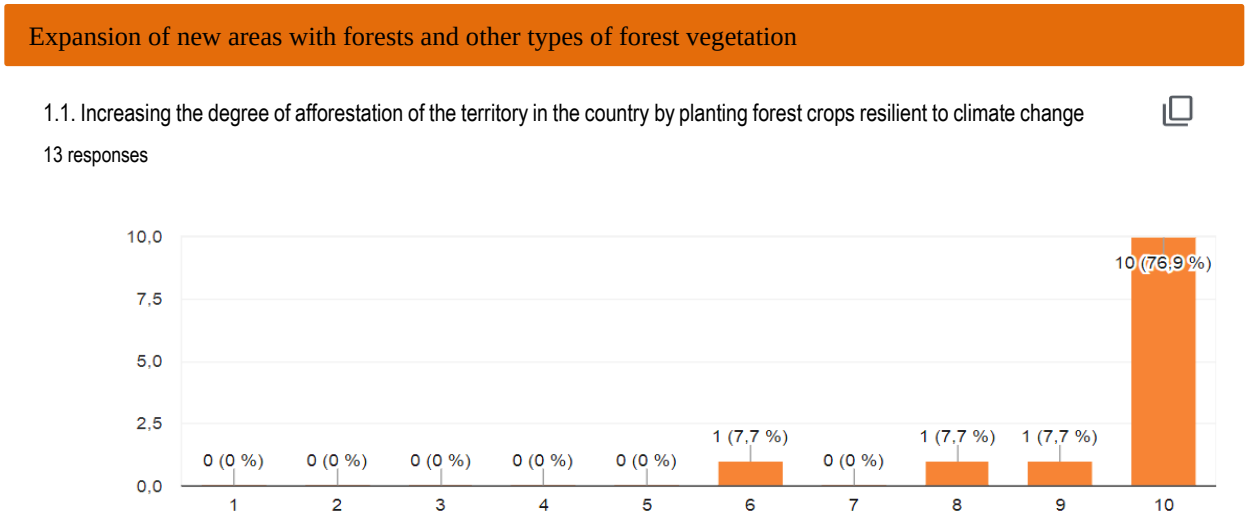


Figure 3.15: Example of scoring in the primary prioritization questionnaire on forestry sector

As a result of studying the available materials, in particular, Technology Sheets (TS), discussions and debates during the workshop, SWG members prioritized through the sectoral web questionnaire 12 technologies from the long list (LLT) proposed for implementation for the forestry sector. Thus, according to the results of the sectoral web questionnaire, the maximum score (123 points) was accumulated by the technologies "1.1. Increasing the degree of afforestation of the territory per country by planting climate-resilient forestry crops" and "1.2. Afforestation of riparian strips, rivers and water basins'. These are followed by technology "3.1. The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" with 121 points.

The remaining technologies scored lower, but are of major importance in the forest-based sector's adaptation to climate change and can constitute the sector's investment portfolio in the field of CCA. The names of technologies prioritized by forestry sector and the cumulative value of the score given by the sectoral working group are set out in Table 3.12.

Table 3.12: List of technologies/tools for adaptation of the forestry sector to climate change

Nr. Crt.	Technology naming	Cumulative score value awarded by SWG
1.	1.1. Increasing the degree of afforestation of the territory per country by planting climate-resilient forestry crops	123
2.	1.2. Afforestation of riparian strips, rivers and water basins	123
3.	3.1. The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions	121
4.	2.1. Ecological restoration of arboretums inadequate and vulnerable to climate change	120

Nr. Crt.	Technology naming	Cumulative score value awarded by SWG
5.	8.2. Training forestry personnel and decision makers involved in forest management on the need and opportunity to implement climate change adaptation and mitigation measures	120
6.	5.1. Ensuring the implementation of the forestry regime in all forests and forest vegetation, regardless of departmental affiliation and nature of property	119
7.	6.2. Strengthening the information system about the state and evolution of forests in the Republic of Moldova by carrying out the National Forest Inventory	118
8.	9.1. Public awareness about forests and climate change, contribution to the management and consumption of wood services and products at individual and community level	118
9.	1.3. Creation and strengthening of forest curtain systems for the protection of agricultural fields and communication routes	116
10.	6.1. Climate change impact considerations, forest species and appropriate forest ecosystem management strategies	113
11.	4.2. Strengthening the system for detecting, monitoring and liquidating outbreaks of forest diseases and pests	110
12.	4.1. Strengthening the forest fire detection, monitoring and liquidation system	108

3.5.2 Identification of criteria for assessment of adaptation technologies in the forestry sector

For the second stage of prioritizing climate change adaptation technologies/measures on the forestry sector, the identification of dedicated evaluation criteria was carried out. This contributed to achieving a clear and transparent process of prioritizing climate change adaptation technologies/measures selected at the primary stage. The evaluation criteria were derived by the national sector consultant based on the objectives specified in subchapters 3.1-3.3 of this Report, using the appropriate guide to the given topic (Sara Trærup and Riyong Kim Bakkegaard, 2015). Subsequently, these criteria were concretized and finalized with the participation of the members of the Sectoral Working Group (SWG). In this context, those criteria are considered appropriate to demonstrate variations between proposed technologies/sectoral measures.

The process aimed to ensure that the criteria include all relevant aspects, are not redundant (do not repeat what is already assessed by another criterion), mutually independent, etc. Criteria that cannot be measured in numbers (qualitative criteria), usually related to benefits, have been converted into a numerical form on a scale from 0 to 10 (scoring), where "0" means the least preferred option and "10" means the most preferred option. Cost criteria included the calculation of investment per operating unit (hectare). Thus, 15 evaluation criteria were selected to prioritize technologies in the forestry sector (Table 3.13). Based on the particularities of the forestry sector, these criteria are associated to 8 categories of assessment: costs; Economic; Social; medium; climate; institutional/implementation; politics; gender. The scoring scale (0-10) is also awarded for each evaluation criterion.

Table 3.13: List of criteria for assessment of adaptation technologies/measures by forestry sector

Rating categories	Criteria code	Name of selected assessment criteria	Scoring scale
Costs	Criterion A	Investment cost of technology, EUR per operating unit	0=costs very high --> 10=costs very LOW
	Criterion B	Technology maintenance/operation costs, EUR per operational unit	0=costs very high --> 10= costs very LOW

Rating categories	Criteria code	Name of selected assessment criteria	Scoring scale
Economic	Criterion D	Revenue generation capacity, scoring	0=very LOW --> 10=very high
	Criterion E	Capacity to attract private investment, score	0=very LOW --> 10=very high
Social	Criterion F	Capacity to generate new jobs, number of jobs created	0=very LOW --> 10=very high
	Criterion G	Potential for transfer and diffusion of new technologies (Degree of innovation), score	0=very LOW --> 10=very high
	Criterion H	Contribution to improving population health (recreational and recreational areas; emission reduction, etc.), scoring	0=very LOW --> 10=very high
Environment	Criterion I	The contribution of technology to protecting and sustaining ecosystem services, score	0=very LOW --> 10=very high
	Criterion J	Common benefits for increasing indigenous GHG sequestration capacities, score	0=very LOW --> 10=very high
Climate	Criterion K	Improving the sector's resilience to climate change (to what extent technology will help reduce climate vulnerability), score	0=very LOW --> 10=very high
	Criterion L	Contribution to improving climate resilience (synergism) for other sectors (agriculture, water, etc.), score	0=very LOW --> 10=very high
Institutional/ Implementation	Criterion M	Implementation ability, scoring	0=very difficult-->10= very easy
	Criterion N	Degree of replicability, score	0=very difficult-->10= very easy
Political	Criterion O	Coherence with national development policies and priorities, score	0=very LOW --> 10=very high
Gender	Criterion P	Impact on gender equality, scoring	0=very LOW --> 10=very high

3.5.3 Final prioritization of adaptation technologies on the forestry sector

In order to achieve the direct prioritization of climate change adaptation technologies/measures on the forestry sector, the multicriteria analysis (MCA) procedure was used. In this context, with the support of spreadsheets based on Excel, 3 interconnected matrices were built: Performance matrix, score matrix and decision matrix[12]. Those matrices have been constructed for each climate impact described in chapters 1.2-1.4 and 3.4 of this Report. Also, at the initial stage, the technologies included in the assessment process were allocated to the corresponding climate impacts (Table 3.14).

Table 3.14: Allocation of technologies/measures to the forestry sector to climate impacts

Name of Climatic Impact	Technology Code	Name of selected technologies
Climate impact 1: Diminishing production of biomass, other forest products and services	T/M-1	Increasing the degree of afforestation of the territory per country by planting climate-resilient forestry crops
	T/M-2	Afforestation of riparian strips, rivers and water basins
	T/M-3	Creation and strengthening of forest curtain systems for the protection of agricultural fields and communication routes
	T/M-4	Ensuring the implementation of the forestry regime in all forests and forest vegetation, regardless of departmental affiliation and nature of property;

[12] The Excel file "MCDA_Selectarea tehnologiilor_Sectorul forestier_fin" is attached separately to this Report.

Name of Climatic Impact	Technology Code	Name of selected technologies
Climate impact 2: Change in forest regeneration rate, degradation and decrease of forest areas	T/M-5	Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change
	T/M-6	The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions
	T/M-7	Climate change impact considerations, forest species and appropriate forest ecosystem management strategies
	T/M-8	Strengthening the information system about the state and evolution of forests in the Republic of Moldova by carrying out the National Forest Inventory (NFI)
Climate impact 3: Worsening phytosanitary status of forest ecosystems and increasing incidence of forest fires	T/M-9	Strengthening the forest fire detection, monitoring and liquidation system
	T/M-10	Strengthening the system for detecting, monitoring and liquidating outbreaks of forest diseases and pests

At the next stage, the share for climate impacts (CI) under which technologies/measures to overcome them are placed was established. For the forestry sector, 3 categories of climate impacts are established and the sum of the weights identified for the CI equals 100 points (Table 3.15).

Table 3.15: Share of climate impacts in the forestry sector

Nr. crt.	Name of climate impact	Percent of climate impact, %
1	Climate Impact 1: Diminishing the production of biomass, other forest products and services	33,33
2	Climate Impact 2: Changing forest regeneration rate, degradation and reduction of forest areas	33,33
3	Climate Impact 3: Change in forest regeneration rate, degradation and decrease of forest areas	33,33
TOTAL		100,00

Based on the materials developed by the national consultant, in particular, the Technology Sheets of developed format (12 TSF, etc.), SWSWG members filled in the primary forms for the performance matrix and for the score matrix, also weighting the evaluation criteria. Thus, within the performance matrix, for 3 evaluation criteria (investment costs, maintenance costs, job generation) the score was calculated in advance by the national consultant based on detailed TFS. For the remaining criteria (12 criteria) each SWSWG member scored (0-10) based on information/openness of technologies/measures in TFS, experience, personal opinion, etc. In order to facilitate the scoring process, each SWSWG member received a recommendation on how to score in the process of prioritising technologies/measures in the forestry sector (Table 3.16).

Table 3.16: Scoring in the process of prioritizing technologies/measures on the forestry sector

Nr. crt.	Score to apply	Application recommendation
1.	0	Used when information about a technology does not apply to specific criteria
2.	1-2	Extremely poor, strongly unfavorable performance
3.	3-4	Poor performance, major improvements needed
4.	5-6	At an acceptable level or above
5.	7-8	Very favorable performance, but still requiring improvement
6.	9-10	Clearly outstanding performance that is well above the norm

At the same time, SWG members individually set the weight of each evaluation criterion (score matrix). As a primary condition, it has been established that the cumulative value of all 15 assessment criteria should not exceed 100 points.

The forms filled in by SWG members were submitted to the national sector consultant. In total, 14 forms were filled in, or 82.4% of the requirement. The gender aspect of the process was acceptable: B/F – 50%/50%. At the final prioritization stage, on 02.12.2021, a webinar was organized with the participation of SWG members (11 people out of 17 or 64.7%) and NAP2 project staff (project manager, TNA group leader, etc.). During that event, the national sectoral consultant presented the results of the preparation of the performance matrix and score matrix forms.

Another important element discussed during the mentioned event was the weighting of the evaluation criteria. Thus, as a result of awarding SWG members (14 respondents) the corresponding score, the ranking of evaluation criteria by forestry sector was obtained (Table 3.17).

Table 3.17: Hierarchy of criteria for assessment of adaptation technologies/measures by forestry sector

Code of evaluation criteria	Name of selected assessment criteria	Total score awarded	Weight of criterion, %	Place occupied
Criterion K	Improving the sector's resilience to climate change (to what extent technology will help reduce climate vulnerability)	172	12,3	1
Criterion I	The contribution of technology to protecting and sustaining ecosystem services	155	11,1	2
Criterion A	Investment cost of technology	126	9,0	3
Criterion G	Potential for transfer and diffusion of new technologies (degree of innovation)	109	7,8	4
Criterion J	Co-benefits to enhance indigenous GHG sequestration capacities	99	7,1	5
Criterion B	Technology maintenance/operation costs	95	6,8	6
Criterion H	Contribution to improving public health (recreational and recreational areas; reducing emissions, etc.)	91	6,5	7
Criterion L	Contribution to improving climate resilience (synergism) for other sectors (agriculture, water, etc.)	91	6,5	8
Criterion D	Revenue generation capacity	89	6,4	9
Criterion M	Ability to implement	80	5,7	10
Criterion O	Coherence with national development policies and priorities	71	5,1	11
Criterion F	Capacity to generate new jobs	69	4,9	12
Criterion E	Ability to attract private investment	67	4,8	13
Criterion N	Degree of replicability	47	3,4	14
Criterion P	Impact on gender equality	39	2,8	15
	TOTAL	1400	100,0	-

Taking into account the specificities of the forestry sector, the maximum score (179 points or 12.3% of the total) was awarded to the Criterion assessment reflecting climate benefits: "Improving the sector's resilience to climate change (to what extent technology will contribute to reducing climate vulnerability)". In 2nd place was the Criterion assessment reflecting the environmental benefits "The contribution of technology to protecting and sustaining ecosystem services", which accumulated 155 points or 11.1%. The Criterion rating reflecting investment aspects (Cost of Technology Investment) accumulated the third score – 126 points or 9.0%. It is important to note that at the meeting the score given to each criterion (Table 3.17) was agreed by consensus by all SWG members. At the same time,

it was mentioned that for sensitivity analysis it is necessary to increase the weight of criteria related to primary investment (Criterion A) and maintenance/operation (Criterion B), as the overall increase in costs generated by the current energy crisis and other related aspects are anticipated, at least in the short term.

The next operation in the prioritization process was to normalize the values/indicators within the performance matrix and build the score matrix. For this, all values in the performance matrix, including costs, are converted to points on the scale 0-100, and the achievement of that operation is ensured by using two equations:

- In cases where the minimum value is preferable (under cost criteria):

$$Y_i = 100*(X_{max} - X_i)/ (X_{max} - X_{min})$$

- In cases where the maximum value is preferable:

$$Y_i = 100*(X_i - X_{min})/ (X_{max} - X_{min})$$

The results of the normalization operation on the forestry sector are presented in Table 3.18. These are intermediate values that are used to prioritize adaptation technologies/measures in the decision matrix.

Table 3.18: Normalization of the value of technology/measure assessment criteria by forestry sector

Name of selected assessment criteria	T/M-1	T/M-2	T/M-3	T/M-4	T/M-5	T/M-6	T/M-7	T/M-8	T/M-9	T/M-10
Investment cost of technology	0	0	28	100	0	70	100	100	0	100
Technology maintenance/operation costs	22	0	11	100	58	0	100	100	0	100
Revenue generation capacity	13	65	100	0	100	81	48	0	0	100
Ability to attract private investment	0	68	100	61	65	100	19	0	0	100
Capacity to generate new jobs	100	46	36	0	100	8	2	0	100	0
Potential for transfer and diffusion of new technologies (Degree of innovation)	13	0	100	0	0	100	80	90	0	100
Contribution to improving public health (recreational and recreational areas; reducing emissions, etc.)	100	97	52	0	100	47	36	0	100	0
The contribution of technology to protecting and sustaining ecosystem services	91	100	64	0	100	63	66	0	100	0
Co-benefits to enhance indigenous GHG sequestration capacities	100	92	75	0	100	66	45	0	100	0
Improving the sector's resilience to climate	100	76	66	0	100	88	65	0	100	0

Name of selected assessment criteria	T/M-1	T/M-2	T/M-3	T/M-4	T/M-5	T/M-6	T/M-7	T/M-8	T/M-9	T/M-10
change (to what extent technology will help reduce climate vulnerability)										
Contribution to improving climate resilience (synergism) for other sectors (agriculture, water resources, etc.)	83	88	100	0	100	55	0	10	100	0
Ability to implement	9	9	9	0	11	100	33	0	0	100
Degree of replicability	71	57	100	0	67	0	100	85	100	0
Coherence with national development policies and priorities	100	100	95	0	80	100	30	0	100	0
Impact on gender equality	100	100	79	0	38	100	35	0	0	100

3.6 Results of prioritizing climate change adaptation technologies on forestry sector

3.6.1 Results regarding the prioritization of climate change adaptation technologies on the forestry sector according to MCA

The final stage of the prioritization exercise with MCA support is the construction of the decision matrix. The decision matrix is based on performance and score matrix data. The results of the MCA exercise were carefully examined to see if the calculations and rows were logical. First, it has ensured that the scores given to different criteria are consistent and reflect technological merits. The results of prioritizing adaptation technologies/measures are presented in Table 3.19. The intermediate score (column 3) is the sum of the calculated values in the score matrix multiplied by the weighting of the assessment criteria. The final score (column 4) is the product of the intermediate score and the value given to climate impact (on average – 33.33%).

Table 3.19: Hierarchy of adaptation technologies/measures by forestry sector according to MCA assessment

Technology codes	Name of technologies assessed	Intermediate score	Final score	Priority level T/M
T/M-5	Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change	67,36	22,45	1
T/M-6	The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions	64,62	21,54	2
T/M-7	Climate change impact considerations, forest species and appropriate forest ecosystem management strategies	53,32	17,77	3
T/M-9	Strengthening the forest fire detection, monitoring and liquidation system	45,86	15,29	4
T/M-1	Increasing the degree of afforestation of the territory per country by planting climate-resilient forestry crops	43,33	14,44	5

Technology codes	Name of technologies assessed	Intermediate score	Final score	Priority level T/M
T/M-3	Strengthening and strengthening forest curtain systems for the protection of agricultural fields and communication routes	41,36	13,79	6
T/M-2	Afforestation of riparian strips, rivers and water basins	38,70	12,90	7
T/M-10	Strengthening the system for detecting, monitoring and liquidating outbreaks of forest diseases and pests	28,36	9,45	8
T/M-8	Strengthening the information system about the state and evolution of forests in the Republic of Moldova by carrying out the National Forest Inventory (NFI)	26,29	8,76	9
T/M-4	Ensuring the implementation of the forestry regime in all forests and forest vegetation, regardless of departmental affiliation and nature of property	18,72	6,24	10

The analysis of the results presented in Table 3.19 shows that SWG members in the forestry sector have given priority to technology aimed at restoring the ecoprotective and bioproductive potential of existing forests, especially degraded and inadequate ones: T/M-5 "**Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change"**, which accumulated a final score of 22.45 points. The technology provides for the application of ecological restoration practices on a total area of 25.0 thousand ha for degraded and inappropriate arboretums (totally derived, inappropriate to stationary conditions, poor productive, etc.), vulnerable to climate change, aiming at replacing arboretums with a single species with mixed and plurian arboretums, maximum use of the shelter of the degraded stand, etc. All silvotechnical interventions within this system will be carried out in accordance with the place and role of each component element of the ecosystem (trees, shrubs, animal kingdom, etc.), applying the ecosystem approach. As intervention methods, substitutions and restorations will be applied as a priority.

Green restoration is a very complex operation and is qualified as an indispensable component of the forest-based sector's adaptation to climate change. The main effects of implementing those operations are:

a) Conversion from the grove regime to the Codru regime, ensuring regeneration from seed, creating long-lasting arboretums capable of adapting to climate change.
b) Taking a decisive step in the conservation of biological diversity, forest vegetation providing refuge and habitats for various species of plants and wild animals endangered by anthropogenic impact;
c) Diminishing soil degradation processes through erosion, landslides, etc.
d) Qualitative improvement of aquatic resources, forest vegetation contributing to efficient groundwater supply, reduction of solid flow and concentration of pollutants.
e) Reducing atmospheric pollution by capturing carbon dioxide and various pollutants that endanger human health and the vitality of biological ecosystems, ensuring the increase of carbon capture capacities by the targeted arboretums by 40-50%, making the most of the available stationary potential.
f) Increasing the potential of products and services of rehabilitated forests (wood, medicinal plants, berries, etc.).
g) Achieving a wide range of transfer and dissemination of existing and new technologies in the forestry sector in the Republic of Moldova (digital technologies (including GIS/GPS); innovative technical solutions for substitution of inappropriate species and arboretums; carbon monitoring; growing and planting seedlings with protected roots, etc.).

h) Testing and improving the mechanisms for carrying out works through interconnection in the implementation process of central public authorities (MoEnv; Moldsilva, etc.), companies and private individuals.
i) Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management, innovative technical solutions for ecological restoration of degraded and inadequate arboretums, forest management in a sustainable manner and in accordance with new climatic conditions.
j) Creation of new jobs in rural areas related to a wide range of activities: Afforestation/reforestation works; development of sustainable forest management; logging; Woodworking; marketing of firewood; collection and marketing of non-wood products of the forest (fruits and berries; medicinal plants; beekeeping, etc.), handicrafts, etc.

The next technology/measure ranked in the hierarchy of the forestry sector is T/M-6: "**Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions**". According to MCA, that technology has accumulated a final score of 21.54 points. The technology provides for the adaptation of the subsector of production of forest reproductive material to the evolution of climate change through activities to strengthen and modernize the process throughout the production chain: Identification, legalization and care/maintenance of seed source arboretums (including forest genetic resources/FGR); harvesting, processing and certification of forest seed; industrial breeding and valorization of forest reproductive material, etc. This process will include the use of biotechnologies for the production of seedlings (multiplication, rooting, in vitro growth, etc.), including with protected roots (about 50-60%). Also, for the regeneration and afforestation works in the Republic of Moldova, the assortment of species of trees and shrubs growing in the forests of the Republic of Moldova (over 85 species) will be ensured. Another important compartment will be the revision of the normative basis aimed at the management and conservation of forest genetic resources, including in terms of adaptation to climate change.

The technology includes the establishment and commissioning of basic elements of the subsector for the production of forest reproductive material: Creation of 2 regional centers for industrial breeding of forest reproductive material (RCIBFRM) usable in the new climatic conditions (northern and southern areas; appropriate technical equipment; primary operational activity; staff training, etc.), creation and appropriate technical endowment of the National Center for Genetics and Forest Seminology/NCFGS (center area; seed base management, certification of regeneration material; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro multiplication; primary operational activity; seed processing equipment, nursery and laboratory equipment for quality evaluation, etc.). The main and direct benefits of implementing the technology are:

a) Production of forest material in the required assortment, quality and in the necessary quantities, which will contribute to increasing the success of forestry crops and adapting regeneration and afforestation works to climate change.
b) Improving the management and conservation process of seed source arboretums as well as forest genetic resources, in particular in terms of adaptation to climate change.
c) Implementation of innovative components foreseen within the measure: Biotechnologies; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro breeding; automated irrigation systems; technical solutions for the care of seed source arboretums and those designated as forest genetic resources; digital technologies (GIS/GPS) for land and works records, etc.

d) Contributes to strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply innovative technical solutions for growing forest reproductive material both for regeneration works within the existing forest fund (including ecological restoration of degraded and inadequate arboretums) and for afforestation works on new lands (forest extension).
e) Creation of new jobs in rural areas, linked to a wide range of activities: Primary harvesting and processing of forest seeds; development of forest nurseries with industrial capacities; research and biotechnology, etc.
f) Review the regulatory basis for the management and conservation of forest genetic resources, including adaptation to climate change.

3.6.2 Analysis of the sensitivity of the process of prioritizing climate change adaptation technologies on the forestry sector according to MCA

The results obtained in the first MCA were tested on robustness or how they are stable to changing factors determining the position T/M in the list of priority levels. In this respect, according to SWG recommendations, robustness has also been studied by changing the weight of evaluation criteria, especially those related to primary implementation investment costs, but also maintenance/operating costs, etc. Also, since most adaptation technologies/measures in the forestry sector target rural areas characterized by shortages of employment, income, etc., criteria characterizing these aspects have also been included in the robustness assessment process. Thus, the scoring values for cost criteria were increased by 50%, gender criteria by 30%, and economic and social criteria by 25% each. At the same time, environmental and climate criteria were lowered by 45%, while criteria referring to institutional/implementation aspects and the policy framework remained unchanged[13]. The approaches and values applied in the robustness assessment process are set out in Table 3.20.

Table 3.20: Approaches and values applied in the sensitivity assessment process for the forestry sector

Code of assessment criteria	Name of selected assessment criteria	Sensitivity approach, %
Criterion A	Investment cost of technology	+50
Criterion B	Technology maintenance/operation costs	+50
Criterion D	Revenue generation capacity	+25
Criterion E	Ability to attract private investment, score	+25
Criterion F	Capacity to generate new jobs, number of jobs created	+25
Criterion G	Potential for transfer and diffusion of new technologies (Degree of innovation)	+25
Criterion H	Contribution to improving public health (recreational and recreational areas; reducing emissions, etc.)	+25
Criterion I	The contribution of technology to protecting and sustaining ecosystem services	-45
Criterion J	Co-benefits to enhance indigenous GHG sequestration capacities	-45
Criterion K	Improving the sector's resilience to climate change (to what extent technology will help reduce climate vulnerability)	-45
Criterion L	Contribution to improving climate resilience (synergism) for other sectors (agriculture, water resources, etc.)	-45
Criterion M	Ability to implement	0
Criterion N	Degree of replicability	0
Criterion O	Coherence with national development policies and priorities	0
Criterion P	Impact on gender equality	+30

[13] The Excel file "MCDA_Selectarea tehnologiilor_Sectorul forestier_ analyze sensitive" is attached separately to this Report.

The use of the approaches in Table 3.20 partially changed the hierarchy of technology/measure assessment criteria for the forestry sector. Comparative results with SWG values are shown in Table 3.21.

Table 3.21: Hierarchy of criteria for assessing technologies/measures by forestry sector according to sensitivity analysis

Code of evaluation criteria	Name of selected assessment criteria	According to SWG			According to sensitivity analysis		
		Score awarded	Percent of criterion, %	Place occupied	Score awarded	Percent of criterion, %	Place occupied
Criterion A	Investment cost of technology	126	9,0	3	189	13,5	1
Criterion B	Technology maintenance/operation costs	95	6,8	6	143	10,2	2
Criterion G	Potential for transfer and diffusion of new technologies (Degree of innovation)	109	7,8	4	136	9,7	3
Criterion H	Contribution to improving public health (recreational and recreational areas; reducing emissions, etc.)	91	6,5	7	114	8,1	4
Criterion D	Revenue generation capacity	89	6,4	9	111	7,9	5
Criterion K	Improving the sector's resilience to climate change (to what extent technology will help reduce climate vulnerability)	172	12,3	1	95	6,8	6
Criterion F	Capacity to generate new jobs, number of jobs created	69	4,9	12	86	6,2	7
Criterion I	The contribution of technology to protecting and sustaining ecosystem services	155	11,1	2	85	6,1	8
Criterion E	Ability to attract private investment	67	4,8	13	84	6,0	9
Criterion M	Ability to implement	80	5,7	10	80	5,7	10
Criterion O	Coherence with national development policies and priorities	71	5,1	11	71	5,1	11
Criterion P	Impact on gender equality	39	2,8	15	55	3,9	12
Criterion J	Co-benefits to enhance indigenous GHG sequestration capacities	99	7,1	5	54	3,9	13
Criterion L	Contribution to improving climate resilience (synergism) for other sectors (agriculture, water, etc.)	91	6,5	8	50	3,6	14
Criterion N	Degree of replicability	47	3,4	14	47	3,4	15
TOTAL		1400	100,0	-	1400	100,0	-

According to the data in Table 3.21, the newly calculated scores created the following hierarchy of assessment criteria for the forestry sector:

1) Investment cost of technology – 189 points or 13.5% of the total.
2) Technology maintenance/operation costs – 143 points or 10.2%.
3) Potential for transfer and diffusion of new technologies (degree of innovation) – 136 points or 9.7%.

The results of prioritization of adaptation technologies/measures by forestry sector according to robustness analysis are presented in Table 3.22.

Table 3.22: Hierarchy of adaptation technologies/measures by forestry sector according to sensitivity analysis

Technology codes	Name of assessed technologies	According to SWG			According to sensitivity analysis		
		Intermediate score	Final score	Priority level T/M	Intermediate score	Final score	Priority level T/M
T/M-6	The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions	64,62	21,54	2	60,0	20,00	1
T/M-5	Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change	67,36	22,45	1	55,0	18,32	2
T/M-7	Climate change impact considerations, forest species and appropriate forest ecosystem management strategies	53,32	17,77	3	54,9	18,30	3
T/M-10	Strengthening the system for detecting, monitoring and liquidating outbreaks of forest diseases and pests	28,36	9,45	8	39,4	13,13	4
T/M-3	Creation and strengthening of forest curtain systems for the protection of agricultural fields and communication routes	41,36	13,79	6	38,2	12,75	5
T/M-8	Strengthening the information system about the state and evolution of forests in the Republic of Moldova by carrying out the National Forest Inventory (NFI)	26,29	8,76	9	35,6	11,88	6
T/M-1	Increasing the degree of afforestation of the territory per country by planting climate-resilient forestry crops	43,33	14,44	5	33,9	11,31	7
T/M-9	Strengthening the forest fire detection, monitoring and liquidation system	45,86	15,29	4	33,2	11,08	8
T/M-2	Afforestation of riparian strips, rivers and water basins	38,70	12,90	7	29,6	9,86	9
T/M-4	Ensuring the implementation of the forestry regime in all forests and forest vegetation, regardless of departmental affiliation and nature of property	18,72	6,24	10	27,3	9,12	10

According to Table 3.22, there are certain changes in the hierarchy of climate change adaptation technologies/measures in the forestry sector. At the same time, it is mentioned that the first two technologies remained the same, only changed with the place. The results obtained in the sensitivity analysis largely confirm the correctness of the MCA exercise carried out with SWG support. In this context, for the promotion and final analysis of adaptation technologies/measures in the forestry sector, it is considered optimal to apply the hierarchy made by SWG within the MCA.

Bibliography

1. Agency „Moldsilva" (2020), Materials of the Scientific-Practical Symposium "Ensuring sustainable forest management by implementing forestry treatments and promoting natural regeneration, afforestation". Chisinau, 61 p.
2. Agency „Moldsilva" (2016). Strategy on adaptation of the forestry sector to climate change for 2017-2025 and Action Plan for its implementation, GD project.
3. Andreev, O. Cazanteva et al. (2017). Forestry sector and ecosystem services - ENPI FLEG II in the Republic of Moldova. – Ch.: Elan Polygraph. – 240 p.
4. Andreev A., Cazanteva O., Izverscaia T., Talmaci I. (2017), Assessment of losses of ecosystem services following illicit logging in the Republic of Moldova. Forestry sector and ecosystem services – ENPI FLEG II in the Republic of Moldova; Ecological Soc. "Biotica", Regional Program ENPI FLEG II. – Chisinau: S. n., (Ed. "Elan Polygraph"), 151-227.
5. Bodrug-Lungu V. (2015), Guide on gender mainstreaming in forestry on climate change. Climate Change Office, Ministry of Environment, 16 p.
6. Cazanțeva O., Andreev A., Munteanu A., Talmaci I., Cerescu A., Margineanu G. (2016), Assessment of lost revenues from illegal forest practices. Proceeding of the Symposium. Sustainable use, protection of animal world and forest management in the context of climate change. Ch., Ed. "Elan Poligraf", p. 255-256.
7. Cerescu A., Șpitoc L., Talmaci I., Galupa D., Lozan A., Evaluation of the Moldsilva Agency institutional reform options. Case study. „Silva-Mileniu III" Public Association, Embassy of Great Britain in the Republic of Moldova, Chisinau, 109 p.
8. Daradur M., Cazac V., Josu V., Leah T., Lopotenco V., Rajendra P. Pandey, Shaker R., Talmaci I., Caisin V., Isac A. (2019), National Drought Plan of the Republic of Moldova. United Nations Convention to Combat Desertification, Ministry of Agriculture, Rural Development and Environment of the Republic of Moldova, State Hydrometeorological Service, Research and Project Centre "Eco Logistica". – Chisinau: Estetini, Ed. „Bons Offices". – 116 p.
9. Demetrescu Ilie C. (1926), From forest statistics. Editor "Progress Silvic" Society, Forest Review nr. 3, Bucharest, pp. 147-150.
10. Institute of Forest Research and Management Chisinau (2011-2021), Annual reports on the development and spread of pests and diseases in forests managed by Agency "Moldsilva", including forecasts for the next period, available at: www.FRMIicas.com.md.
11. IPCC (2000), Methodological and Technological Issues in Technology Transfer. Available at: https://www.ipcc.ch/report/methodological-and-technological-issues-in-technology-transfer/.
12. Galupa D., Ciobanu A., Scobiolă M., Left-handed V., Lozan A. (2012). Illicit logging of forest vegetation in the Republic of Moldova: Analytical study 2010-2012. Report prepared within the ENPI FLFG Moldova Program.
13. Galupa D., Talmaci I. et al. (2017). Technical guide on agroforestry best practices in sustainable land management. – Chisinau: Prince Caro, - 148 p. Available at: www.icas.com.md.
14. Galupa D., Talmaci I. (2021), Establishment of forest protection curtains as a measure of adaptation to climate change. Practical guide for agricultural producers. – Chisinau, "Bons-Offices SRL" Printing House. – 60 p.
15. Andrew Mitchell, Arcadie Capcelea, Nina Rinnerberger [et al.] (2015), Republic of Moldova: Note on Forest Policy, – Ch.: I.E.P. Science, 2015 (Printing house). – 68 p., ISBN 978–9975–67–892–6.
16. Popescu Laurenţiu N. (2009), Theoretical and methodological aspects of the system of record-keeping, analysis and forecast indicators in forestry and forest economics. "Dimitrie Cantemir" Christian University of Bucharest, Faculty of Economic Sciences of Cluj. An. Inst. de Ist. "G. Bariţiu" from Cluj-Napoca, Series Humanistica, Tom. VII, pp. 281–306.
17. Talmaci I., Miron A., (2016), Sustainable management of forests and grasslands owned by local public authorities. Ch., Clima East Moldova, 48 p.

18. Ion Talmaci, Erii Prosii, Ala Mardari, Alexandru Varzari, Alexandru Galupa (2016), Report on updating the basic indicators of forests and other types of forest vegetation in the Republic of Moldova. Climate Change Office, 98 p.
19. Ion Talmaci, Erii Prosii, Ala Mardari, Alexandru Varzari, Alexandru Galupa (2018), Forests of the Republic of Moldova, current state, qualitative and quantitative indicators. Revista Pădurelor, nr. 3/2018, SC Magic Print SRL, Oneşti. pp. 7–20. ISSN 1583-7890.
20. Talmaci I., Miron A., Șpitoc L. (2021), Chapter 6: Land use, land use category change and forestry. National Inventory Report: Sources of sequestration and greenhouse gas emissions in the Republic of Moldova: 1990-2019. Prepared for reporting to the United Nations Framework Convention on Climate Change. – Chisinau: Public Institution "Environmental Project Implementation Unit" (IP "UIPM"), Environment Agency, United Nations Environment Programme, 2021 (Ed. "Bons Offices"). – 715 p.
21. Lilia Taranu, Dumitru Deveatii, Lidia Trescilo et al. (2018), Vulnerability Assessment and Climate Change Impacts in the Republic of Moldova: Researches, Studies, Solutions/Led.: Vasile Scorpan, Marius Ţaranu; Climate Change Office, Min. of Agriculture, Regional Development and Environment of the Rep. of Moldova, United Nations Environment Programme. – Chişinău: S.n., (Ed. "Bons Offices"). – 352 p.
22. Sara Traerup, Riyong Kim Bakkegaard (2015), Determining technologies for climate change adaptation. A hands-on guidance to multi criteria analysis (MCA) and the identification and assessment of related criteria. Climate Resilient Development programme, UNEP DTU Partnership, 32 p.
23. Transilvania University of Brasov (UTB), Faculty of Forestry and Forestry (2015), Forest Ecosystem Services Assessment (SEF) of the Republic of Moldova. Technical Report under the ENPI FLEG II Program, 89 p.
24. Official Gazette of the Republic of Moldova no. 090 of 02.08.2001, Parliament Decision approving the National Strategy and Action Plan in the field of conservation of biological diversity, no. 112-XV of 27.04.2001.
25. Official Monitor of the Republic of Moldova no. 133 of 08.11.2001, Parliament Decision no. 350 of 12.07.2001 approving the Strategy for sustainable development of the forestry sector in the Republic of Moldova.
26. Official Gazette of the Republic of Moldova no.126-131 of 27.06.2003, GD no. 739 of 17.06.2003 on the implementation of the Strategy for sustainable development of the national forestry sector.
27. Official Monitor of the Republic of Moldova no. 33 of 05.03.2010, GD no. 150 of 02-03-2010 approving the Regulation on organization and functioning of the Agency "Moldsilva", structure and staff limit of its central apparatus.
28. Official Gazette of RM no. 4-5/36 of 16.01.1997, Forestry Code, no. 887-XIII of 21.06.96.
29. Monitor of the Parliament of the Republic of Moldova 1993, no. 3, art. 58, 59, 60, Land Code, no. 828 of 25.12.91.
30. Official Gazette nr. 40/337 of 19.06.1997, Law on Natural Resources, nr. 1102-XIII of 06.02.97.
31. Official Gazette no. 10/283 of 30.10.1993, Law on environmental protection, no. 515-XII of 16.06.93.
32. Official Gazette no. 66-68/442 of 16.07.1998, Law on the fund of state protected natural areas, no. 1538-XIII of 25.02.98.
33. Official Gazette no. 43/482 of 03.08.1995, Law on protection zones and strips of rivers and water basins, no. 440-XIII of 27.04.95.
34. Official Gazette no. 141-143 of 09.11.2000, Law on improvement through afforestation of degraded lands, no. 1041-XIV of 15.06.2000.
35. Official Gazette of the Republic of Moldova no. 104-109 of 06.05.2014, GD no. 301 of 24.04.2014 on the approval of the Environmental Strategy for 2014-2023 and the Action Plan for its implementation.
36. Official Monitor of the Republic of Moldova no. 372-384 of 19.12.2014, GD no. 1009 of 10.12.2014 on the approval of the Strategy of the Republic of Moldova for adaptation to climate change until 2020 and the Action Plan for its implementation.

37. Official Monitor of the Republic of Moldova no. 131-138 of 29.05.2015, GD no. 274 of 18.05.2015 on the approval of the Strategy on biological diversity of the Republic of Moldova for 2015-2020 and of the Action Plan for its implementation.
38. Official Gazette of the Republic of Moldova no. 297-300 of 30.10.2015, GD no. 742 of 21.10.2015 for the approval of the Action Plan on the implementation of the National Strategy for Agricultural and Rural Development for 2014-2020.
39. Official Monitor of the Republic of Moldova no. 85-91 of 24.03.2017, GD no. 1470 of 30.12.2016 on the approval of the Strategy for low-emission development of the Republic of Moldova until 2030 and the Action Plan for its implementation.
40. Official Gazette of the Republic of Moldova no. 322-328 of 01.09.2017, GD no. 695 of 30.08.2017 on the organization and functioning of the Ministry of Agriculture, Regional Development and Environment.
41. Ukrainian Forest Management Enterprise (1988), Forest Fund of the Moldavian SSR as of 01.01.1988. Irpin, 345 p.

Annex 1: Concise Technology Fact Sheets for the Long List of Climate Adaptation Options of the Forest Sector

To facilitate the process of prioritization of adaptation technologies in the forest sector, the Long List of adaptation technology options is subject to an assessment with the support of Technology Fact Sheets (TFS), short format.

Sector / sub-sector	Forestry
TNA technology name	*1. Increasing the average afforestation rate of the country by planting climate-resilient forest crops*
National policy framework supporting technology	● Law for the improvement of degraded land by afforestation, no. 1041 of 15.06.2000; ● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014.
Short technological description of the option	The technology provides for afforestation of degraded and some marginal lands. Afforestation will be prioritized in areas of maximum influence on the land and related infrastructure. The afforestation technologies will be adapted to the primary conditions of the respective lands, and the planting material will be made up of tree and shrub species that have confirmed their suitability for heavy seasonal conditions and soil and climatic limiting factors (pedunculate oak, red oak, black pine, camphor, sapphora, field palm, field maple, field elm, Turkestan elm, Turkestan elm, Turkestan cherry, bird cherry, bird scorus, silver currant, scampia, horn, cork, etc.).
Cost and profitability (estimated)	€75 million
Market potential (scalability)	MADRM, Agency "Moldsilva", APL, companies and private persons. Coverage area - about 30 thousand ha of degraded and marginal lands, unsuitable for efficient agriculture, located throughout the country.
Impact and benefits of adaptation	The impact will be felt by increasing the areas covered with forest vegetation, which will reduce slope degradation processes, surface runoff, protect agricultural land, water bodies, infrastructure and human settlements. Proper application will create forests resistant to unfavorable factors (disease and pest attacks; weather and climate change, etc.). It will also increase thermal and living comfort of the population, soil moisture resources, biodiversity. Expanded forest areas will improve the rural landscape and will complement the widening of recreational areas for the population. The expansion of forested areas will strengthen indigenous GHG sequestration capacities.

Sector / sub-sector	Foresry
TNA technology name	*2. Ecological restoration of unsuitable and climate vulnerable stands*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and the Action Plan for its implementation, GD 301/2014; ● State Program for the regeneration and afforestation of forest land for the years 2003-2020, GD no. 737 of 17.06.2003.
Short technological description of the option	The technology provides for the application of practices for the reconstruction of degraded and unsuitable stands (totally derived, braced, unsuitable for seasonal

	conditions, poorly productive, etc.), particularly of oak and willow, with the aim of preserving the internal forest environment unaltered by making maximum use of the shelter of the degraded stand. All silvicultural interventions within this system will be carried out in full accordance with the place and role of each component of the ecosystem (trees, shrubs, animal kingdom, etc.). In local and regional forestry practice, three main methods of intervention are applied: substitution, improvement and restoration.
Cost and profitability (estimated)	EUR 50 million
Market potential (scalability)	MADRM, "Moldsilva" Agency. Coverage area - about 25 thousand ha on the account of degraded and inadequate stands of degraded and inadequate stands located in the state-owned forest fund.
Impact and benefits of adaptation	The basic impact will be the creation of stands resistant to unfavorable factors (disease and pest attacks; weather and climate change, etc.). It will also improve the condition of forest habitats and biodiversity. Reconstruction will help to increase the carbon sequestration capacity of the targeted stands by 40-50%, maximizing the available standing potential.

Sector / sub-sector	Forestry
TNA technology name	*3. Afforestation of riparian strips of rivers and water basins*
National policy framework supporting technology	● Law on zones and strips of protection of waters of rivers and water basins, no 440 of 27.04.95; ● Water Law No 272 of 23.12.2011 ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● HG no. 32/2001 on the measures for the establishment of riparian zones and strips for the protection of rivers and water basins; ● National program on the establishment of the national ecological network for the years 2011-2018, HG No 593/2011;
Short technological description of the option	The technology provides for the application of afforestation practices of riparian strips for the protection of rivers and water basins. Afforestation will be carried out where soil, topography and infrastructure conditions allow, with priority being given to meadow areas. The assortment of species and shrubs will be characteristic of the seasonal conditions (white poplar, black poplar, white willow, red willow, red willow, elm, ash, red hawthorn, black elder, blackthorn, hawthorn, etc.)
Cost and profitability (estimated)	EUR 37.5 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, "Moldova Waters" Agency, LPA, companies and private persons. Coverage area - about 15000 ha in riparian areas, river/streambeds and wetlands all over the country.
Impact and benefits of adaptation	The impact will be felt through an increase in forest cover, which will reduce surface runoff, increase infiltration into the soil and contribute to increased moisture in riparian and wet areas (especially in summer) and to increased soil moisture resources. New forests will help regulate river flows, minimizing the risks of water shortages and flooding. As a result, it will improve the quality of meadow ecosystems, maintain and enhance biodiversity. New forest areas will complement the widening of recreation areas. The expansion of forested areas will contribute to landscape improvement and strengthen the indigenous GHG sequestration capacities.

Sector / sub-sector	Forestry

TNA technology name	*4. Establishment of new (including strengthening existing) systems of protective forest shelterbelts*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014.
Short technological description of the option	The technology foresees the application of practices for the creation and/or consolidation/rehabilitation of forest protection for agricultural fields, watercourses, roads, etc. Planting will be carried out as a priority in areas of maximum influence on the land and related infrastructure. The planting technologies will be adapted to the respective conditions, and the planting material will be of tree and shrub species that have proven their suitability for the conditions and characteristics of the assigned land (pedunculate oak, camphor, field palm, field maple, field elm, Turkestan elm, Turkestan elm, Turkestan cherry, bird cherry, bird scorus, silver currant, currant, sweetgum, hornbeam, cork oak, etc.).
Cost and profitability (estimated)	EUR 12.5 million
Market potential (scalability)	MADRM, Agency "Moldsilva", APL, companies and private persons. Area of coverage - about 5 thousand ha of forest protection forest protection of agricultural fields, watercourses, roads, etc. The works will be carried out on public and private land located throughout the country.
Impact and benefits of adaptation	The main impact will consist in the extension (consolidation/rehabilitation) of the area of the protective forest buffer systems, which will contribute to the reduction of degradation processes on sloping land, surface runoff, protect agricultural land, water bodies, infrastructure, etc. These systems will also increase the productivity of neighboring agricultural land by about 12-15%, contributing to improved food security, providing a means of diversification of production systems, conservation of soil moisture resources, biodiversity, etc. New forest buffer systems will contribute to landscape improvement and strengthening of indigenous GHG sequestration capacities.

Sector / sub-sector	Forestry
TNA technology name	*5. Adapting the production of forestry seed and planting material to climate change developments*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015;
Short technological description of the option	The technology foresees the strengthening and modernization of the forest reproductive material production sector along the whole production chain: identification and legalization of seed source stands (including forest genetic resources/FGR); harvesting, processing and certification of forest seeds; industrial breeding and valorization of forest reproductive material, etc. This process will include the use of biotechnologies for the production of planting material (multiplication, rooting, *in vitro* growth, etc.), including with protected roots (about 50-60%). It will also ensure the assortment of tree and shrub species growing in the forests of the RM (more than 85 species). Another important area will be the revision of the regulatory basis for the management and conservation of forest genetic resources, including adaptation to climate change.

Cost and profitability (estimated)	EUR 7.8 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, APL, companies and private persons. The activities for the current stage will include identification, legalization and improvement of the status of 3150 ha of forest genetic resources and forest seed source stands; establishment of 3 centers for industrial breeding of forest reproductive material with a total annual capacity of production of 45 million seedlings, which will be used in the afforestation of degraded lands, riparian strips, creation of green spaces, etc.
Impact and benefits of adaptation	The impact will focus on increasing the quantity of forest reproductive material harvested from identified sources, with beneficial consequences on the quality of forest reproductive material grown in forest nurseries. The centers will also provide the whole assortment of tree and shrub species necessary for regeneration and afforestation works based on seasonal conditions. These centers will ensure the production of 50-60% of forest material with protected roots, which will contribute to increasing the success of forest crops and adaptation of regeneration and afforestation works to climate change. Another important result will be the revision of the regulatory basis for the management and conservation of forest genetic resources, including adaptation to climate change.

Sector / sub-sector	Forestry
TNA technology name	*6. Implementation of practical activities for the creation and rehabilitation of silvopastoral and agroforestry systems*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015; ● Regulation on grazing and mowing, HG No 667/2010;
Short technological description of the option	The technology foresees activities for the creation of silvopastoral systems and/or the rehabilitation of similar degraded systems owned by the TAUs. The initial phase includes the elaboration of silvopastoral management plans as medium-term management plans (10 years). The technology foresees the sowing of perennial grasses characteristic of natural grasslands in the Republic of Moldova. These works will be combined with the planting of trees and shrubs in alignments or biogroups for the protection of grasslands, animals and water sources, as well as the consolidation of landforms and territorial organization. Care/maintenance works will also be carried out, as well as technical regulations on the use of meadows, etc.
Cost and profitability (estimated)	EUR 3.8 million
Market potential (scalability)	MADRM, Agency "Moldsilva", APL, companies and private persons. Activities for the current phase will include the creation and/or improvement of the condition of about 5000 ha of silvopastoral systems.
Impact and benefits of adaptation	The impact will be an increase in the area of forest-pastoral or rehabilitated systems, which will contribute to the reduction of degradation processes on sloping land, surface runoff, etc. The planting of trees and shrubs on or adjacent to grassland will contribute to their adaptation to climate change. These systems will also increase grassland productivity, soil moisture resources, biodiversity, etc. New/improved silvo-forestry systems will contribute to landscape improvement and enhance indigenous GHG sequestration capacities.

Sector / sub-sector	Forestry
TNA technology name	*7. Expanding green spaces in urban and rural areas*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015; ● Law on Green Spaces of Urban and Rural Settlements, No. 591-XIV of 23.09.1999;
Short technological description of the option	The technology envisages the extension of green spaces in the urban and rural areas of urban and rural localities (park forests, parks, squares, street alignments, etc.). The technology will involve the planting of trees and shrubs on bare areas in the localities. Tree and shrub species adapted to unfavorable local conditions (gases/noxes, dust, etc.), as well as contributing to the improvement of aesthetics and living conditions of the inhabitants will be used.
Cost and profitability (estimated)	EUR 10.5 million
Market potential (scalability)	MADRM, Agency "Moldsilva", Ministry of Health, Labor and Social Protection, APL, companies and private persons. Coverage area - about 3.0 thousand ha in localities all over the country.
Impact and benefits of adaptation	The main impact will be expressed by increasing the areas covered with forest vegetation in the settlements, which will contribute to increase thermal comfort, reduce surface runoff, increase its infiltration into the soil and increase humidity in urban areas, especially in summer. Forested areas will reduce storm runoff and contribute to reducing pressure on urban infrastructure.

Sector / sub-sector	Forestry
TNA technology name	*8. Planting and promotion of industrial and energy forest crops*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Energy Strategy of the Republic of Moldova until 2030, GD no. 102/2013; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014;
Short technological description of the option	The technology envisages the planting of fast-growing forest crops (poplar, willow, etc.), managed at short production cycles (3-10 years) on communal and private land, and the utilization of residual forest biomass resources for energy purposes. It also envisages the creation of a regional network of mother plantations and demonstration plots for local promotion and transfer.
Cost and profitability (estimated)	EUR 10.5 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, APL, companies and private persons. Activities for the current stage will include identification, legalization and improvement of the status of the volume for the current stage - about 3000 ha.
Impact and benefits of adaptation	The impact of the technology will be to increase the area of fast-growing forest crops for energy use, which will contribute to reducing fossil fuel use. Forestry crops will also partly contribute to the reduction of degradation processes on sloping land, surface runoff, protect agricultural land, water bodies, infrastructure, etc. They will also contribute to the strengthening of indigenous GHG sequestration capacities.

Sector / sub-sector	Forestry
TNA technology name	*9. Strengthening forest fire detection, monitoring and suppression system*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014;
Short technological description of the option	Technology provides for the strengthening and modernization of the forest fire detection and suppression system, including through the wider use of information/digital technologies and the implementation of a project of fire prevention planning of all forests in the Republic of Moldova regardless of the nature of ownership (creation of the digital forest fire monitoring system with connection to international and spatial resources in the field; classifying forests and other types of forest vegetation into fire hazard categories; developing forest fire management measures; identifying forest sectors with strict needs for implementation of fire prevention measures, etc.The activity will include the revision of the normative basis related to forest fire prevention and suppression, post-fire adaptation and forest restoration. It is also planned to draw up a set of fire detection and intervention protocols, including the coordination and unification of efforts/resources of forestry personnel and the General Inspectorate for Emergency Situations (IGSU).
Cost and profitability (estimated)	EUR 1.2 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, Environment Agency, IGSU, APL, companies and private persons. The activities for the current phase will include the realization of a project of fire management of all forests in the Republic of Moldova regardless of the nature of ownership (about 425 thousand ha) and the creation of the digital fire monitoring system of forests.
Impact and benefits of adaptation	The impact of the implementation of the given technology will be to increase the detection and timely intervention capabilities in forest fires. The reduction of forest areas affected by fires will contribute to the preservation of biodiversity in forest ecosystems. The proper functioning of the forest fire detection and suppression system will contribute to the strengthening of indigenous GHG sequestration and/or GHG emission reduction capacities.

Sector / sub-sector	Forestry
TNA technology name	*10. Strengthening the system for detecting, monitoring and eradicating outbreaks of forest pests and diseases*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015; ● Forest Code, no. 887 of 21.06.1996;
Short technological description of the option	The technology foresees the strengthening and modernization of the system of detection and liquidation of outbreaks of forest diseases and pests by revising and strengthening the monitoring network of forest health and forest pathology, including the creation of the digital subsystem of forest health with the connection to international and spatial resources in the field. The work also includes the revision of the RM Forest

	Health Rules, as well as the development of a set of protocols for screening and intervention in the field of forest protection.
Cost and profitability (estimated)	EUR 1.2 million
Market potential (scalability)	MADRM, Agency "Moldsilva", Environment Agency, IGSU, APL, companies and private persons. Activities for the current phase will include the revision and strengthening of the forest health and forest pathology monitoring network, including the creation of the digital forest health subsystem, etc.
Impact and benefits of adaptation	The main impact of the implementation of the given technology will be to increase the detection and timely intervention capabilities in forest pest and disease outbreaks. The reduction of forest areas affected by diseases and pests will contribute to improved health and preservation of biodiversity in forest ecosystems. It will also contribute to reducing the area of stands vulnerable to various unfavorable factors, including climatic ones. The proper functioning of the system for the detection and eradication of outbreaks of forest pests and diseases will contribute to the strengthening of the indigenous GHG sequestration capacities.

Sector / sub-sector	Forestry
TNA technology name	*11. Strengthening the information system on the state and evolution of forests in the Republic of Moldova by realizing the National Forest Inventory (NFI)*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector of the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015; ● Forest Code, no. 887 of 21.06.1996;
Short technological description of the option	The technology foresees the consolidation and modernization of the information system on the state and evolution of forests in the Republic of Moldova through the realization of the National Forest Inventory (NFI). The NFI will be carried out through a network of permanent sample areas in a continuous regime and will be updated every 4 years, includes the collection of field data (on trees, stands, dead wood, forest soils, etc.), digital photogrammetry, laboratory analysis and statistical data processing. The NFI also includes the preparation of studies/scenarios on forest sector development to be used, in particular, in forest policy development and inter-sectoral cooperation processes, as well as for providing data for reporting indicators of sustainable forest management, in line with the country's international commitments.
Cost and profitability (estimated)	EUR 1.6 million
Market potential (scalability)	MADRM, Agency "Moldsilva", Environment Agency, MEI, APL, companies and private persons. The activities for the current phase will include the realization of NFIs (field and office phase) for the entire national forest fund (about 448 thousand ha), as well as forest vegetation outside it (about 51 thousand ha).
Impact and benefits of adaptation	The realization of the NFI will provide credible and reliable up-to-date information on the status and trends of forest vegetation throughout the country. The NFI data will be a credible source for providing indispensable data for forest policy development and inter-sectoral cooperation processes, as well as national reporting to the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity.

Sector / sub-sector	Forestry

TNA technology name	*12. Ensure the implementation of the forestry regime in all forests and forest vegetation regardless of departmental affiliation and nature of ownership*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015; ● Forest Code, no. 887 of 21.06.1996;
Short technological description of the option	The technology provides for strengthening the process of implementing the forestry regime in the forest and other types of forest vegetation outside the forest (forest cover; green spaces; silvopastoral and agroforestry practices, etc.) by developing forest management plans (forest management plans) for forest land owned by owners other than the state (LPA; MEI; private companies and individuals, etc.). The work will include the description of the current state of forests, as well as the design of concrete management and improvement measures, including in terms of adaptation to climate change.
Cost and profitability (estimated)	EUR 2.1 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, Environment Agency, MEI, APL, companies and private persons. The activities for the current phase will include the realization of forest management works (field and office phase) for the forest fund owned by owners other than the "Moldsilva" Agency (about 86 thousand ha), as well as forest vegetation outside it (about 51 thousand ha).
Impact and benefits of adaptation	The elaboration of forest management plans will contribute to a decisive improvement in the management of forests and forest vegetation (including adaptation to climate change) owned by LPAs, MEIs, companies and private persons. Forest management plans will provide credible and reliable up-to-date information on the state and development of forests and forest vegetation throughout the country. The forest management data will be used in the processes of policy making and inter-sectoral cooperation (agriculture; territorial organization, etc.), international reporting, etc.

Sector / sub-sector	Forestry
TNA technology name	*13. Encouraging the development of small wood processing enterprises in rural areas to reduce the carbon footprint and increase the use of wood in long-life products*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014;
Short technological description of the option	The technology envisages the creation and implementation of a system of facilities for the development of small wood processing enterprises in rural areas, in the context of reducing the carbon footprint and increasing the use of wood in long-life products. This system must also include support for the creation of plantations for the industrial growth of wood to be harvested and processed at small rural enterprises.
Cost and profitability (estimated)	EUR 3.0 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, MEI, APL, companies and private persons. The activities for the current stage will include the amendment of the legislation to grant incentives, the establishment of grant programs for the establishment of units in the field of primary processing (timber, etc.) and / or final processing (weaving, furniture,

	etc.) of wood products in rural localities, as well as support for the creation of plantations for industrial wood growth, which will be harvested and processed in small rural enterprises.
Impact and benefits of adaptation	The impact of the implementation of the given technology will be to increase the amount of wood mass with a long period of use (over 20 years). It will also contribute to the creation of plantations for the industrial growth of wood, which will be harvested and processed by small rural enterprises, as well as to the strengthening of the domestic GHG sequestration capacities.

Sector / sub-sector	Forestry
TNA technology name	*14. Adapting forest regeneration rules and practices to the needs of climate change*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015;
Short technological description of the option	The technology foresees a thorough review of the regulatory framework for forest regeneration, in particular aspects related to the timing of works, regeneration compositions, species mix (including the use of tree/shrub genotypes adapted to new climatic conditions), planting schemes, etc. This review will be based on relevant applied research and investigations, including climate change.
Cost and profitability (estimated)	EUR 0.2 million
Market potential (scalability)	MADRM, Agency "Moldsilva", APL, companies and private persons. The activities for the current phase will include the revision of technical norms and guidelines aimed at forest regeneration based on applied research and investigations in the field, etc.
Impact and benefits of adaptation	The impact of the implementation of the given technology will consist in the climatic amendment of the technical norms and guidelines aimed at forest regeneration and consequently - in the reduction of failures in forestry practice in the given field. The result of regeneration activities will be productive, stable stands adapted to the new climatic conditions. Indirectly, by increasing the productivity and stability of regenerated stands, it will also contribute to strengthening indigenous GHG sequestration capacities.

Sector / sub-sector	Forestry
TNA technology name	*15. Adapting wood utilization practices in RM forests to climate change*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015;
Short technological description of the option	The technology foresees the strengthening and modernization of the sub-sector of utilization of wood products by aligning the process of valorization of current growths through treatments and forestry works with European practices and trends (about 50-60% of current growths). It also provides for the revision of forest exploitation

	processes and technologies, an increase in the share of processed wood products, and some amendments to the regulatory basis in this area.
Cost and profitability (estimated)	EUR 3.0 million
Market potential (scalability)	MADRM, Agency "Moldsilva", MEI, APL, companies and private persons. The activities for the current phase will include certain amendments to the normative basis in the field of forestry design and exploitation, including in terms of minimizing forest damage. The process of forest harvesting will also be modernized through the use of new forest-friendly equipment and technologies.
Impact and benefits of adaptation	The main impact will be to reduce the damage caused to forests in the process of logging, and the timely capitalization of the timber increment will reduce uncontrolled pressure on forests (illegal logging and other illegalities). The major benefit will be a reduction in the area of damaged, degraded and vulnerable to various unfavorable factors (climate change, attacks by diseases and pests, etc.).

Sector / sub-sector	Forestry
TNA technology name	*16. Normative regulation of carbon conservation practices in forests and their incorporation into forest management*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015;
Short technological description of the option	The technology provides for the revision of the regulatory basis for forest management in the context of the need to ensure the permanence of carbon stocks, including the adoption of effective measures to protect the integrity of the forest, prohibition of changing the use of land covered by forests and other forms of forest vegetation (forest cover; green areas; forest-pastoral formations, etc.). It is also planned to include carbon stock indicators in the criteria for assessing the quality of forest management.
Cost and profitability (estimated)	EUR 0.1 million
Market potential (scalability)	MADRM, Agency "Moldsilva", Environment Agency, APL, companies and private persons. The activities for the current stage will include the revision of the normative basis related to forest management in the context of the correlation with the need to ensure the permanence of carbon stocks, as well as their implementation in forests regardless of departmental affiliation or nature of ownership.
Impact and benefits of adaptation	The impact will be to increase the resilience of forests to climate change and to reduce carbon losses as a result of the activities that make up forest management. The inclusion of carbon stock indicators in the criteria for assessing the quality of forest management will contribute to increasing the quality of the forest management process, including from a climate perspective. The system will also help to strengthen domestic GHG sequestration capacities.

Sector / sub-sector	Forestry
TNA technology name	*17. Improving the capacity of public advisory services and supporting research in forestry and climate change relations*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001;

	● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015;
Short technological description of the option	The technology envisages strengthening and modernizing the capacity of public forestry advisory structures, including through the creation of regional and local forestry advisory levels. The activity includes the development and promotion of good practice guidelines on forestry to ensure the resilience of forests to the effects of climate change, tailored to private/state needs and sustainable management principles.
Cost and profitability (estimated)	EUR 0.4 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, Environment Agency, "Moldova's Waters" Agency, LPAs, companies and private persons. The activities for the current phase will include the strengthening of the republican level, as well as the creation of regional and local levels in the field of forestry consultancy. The respective structures will also promote the guidelines that ensure the resilience of forests to the effects of climate change and the principles of sustainable management.
Impact and benefits of adaptation	The main impact will be to increase the level of forest management (including resilience to the effects of climate change), irrespective of departmental affiliation and nature of ownership. It will ensure the implementation of practical forestry activities that will ensure the resilience of forests to the effects of climate change, adapted to the principles of sustainable forest management.
Sector / sub-sector	Forestry
TNA technology name	*18. Training forestry staff and decision-makers involved in forest management on the need and appropriateness of implementing climate change adaptation and mitigation measures*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova on adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015;
Short technological description of the option	The technology includes a complex of measures aimed at understanding the influence of climate change on forestry by forestry staff and forest management stakeholders and raising awareness that adaptation is the most effective management and sustainable development measure. Technology includes: seminars, round tables, professional competitions, technical and thematic publications, etc.
Cost and profitability (estimated)	EUR 0.3 million
Market potential (scalability)	MADRM, Agency "Moldsilva", Environment Agency, APL, companies and private persons. The current activities include the elaboration and implementation of a comprehensive medium-term sectoral training plan for forestry personnel and all those involved in forest management in the country, regardless of departmental affiliation.
Impact and benefits of adaptation	The major benefit will be improved management and reduced pressures on forests and other forest vegetation, with the consequences for their ability to adapt to climate change.

Sector / sub-sector	Forestry

TNA technology name	*19. Raising awareness about forests and climate change, contributing to the management and consumption of wood products and services at individual and community level*
National policy framework supporting technology	● Strategy for sustainable development of the forest sector in the Republic of Moldova, HP no. 350/2001; ● Strategy of the Republic of Moldova for adaptation to climate change until 2020 and Action Plan for its implementation, GD 1009/2014; ● Environmental Strategy for 2014-2023 and Action Plan for its implementation, GD 301/2014; ● Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and Action Plan for its implementation, GD no. 274/2015;
Short technological description of the option	The technology includes a complex of measures aimed at understanding the influence of climate change on forestry and raising public awareness that adaptation is the most effective survival measure. The technology includes: seminars, round tables, specialized competitions, publications, TV/radio broadcasts, etc.
Cost and profitability (estimated)	EUR 0.2 million
Market potential (scalability)	MADRM, "Moldsilva" Agency, Environment Agency, APL, companies and private persons. Current activities include the elaboration and implementation of a comprehensive medium-term sectoral communication plan targeting all social groups in the country.
Impact and benefits of adaptation	The major benefit will be to reduce anthropogenic pressures on forests and other forest vegetation, with the consequences for their ability to adapt to climate change.

I.BIBLIOGRAPHY

1. "Moldsilva" Agency (2020), *Materials of the scientific-practical symposium "Ensuring sustainable forest management through the implementation of forest treatments and promotion of natural regeneration, afforestation"*. Chisinau, 61 p.
2. "Moldsilva" Agency (2016). *Strategy on forest sector adaptation to climate change for 2017-2025 and Action Plan for its implementation, draft HG*.
3. Andrew Mitchell, Arcadie Capcelea, Nina Rinnerberger [et al.] (2015), *Republic of Moldova: Note on Forest Policy*, - Ch.: I.E.P. Stiinta, 2015 (Combinatul Poligrafi c) - 68 p., ISBN 978-9975-67-892-6.
4. IPCC (2000), *Methodological and Technological Issues in Technology Transfer*. Available at: https://www.ipcc.ch/report/methodological-and-technological-issues-in-technology-transfer/
5. Galupa D., Talmaci I. et al. (2017) *Technical guide on best agroforestry practices in sustainable land management* - Chisinau: Print Caro, - 148 p. Available at: www.icas.com.md.
6. Galupa D., Talmaci I. (2021), *Establishment of protective forest buffers as a climate change adaptation measure. Practical guide for agricultural producers.* - Chișinău, Tipografia "Bons-Offices SRL". - 60 p.
7. Talmaci I., Miron A., (2016), *Sustainable management of forests and grasslands owned by local public authorities.* Ch., Clima East Moldova, 48 p.
8. Official Monitor of the Republic of Moldova no. 090 of 02.08.2001, *Parliament Decision on the approval of the National Strategy and Action Plan in the field of conservation of biological diversity, no. 112-XV of 27.04.2001.*
9. Official Monitor of the Republic of Moldova no. 133 of 08.11.2001, *Parliament Decision no. 350 of 12.07.2001 for the approval of the Strategy for the sustainable development of the forestry sector in the Republic of Moldova.*
10. Official Monitor of RM no.126-131 of 27.06.2003, *GD no. 739 of 17.06.2003 on the implementation of the Strategy for sustainable development of the national forest sector.*
11. Official Monitor of RM no. 4-5/36 of 16.01.1997, *Forestry Code, no. 887-XIII of 21.06.96*.

12. Official Gazette no. 10/283 of 30.10.1993, *Law on Environmental Protection, no. 515-XII of 16.06.93*.
13. Official Gazette no. 43/482 of 03.08.1995, *Law on Protected Zones and Protected Waters of Rivers and Water Basins, no. 440-XIII of 27.04.95*.
14. Official Gazette no. 141-143 of 09.11.2000, *Law on the Improvement of Degraded Lands by Afforestation, no. 1041-XIV of 15.06.2000*.
15. Official Monitor of the Republic of Moldova no. 27-30 of 08.02.2013, *GD no. 102 of 05.02.2013 on the Energy Strategy of the Republic of Moldova until 2030.*
16. Official Monitor of RM no. 104-109 of 06.05.2014, *GD no. 301 of 24.04.2014 on the approval of the Environmental Strategy for 2014-2023 and the Action Plan for its implementation.*
17. Official Monitor of RM no. 372-384 of 19.12.2014, *GD no. 1009 of 10.12.2014 on the approval of the Republic of Moldova's Strategy for adaptation to climate change until 2020 and the Action Plan for its implementation.*
18. Official Monitor of RM no. 131-138 of 29.05.2015, *GD no. 274 of 18.05.2015 on the approval of the Biological Diversity Strategy of the Republic of Moldova for 2015-2020 and the Action Plan for its implementation.*
19. Official Monitor of the Republic of Moldova no. 85-91 of 24.03.2017, *GD no. 1470 of 30.12.2016 on the approval of the Strategy for Low Emission Development of the Republic of Moldova until 2030 and the Action Plan for its implementation.*

Annex 2: Detailed Technology Fact Sheets for Shortlisting Technological Options to Adapt the Forest Sector to Climate Change

The rapid pace of climate change due to human activity is exceeding the natural capacity of forest ecosystems to adapt. Extreme phenomena (storms, fires, droughts, heat waves, etc.) are expected to become more frequent and/or more severe, thus increasing the pressure on forests . Consequently, some territories will no longer be favorable for the development of certain types of forests, which will cause changes in the natural distribution of forest species and changes in the growth of existing stands . In the context of ensuring the adaptation of the forestry sector to climate change, the following general sectoral objective is established:

- Increasing the capacity of the forestry sector in the Republic of Moldova to adapt to the consequences of climate change by maintaining and improving the abilities of forest ecosystems to provide services for society and by maximizing the contribution to mitigating the effects by consolidating and increasing the volumes of carbon dioxide sequestration compared to the current situation .

To ensure the development of relevant measures/technologies, based on concrete goals and targets, the potential climate impacts (CI) on forest ecosystems have been aggregated into the following categories:

- Climate impact 1: Decrease in biomass production, other forest products and services;
- Climate impact 2: Changing the rate of forest regeneration, degradation and reduction of forested areas;
- Climate impact 3: Worsening the phytosanitary status of forest ecosystems and increasing the incidence of forest fires.

In order to facilitate the process of prioritization of technologies (measures) for adaptation in the forestry sector from the list of technological options, a set of technical sheets describing the technologies was developed according to a predetermined format. As general priorities applicable to all technologies/measures selected primarily for the forestry sector are the following aspects:

The country's social development priorities	According to the Moldova 2030 National Development Strategy (SND 2030), the social development objectives in the Republic of Moldova are in accordance with the ODD-Agenda 2030, namely: eliminating poverty in all its forms by increasing incomes, reducing unemployment by providing jobs to 60% of population, ensuring a literacy level for at least 95% of the population.
The country's priorities for economic development	SND 2030 foresees an annual economic growth of at least 5%, with a GDP growth level of 7% by 2030.
The country's environmental development priorities	SND 2030 provides for ensuring the fundamental right to a healthy and safe environment, establishing the following objectives: - Reducing environmental pollution, eliminating sources of water pollution, reducing the volume of waste and increasing the sustainable management of natural resources and developing ecosystem services ; - Afforestation of lands, reducing the level of soil degradation, improving the quality and quantity of water resources and developing local communities by offering ecosystem services ; In the medium term, the following are the priority directions: - Policies and management in the field of environmental protection; - Integrated management of waste and chemical substances; - Environmental quality monitoring ; - Protection and conservation of biodiversity.

	Through the Sustainable Development Strategy of the Forestry Sector in the Republic of Moldova, the following objectives are established: - Increasing the potential ecoprotective and bioproductive of natural forests; - Conservation of biological diversity of forests; - Expansion of the areas covered with forest vegetation ; - Increasing efficiency security activities and protection of the forest fund; - Increasing the contribution of the forestry sector to solving social-economic problems; - Preservation of the national rural landscape .
The country's climate priorities	As a national priority is the implementation of measures to adapt to climate change, by incorporating the climate component in medium and long-term strategic planning, encouraging adaptation actions to mitigate climate risks in the investment decision-making process and in business planning, with the aim of increase the resilience of the national economy, land use and ecosystem sectors, as well as to accelerate the country's transition to low carbon and resilient development . For the forestry sector, the objectives and actions aimed at adapting to climate change include scientifically justified adaptation measures with clear mitigation co -benefits and approaches to sustainable development, maintenance and adequate monitoring of the state of forests, with the intensification of the afforestation/reforestation process using species of climate resistant trees and shrubs. It is also foreseen to promote new sustainable forest management practices to stop the reduction of forested areas, stop the degradation of forest biodiversity by promoting natural forest types; reducing the fragmentation of forest massifs; combating illegal exploitation of forests and related trade by implementing methods to ensure wood traceability and forest certification.
The national and international regulatory, policy framework that supports adaptation technologies/measures	- Strategy for the sustainable development of the forestry sector in the Republic of Moldova, PD no. 350/2001; - Strategy of the Republic of Moldova for adaptation to climate change and Action Plan for its implementation, GD no. 1009/2014; - The environmental strategy for the years 2014-2023 and the action plan for its implementation, GD no. 301/2014; - The energy strategy of the Republic of Moldova until 2030, GD no. 102/2013; - EU Forest Strategy (2013/2014); - European Parliament Resolution on the EU Strategy for Forests – The Way Forward (2019/2157(INI); - EU Directive 2018/2001 on the promotion of the use of energy from renewable sources; - United Nations Strategic Plan for Forests 2017–2030; - The forestry code, no. 887 of 21.06.1996; - Law for the amelioration of degraded lands by afforestation, no. 1041 of 15.06.2000; - Law on the protection zones and strips of the waters of rivers and water basins, no. 440 of 27.04.95; - Water Law, no. 272 of 23.12.2011; - Law on green spaces of urban and rural localities, no. 591-XIV of 23.09.1999; - GD no. 32/2001 regarding measures to establish areas and riparian strips for the protection of river waters and water basins;

The detailed description of the technology options according to the data sheets of the default format is set out below. In total, 12 technologies focused on the 3 generalized climate impacts are described (IC 1 – 4 technologies/measures; IC 2 – 6 technologies/measures; IC 3 – 2 technologies/measures). The cumulative budget of the respective options is estimated at EUR 200.3 million.

General information	
Section	The forestry sector
Climate impact	1. Decrease in biomass production, other forest products and services
Category	1.1. Expansion of new areas with forests and other categories of forest vegetation
The name of the technology	*1.1. 1. Increasing the degree of afforestation of the territory in the country by planting forest crops resilient to climate change*
Brief description of the technology option	The technology provides for the application of afforestation practices on degraded lands and some marginal lands. Afforestation will be carried out as a priority in the areas of maximum influence on land and infrastructure (communication, transport, etc.). The afforestation technologies will be adapted to the primary conditions of the respective lands, and the planting material will consist of tree and shrub species that have confirmed their ability to withstand heavy seasonal conditions and pedological and climatic limiting factors (pedunculate oak, red oak, black pine, sophora) In some cases the technology will represent an operation of ecological reconstruction of the land through afforestation.
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding the intensification of the process of afforestation/reforestation of land, stopping the degradation of forest biodiversity by promoting natural forest types, as well as ensuring the resilience of forests to climate change. In context, the activity foresees a paradigm shift in the process of afforestation of new lands by using only flexible and long-lived tree and shrub species, corresponding to seasonal conditions , as well as able to adapt to climate changes. During the planting activities, planting material with protected roots will be widely used, which has an increased capacity for accommodation on lands with difficult pedo-ecological conditions . As a result, through proper application, forests will be created that are resilient to adverse factors (disease and pest attacks; weather and climate change, etc.). Also, new forests will partially compensate for the inevitable losses from diminishing production of biomass, other forest products and services caused by climate change
Implementation assumptions and applicability scale	The technology implementation process will include the involvement of a wide spectrum of institutions: MM, " Moldsilva " Agency (including territorial entities; FRMI), NGB, IEG, LPA, companies and private individuals. For the immediate implementation, the mechanisms established by the Law for amelioration by afforestation of degraded lands (LP1041/2000) and the Regulation on the afforestation of degraded lands in public property of administrative-territorial units and degraded lands in private property (GD 1186/2016) will be used). The coverage area - about 30 thousand ha from the account of degraded lands and some marginal lands, unsuitable for efficient agriculture, located throughout the country. That indicator constitutes about 23% of the afforestation task necessary to comply with the provisions of the Determined National Contribution (NDC).
Technology features	
Capital costs	The estimated value of the investments will be around EUR 75 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately EUR 1.1 million annually (guarding; protection; forestry; forest management, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in the field of afforestation does not report important cases of environmental damage as a result of afforestation of land in compliance with technical regulations.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	Moldsilva "Agency" (including territorial entities), NGB, IEG, LPA, companies and private individuals will be trained in the implementation process . The main implementation obligations fall to the "Moldsilva" Agency, which has the capacity, experience (in the post-war period the afforestation works of new lands covered over 200 thousand ha) and tools to apply the technology through its territorial subdivisions. The

	capacities of LPA, companies and private individuals are limited, but they can be gradually developed, including taking over an important part of Moldsilva's bonds.
Scale of applicability	The technology provides for the afforestation of about 30 thousand ha of land with varying degrees of degradation. Estimated number of beneficiaries: about 650 town halls (about 1.3 million inhabitants, of which an estimated 0.68 million women and 0.62 million men); about 2000 private land owners.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best-expressed effect is long-term (over 30 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the country. Moldsilva has some experience in the application of similar technologies/technical elements that will contribute to the successful implementation of the newly promoted activities . The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the technology, it is mentioned the use in afforestation activities of only flexible and long-lived species of trees and shrubs, able to adapt to climate changes; the use of planting material with protected roots; conservative tillage technologies; digital technologies/GIS/GPS for records of lands and works, etc.
Acceptability for locals	Most of the inhabitants of rural settlements support the need to increase the degree of coverage of the territory of the Republic of Moldova with forests by afforestation of poorly productive, degraded and unusable lands for agriculture. Among the basic conditions are the application of optimal tillage solutions, which do not generate new degradation processes, the inclusion of fruit/honeybee species in the composition of forest crops, the timely information and consultation of stakeholders, the involvement of the local workforce as possible, etc. At the same time, cases are recorded when the local population abandons the planting of forests or the newly planted forests are destroyed/degraded (grazing, arson, illegal cutting, etc.). Those situations are overcome through communication companies, as well as the strengthening of security and protection activities.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely involved in the implementation process in most stages and activities: harvesting tree and shrub seeds; growing saplings in forest nurseries; planting seedlings; care and maintenance of forest crops; harvesting non-wood forest products (fruits, berries, medicinal plants) , etc. Also, the wood production harvested as a secondary result of the management of newly created forests contributes to the improvement of living conditions and household comfort in the neighboring localities. The degree of direct involvement in technology is estimated at 70% men and 30% women.
Other country-specific characteristics related to the technology (such as market potential)	Within the country, there is a great potential of lands affected by various forms of degradation (landslides, erosions, salinity, etc.) suitable for afforestation activities. Thus, the soils affected by surface erosion occupy about 982 thousand ha including: 558 thousand ha with weak degree of erosion, moderate – 288 thousand ha and strong 135 thousand ha. It also mentions the increase in the market potential of forest products and services from the increase of forest biomass and wood production, the creation of new jobs, recreation, ecological services, etc.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand to the level of achieving the entire need/current potential of afforestation (from 30 thousand ha to about 130 thousand ha). Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The technology contributes to strengthening the capacities of the "Moldsilva" Agency, its territorial structures, NGB, IEG, as well as local authorities/communities to afforest degraded lands, to sustainably manage new forests, etc. The activity includes exchange of experience between the national institutions involved in the process, but also with similar institutions from neighboring countries (Romania, Ukraine; Hungary, Bulgaria, etc.). The technology will also facilitate involvement in the development of small and

	medium-sized forest enterprises (SMEs) within the LPA and private sector (tillage; transport, logistics, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of GIS/GPS technologies; machines and equipment for mechanized tillage, planting and care of forest crops, harvesting wood; equipment for monitoring accumulated/sequestered carbon, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires, at the initial/preparatory stage, an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at solving them (developing and/or strengthening the institutional framework for afforestation and forest management activities; updating some technical norms and regulations; strengthening sub-sector of planting material; contractual arrangements with the definition of roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the rural environment and especially in the different categories of SMEs. These are related to a wide spectrum of activities: the development of forest nurseries; afforestation/reforestation works; development of sustainable forest management; wood processing; sale of firewood; collection and sale of non-timber forest products (fruits and berries; medicinal plants; beekeeping, etc.), hunting, crafts , etc.
investment	The investment is a priority of the country, and the attraction of funding for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 75 million, of which external financing will constitute approximately EUR 60 million.
Public and private spending	The expenses will be borne through the public institution "Moldsilva" Agency. At the initial stage, the contribution of LPA and the private sector related to the development of expenditures in the forestry sector is insignificant, and will increase, starting with the management activities of the newly created forests.
Social benefits	
Income	The implementation of the technology will contribute to increasing income in local budgets and for the population, especially in rural areas. Thus, it is estimated that the forests created within the technology will generate on average about 80 EUR/ha/year or about 2.4 million EUR annually. The main revenues will be obtained from the sale of wood mass (about 70%) harvested in the process of sustainable management of new forests, as well as from non-wood services and products (about 30%: carbon sequestration; forest fruits; medicinal plants; hunting; beekeeping; recreation, etc.). Also, certain revenues in the budget will be obtained from the realization of the primary investment of EUR 75 million, as well as the operating and management costs (about EUR 1.1 million annually) through the related fees and taxes.
Learning	The technology includes carrying out a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (GIS/GPS; carbon monitoring; growing and planting saplings with protected roots; conservative tillage technologies; digital forest record technologies, etc.). Also, the mechanisms for carrying out land expansion works within all types of properties (state; UAT; private) will be tested and perfected through the interconnection of central public authorities (MM; Moldsilva, etc.), local public authorities (local councils, town halls, district councils), companies and private individuals.
Health	As a result of the implementation of the technology, the extended forest areas will improve the rural landscape and will be a supplement to the expansion of the recreation areas of the population. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The main environmental benefit will consist in increasing the areas covered with forest vegetation, which will reduce the processes of land degradation on slopes, surface runoff,

	protect agricultural land, water bodies, infrastructure and human settlements. The expansion of the forested areas by 30 thousand ha will strengthen the domestic GHG sequestration capacities by about 270 kt CO_2 annually.
Others, if any	The newly created forests will contribute to the improvement of energy and food security, providing means to diversify production systems, raw material reserves, conservation of soil moisture resources, biodiversity, etc.

General information	
Section	The forestry sector
Climate impact	1. Decrease in biomass production, other forest products and services
Category	1.1. Expansion of new areas with forests and other categories of forest vegetation
The name of the technology	*1.1.2. Afforestation of riparian strips of rivers and water basins*
Brief description of the technology option	The technology provides for the application of afforestation practices of riparian strips for the protection of rivers and water basins. The afforestation will be carried out in the places where the soil, relief and infrastructure conditions allow, priority in the meadow areas. In some cases the technology will represent an operation of ecological land reconstruction. The assortment of species and shrubs will be characteristic of the seasonal conditions (white poplar, black poplar, white willow, buck willow, velnish elm, ash, red buckthorn, black elder, heather, etc.).
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding the intensification of the process of afforestation/reforestation of land, ensuring the resilience of forests to climate change, promoting new sustainable forest management practices. In context, the activity provides for the afforestation of new lands in the riparian strips, river/river meadows and wetlands by using flexible and long-lived tree and shrub species, able to adapt to climate changes, including the conditions of the respective lands. Through proper application, forests will be created resilient to adverse factors (disease and pest attacks; weather and climate change, etc.). Also, the new forests created by the technology in question will contribute to climate change adaptation of the water resource sector by increasing humidity in riverine and wet areas (especially in the summer), increasing soil moisture resources, as well as regulating river flows, minimizing risks related to water shortages and floods.
Implementation assumptions and applicability scale	The implementation process will include the involvement of a wide spectrum of institutions: MM, "Moldsilva" Agency (including territorial entities; FRMI), NGB, IEG, LPA, "Apele Moldovei" Agency, companies and private individuals. For immediate implementation, the mechanisms established by Law for amelioration by afforestation of degraded lands (LP1041/2000) and Regulation regarding the afforestation of degraded lands of public property of administrative-territorial units and degraded lands of private property (GD 1186/2016). The coverage area – about 15 thousand ha from the account of the lands in the riparian strips, the meadows of the rivers/streams and the wetlands, located throughout the country. The respective indicator constitutes about 50% of the afforestation task required for this compartment to comply with the provisions of the Determined National Contribution (NDC).
Technology features	
Capital costs	The estimated value of the investments will be around EUR 37.5 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.7 million annually (guarding; protection; forestry; forest management, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in the field of afforestation does not report important cases of environmental damage as a result of the afforestation of riparian lands in compliance with technical regulations, information/consultation of institutions/stakeholders.

Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	In the implementation process, MM, "Moldsilva" Agency (including territorial entities, FRMI), NGB, IEG, LPA, "Apele Moldovei" Agency, companies and private individuals will be trained. The main implementation obligations rest with the "Moldsilva" Agency, which has the capacity, experience and tools to apply the technology through its territorial subdivisions. The capacities of LPA, companies and private individuals are limited, but they can be gradually developed, including taking over an important part of Moldsilva's bonds.
Scale of applicability	The technology envisages the afforestation of about 15 thousand ha of land from the riparian strips, river/river meadows and wetlands, which represents about 50% of the land area established for such activities.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best-expressed effect is long-term (over 30 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the country. Moldsilva has some experience in applying similar technologies or elements. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the technology, it is mentioned the use in afforestation activities of only flexible and long-lived species of trees and shrubs, able to adapt to climate changes; the use of planting material with protected roots; conservative tillage technologies; digital technologies/GIS/GPS for records of lands and works; bank strengthening approaches and technologies, etc.
Acceptability for locals	The majority of the inhabitants of rural settlements support the need to increase the degree of coverage of the territory with forests by afforesting the lands located in riparian zones of rivers and water basins. Among the basic conditions are the application of optimal tillage solutions, which do not generate new degradation processes, the inclusion of fruit/honey-bearing species in the composition of forest crops, the timely information and consultation of stakeholders, the arrangement and provision of access to animal watering points , the involvement of the local workforce as possible, etc. At the same time, cases are recorded when the local population gives up planting forests or the newly planted forests are destroyed/degraded through various illegal actions (grazing, arson, illegal cutting, etc.). Those situations are overcome through communication companies, as well as the strengthening of security and protection activities.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely involved in the implementation process in most stages and activities: harvesting tree and shrub seeds; growing saplings in forest nurseries; planting seedlings; care and maintenance of forest crops; harvesting non-wood forest products (fruits, berries, medicinal plants), etc. Also, the wood production harvested as a secondary result of the management of newly created forests contributes to the improvement of living conditions and household comfort in the neighboring localities. The degree of direct involvement in technology is estimated at 70% men and 30% women.
Other country-specific characteristics related to the technology (such as market potential)	Within the Republic of Moldova, there is a sufficient potential of lands within the riparian strips, river/river meadows and wetlands suitable for carrying out afforestation activities. Thus, according to the provisions of the National Program regarding the establishment of the national ecological network for the years 2011-2018 (GD593/2011), about 30 thousand ha of the respective areas suitable for afforestation are identified. It also mentions the increased market potential of forest products and services from increasing biomass and wood production, creating new jobs, recreation and ecological services.
The potential for a paradigm shift	

Extensibility, replicability and applicability	Extensibility: It is possible to expand from the quality of a pilot project to the level of achieving the entire current need/potential of afforestation (from 15 thousand ha to about 30 thousand ha). Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The technology contributes to the strengthening of the capacities of the "Moldsilva" Agency and its territorial structures, GNBI, IEG, "Apele Moldovei" Agency, as well as local authorities/communities for the afforestation of lands within riparian strips, river/river meadows and wetlands, to manage sustainably new forests. The activity includes exchange of experience between the national institutions involved in the process, but also with similar institutions from neighboring countries (Romania, Ukraine; Hungary, Bulgaria, etc.). The technology will also facilitate involvement in the development of small and medium-sized forest enterprises (SMEs) within the LPA and private sector (tillage; seedling planting; transport, logistics, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of digital technologies/GIS/GPS in the record of land and works; machines and equipment for mechanized tillage, planting and care of forest crops, harvesting wood; the use of planting material with protected roots; bank strengthening approaches and technologies; equipment for monitoring accumulated/sequestered carbon, etc.
Potential contribution to setting the regulatory and policy framework	At the initial/preparatory stage, it calls for an extensive analysis of regulatory and political barriers, but also a list of activities aimed at solving them (developing and/or strengthening the institutional framework for afforestation and forest management activities; strengthening the sub-sector of planting material growth; correlation of management forestry with that of hydrographic/aquatic basins; updating some technical rules and regulations; defining the roles and responsibilities of the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the rural environment and especially in the different categories of SMEs. These are related to a wide spectrum of activities: the development of forest nurseries; afforestation/reforestation works; development of sustainable forest management; wood processing; sale of firewood; collection and sale of non-timber forest products (fruits and berries; medicinal plants; beekeeping, etc.), hunting, crafts, etc.
investment	The investment is a priority of the country, and the attraction of financing means for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 37.5 million, of which external financing will constitute approximately EUR 30 million.
Public and private spending	The expenses are covered mainly through the public institution Agenția "Moldsilva". At the initial stage, the contribution of LPA, "Apele Moldovei" Agency and the private sector related to the development of expenses in the forestry sector is insignificant, and will increase starting with the management activities of the newly created forests.
Social benefits	
Income	The implementation of the technology will contribute to increasing income in local budgets and for the population, especially in rural areas. Thus, it is estimated that the new forests created within the technology will generate on average about 80 EUR/ha/year or about 1.2 million EUR annually. The main revenues will be obtained from the sale of wood mass (about 70%) harvested in the process of sustainable management of new forests, as well as from non-wood services and products (about 30%: carbon sequestration; forest fruits; medicinal plants; hunting; beekeeping; recreation, etc.). Also, certain revenues in the budget will be obtained from the realization of the primary investment of EUR 37.5 million, as well as the operating and management costs (about EUR 0.7 million annually) through the related fees and taxes.
Learning	The technology includes the realization of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (GIS/GPS; carbon monitoring; growing and planting seedlings with protected roots; conservative tillage technologies; digital forest record technologies, etc.). Also, the

	mechanisms for carrying out land expansion works within all types of properties (state; UAT; private) will be tested and perfected through the interconnection of central public authorities (MM; Moldsilva, Apele Moldovei, etc.), local public authorities (local councils, town halls, district councils), companies and private individuals.
Health	As a result of the implementation of the technology, the extended forest areas will improve the rural landscape and will be a supplement to the expansion of the recreation, sanitation and leisure areas of the population. Forest plantations in riparian areas will make an important contribution to improving the quality of drinking water. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The main environmental benefit will consist in increasing the areas covered with forest vegetation, which will reduce surface runoff, increase infiltration into the soil and contribute to the increase of humidity in riparian and wet areas (especially in the summer), as well as increasing the resources of soil moisture. New forests will help regulate river flows, minimizing the risks of water shortages and floods. As a result, the quality of the state of meadow ecosystems will increase, and biodiversity will be maintained and increased. The expansion of forested areas will contribute to improving the landscape and recreation areas. Also, the area of new plantations of 15 thousand ha will contribute to strengthening the local GHG sequestration capacities by about 140 kt CO_2 annually.
Others, if any	New forests will contribute to improving energy and food security, providing means to diversify production systems, raw material reserves, etc.

General information	
Section	The forestry sector
Climate impact	1. Decrease in biomass production, other forest products and services
Category	1.1. Expansion of new areas with forests and other categories of forest vegetation
The name of the technology	*1.1.3. Creation and strengthening of forest curtain systems to protect agricultural fields and roads*
Brief description of the technology option	The technology provides for the application of practices for the creation and/or consolidation/rehabilitation of forest curtains for the protection of agricultural fields, roads, etc. In this context, formations with forest vegetation will be created , located at a certain distance from each other or from an objective with the aim of protecting it against the effects of harmful factors and /or for climatic, economic and esthetic -sanitary of the lands. The plantings/rehabilitation will be carried out as a priority in the areas of maximum influence on the lands and related infrastructure. The realization process will be adapted to the respective conditions, and the planting material will consist of species of trees and shrubs that have confirmed ability for the conditions and characteristics of the assigned lands (pedunculated oak, sofora, field paltin, Tatar maple, field elm, elm of Turkestan, Turkish cherry, bird's sloe, silver currant, scumpie, horn, hornbeam, etc.).
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding the intensification of the process of afforestation/reforestation of land, the promotion of new sustainable land management practices. In context, newly created and/or rehabilitated forest protection systems/curtains (PFP) will contribute to increasing the resilience of protected sectors and lands (agriculture; animal husbandry; communications/infrastructure, etc.). Thus, for agricultural land and related infrastructure PFP will contribute to the improvement microclimatic conditions (change in albedo, decrease in diurnal and annual air temperature amplitude, reduction in wind speed, retention of snow, reduction in evapotranspiration, increase in air humidity, etc.); growth conditions of soil fertility and conservation, reduction of erosion and water leaks on the slopes, reduction until the total stop of deflation , increase of soil moisture , etc. Also, the technology provides for the use of flexible and long-lived tree and shrub species

	in the works, resilient to adverse factors (disease and pest attacks; weather and climate changes, etc.), able to adapt to climate change.
Implementation assumptions and applicability scale	The implementation will be carried out with the participation of MM, MAIA, MIDR, "Moldsilva" Agency (including territorial entities), LPA, companies and private individuals. For the immediate implementation, the mechanisms established by the legislation in the field will be used (Land Code; GD 1186/2016, etc.). The coverage area will be approximately 12 thousand ha of forest curtains for the protection of agricultural fields, roads, etc., located throughout the country. That indicator constitutes about 55% of the afforestation task necessary to comply with the provisions of the Determined National Contribution (NDC).
Technology features	
Capital costs	The estimated value of the investments will be around EUR 21.6 million.
Operation and Management (O&M) costs	The value of operating and management costs will be about 0.5 million annually (guarding; protection; forestry; forest management, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. National experience in the field of creating forest systems for the protection of agricultural fields, infrastructure, etc. does not report important cases of damage to the environment as a result of land afforestation.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	Moldsilva " Agency (including territorial entities), NGB, IEG, LPA, companies and private individuals will be trained in the implementation process. The main implementation obligations rest with the "Moldsilva" Agency, which has the capacity, experience and tools to apply the technology through its territorial subdivisions. The capacities of LPA, companies and private individuals are limited, but can be gradually developed, including taking over a significant part of Moldsilva's initial bonds.
Scale of applicability	The technology provides for the planting/rehabilitation of about 12 thousand ha of forest curtains for the protection of agricultural fields and roads. The works will be carried out at the expense of public and private lands, located throughout the country. The estimated area of protected agricultural land will be about 355 thousand ha. Estimated number of beneficiaries: about 480 town halls (about 0.9 million inhabitants, including an estimated 0.5 million women and 0.4 million men); about 400 thousand private owners of neighboring agricultural lands.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best-expressed effect is long-term (over 20 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the country. Moldsilva is certain in the application of similar technologies/elements. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the technology, it is mentioned the use in afforestation activities of only flexible and long-lived tree and shrub species, able to adapt to climate changes; the use of planting material with protected roots; conservative tillage technologies; digital technologies (GIS/GPS) for recording land and works; silvopastoral arrangements such as grassland and land management plans, etc.
Acceptability for locals	The majority of the inhabitants of rural settlements support the need to expand and/or strengthen the forest systems for the protection of agricultural fields, communication routes, including due to the benefits brought. Among the basic conditions are the application of optimal tillage solutions, which do not generate new degradation processes, the inclusion of fruit/honey-bearing species in the composition of forest crops, the timely information of stakeholders, the involvement of the local workforce as possible, etc. At the same time, cases are recorded when the local population, farmers/owners of agricultural land abandon the planting of forest curtains or the newly planted forest curtains are destroyed/degraded (grazing, arson, illegal cutting, etc.). The

	respective situations are overcome through communication companies, the implementation of fire prevention measures , as well as the strengthening of security and protection activities.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely involved in the implementation process in most stages and activities: harvesting tree and shrub seeds; growing saplings in forest nurseries; planting seedlings; care and maintenance of forest crops; harvesting of non-wood products (fruits, berries, medicinal plants), etc. Also, the wood production harvested as a secondary result of the sustainable management of the newly created and/or rehabilitated forest curtains contributes to the improvement of living conditions and household comfort in the neighboring localities. The degree of direct involvement in technology is estimated at 70% men and 30% women.
Other country-specific characteristics related to the technology (such as market potential)	Within the country there is sufficient potential for activities to create and/or strengthen protective forest curtains. Thus, at the moment there are about 30 thousand ha of forest curtains protecting agricultural fields, communication routes created 30-70 years ago and which require extensive rehabilitation/consolidation measures, resulting from the need to ensure functionality, adapt to climate changes, etc. Also, according to various national strategies, programs and plans it is provided that protective forest curtains to constitute 4% of agricultural land or the need to plant about 40 thousand ha more. At the same time, it is mentioned the increase in the market potential of forest products and services from the increase of forest biomass and wood production, the creation of new jobs, recreation, ecological services, etc.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand from the quality of a pilot project to the realization of the entire current need/potential of protective forest curtains (from 12 thousand ha to about 40 thousand ha). Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The technology contributes to the strengthening of the capacities of MM, MAIA, MIDR, the "Moldsilva" Agency, its territorial structures, NGB, IEG, as well as local authorities/communities for the creation and/or consolidation of forestry systems for the protection of agricultural lands, the promotion of agroforestry and silvopastoral practices, managing them sustainably. The activity includes exchange of experience between the national institutions involved in the process, but also with similar institutions from neighboring countries (Romania, Ukraine; Hungary, Bulgaria, etc.). The technology will also facilitate involvement in the development of small and medium-sized forest enterprises (SMEs) within the LPA and private sector (tillage; seedling planting; transport, logistics, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of GIS/GPS technologies; machines and equipment for mechanized tillage, planting and care of forest crops, harvesting wood; equipment for monitoring accumulated/sequestered carbon, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires at the initial stage an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (developing and/or strengthening the institutional framework for afforestation and forest management activities; updating some technical rules and regulations; strengthening the subsector of increase of planting material; contractual arrangements with the definition of roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the rural environment and especially in the different categories of SMEs. These are related to a wide spectrum of activities: the development of forest nurseries; afforestation/reforestation works; development of sustainable forest management; wood processing; sale of firewood;

	collection and sale of non-timber forest products (fruits and berries; medicinal plants; beekeeping, etc.), hunting, crafts, etc.
investment	The investment is a priority of the country, and the attraction of funding for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 21.6 million, of which external financing will constitute approximately EUR 15 million .
Public and private spending	The expenses will be borne predominantly through the public institution Agency "Moldsilva". At the initial stage, the contribution of LPA and the private sector related to the development of expenditure in the forestry sector is insignificant, and will increase, starting with the newly created forest management/PFP activities.
Social benefits	
Income	The implementation of the technology will contribute to increasing income in local budgets and for the population, especially in rural areas. Thus, estimated new forest areas created and/or rehabilitated within the technology will generate on average about 80 EUR/ha/year or about 1.0 million EUR annually. The main revenues will be obtained from the sale of wood mass (about 70%) harvested in the process of sustainable management of new/rehabilitated PFP, as well as from services and non-wood products (about 30%: carbon sequestration; forest fruits; medicinal plants; hunting; beekeeping; recreation, etc.). Certain revenues in the budget will be obtained from the realization of the primary investment of EUR 21.6 million, as well as the operating and management costs (about EUR 0.5 million annually) through the related fees and taxes.
Learning	The technology includes the realization of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (GIS/GPS; carbon monitoring; growing and planting seedlings with protected roots; conservative tillage technologies; digital forest record technologies; stopping /decreasing soil/land degradation processes, etc.). Also, the mechanisms for carrying out works to expand/rehabilitate protective forest curtains within all types of properties (state; UAT; private) through the interconnection of central public authorities (MM; MAFI, MIDR, Moldsilva, etc.) will be tested and perfected.), local public authorities (local councils, town halls, district councils), companies and private individuals.
Health	As a result of the implementation of the technology, the extended/rehabilitated forest curtains will improve the rural landscape and will be a supplement to the expansion of the recreation areas of the population. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The main environmental benefit will consist in the expansion of the area and the consolidation/rehabilitation of the protective forest curtain systems, which will contribute to the reduction of the degradation processes of sloping lands, surface runoff, will protect agricultural lands, infrastructure, etc. The new forest curtain systems will contribute to the reconstruction and improvement of the landscape, as well as to the strengthening of the local GHG sequestration capacities by about 110 kt CO_2 annually.
Others, if any	The planted/rehabilitated forest curtains will ensure the protection of about 355 thousand ha of adjacent agricultural land. Also, the respective functional systems will increase the productivity of the neighboring agricultural lands by about 12-15%, contributing to the improvement of food security, providing means of diversifying production systems, of raw materials, conservation of soil moisture resources, biodiversity, etc.

General information	
Section	The forestry sector
Climate impact	1. Decrease in biomass production, other forest products and services
Category	1.2. Regulation of forest management
The name of the technology	*1.2.1. Ensuring the implementation of the forestry regime in all forests and forest vegetation regardless of departmental membership and the nature of the property*

Brief description of the technology option	Technology contributes to the adaptation of the forestry sector to climate change by strengthening the process of implementing the forestry regime in the forest fund and other types of forest vegetation outside it (forest curtains; green spaces; silvopastoral and agroforestry practices , etc.) by developing forest management plans (forestry facilities) for forest lands owned by other owners than the "Moldsilva" Agency (LPA; MIDR; companies and private individuals, etc.). The work will include the description of the current state of the forests, as well as the design of concrete measures to adapt to climate change through management and improvement measures.
Adaptation needs. How technology contributes to adaptation	Technology contributes to the adaptation of the forestry sector to climate change by promoting new sustainable forest management practices to stop the processes of reducing forested areas, stopping the degradation of forest biodiversity by promoting natural forest types, reducing the fragmentation of forest massifs, increasing efficiency security activities and protection of the forest fund (including the fight against illegal exploitation of forests and related trade), etc. In this context, the forestry facilities will contribute to the substantial improvement of the management of forests and forest vegetation owned by LPA, MIDR, companies and private individuals in terms of adaptation to climate change. The forest management plans will contain concrete measures for adapting to climate change through management measures, improving the condition of degraded and inadequate forests, etc. It will also contribute to increasing the forestry sector's contribution to solving social-economic problems (jobs, combating poverty in rural areas, etc.).
Implementation assumptions and applicability scale	The implementation will be carried out with the participation of MM, "Moldsilva" Agency (including territorial entities), LPA, MIDR, companies and private individuals. For the immediate implementation, the mechanisms established by the legislation in the field will be used (Forestry Code; technical rules, guides and recommendations regarding forest management, etc.). The coverage area will be the forest lands owned by owners other than the "Moldsilva" Agency (LPA; MIDR; companies and private individuals, etc.) with a total area of about 130 thousand ha, located throughout the country .
Technology features	
Capital costs	The estimated value of the investments will be around EUR 2.1 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.2 million annually (security; technical revisions and improvements; modernization, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in the field of the development of forest management plans does not detect important cases of environmental damage as a result of the appropriate application of technical operations in the forest management process.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the pilot project.
Country specific applicability	
Institutional capacity	Moldsilva " Agency, MIDR, LPA, companies and private individuals will be trained in the implementation process . The main implementation obligations fall to the "Moldsilva" Agency (FRMI), which has the capacity, experience and tools to apply the technology. At the same time, in certain fields (technical equipment; personal training in the field of forestry planning, etc.) certain actions will be implemented to strengthen the capacities of Moldsilva /FRMI/LPA to ensure the success of the activities.
Scale of applicability	The technology covers all forest lands owned by owners other than Moldsilva (LPA; MIDR; companies and private individuals, etc.) with a total area of about 130 thousand ha. Estimated number of beneficiaries: about 845 town halls (about 2.6 million inhabitants, of which an estimated 1.36 million women and 1.24 million men); about 2000 private land owners.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best-expressed effect is long-term (over 10 years, with a well-expressed inertia).

Status of technology in the country	Technology is a priority for the forestry sector. Moldsilva (FRMI) and LPA have some experience in the application of similar technologies/elements that will contribute to the successful implementation of the new promoted activities. The lands of the forest fund managed by Moldsilva are in the third cycle of forest management according to the European system. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the measure, the use of digital technologies (including GIS/GPS) for recording land and works, climate projections and evolution of the state of forest vegetation, etc. is mentioned.
Acceptability for locals	Most of the inhabitants of rural settlements support the need to improve the state of forest lands owned by LPAs and private individuals, including due to the social and environmental benefits brought. Among the main conditions are the design/planning of optimal management solutions, but also the sustainable valorization of forest products and services: wood mass; accessory products (medicinal plants; forest fruits; beekeeping, etc.); recreation; hunting; the involvement of the local workforce as possible, etc.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely included in the implementation process in most stages and activities: carrying out forestry management activities; participation in forest management activities; the harvesting and processing of forest products in the management/farming process, etc. The degree of direct involvement in technology is estimated at 70% men and 30% women.
Other country-specific characteristics related to the technology (such as market potential)	Within the country there is sufficient potential for forest management activities of forest lands owned by other owners than the "Moldsilva" Agency (about 130 thousand ha). The implementation period of the entire volume will be around 10-15 years.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand from the surface available at the moment (about 130 thousand ha) to the level of carrying out forest management works of forest crops planted on new lands (about 75-100 thousand ha) according to national policy documents. Replicability and applicability: high.
Potential for knowledge sharing and capacity building	Technology contributes to the strengthening of the capacities of the "Moldsilva" Agency (FRMI), LPA, MIDR, companies and private individuals for the wider application/use of informational/digital technologies in the forest management process (choice and implementation of innovative technical management solutions; monitoring and record of forest management works and elements, etc.) . The activity includes exchange of experience between the national institutions involved in the process, but also with similar institutions from neighboring countries (Romania, Czech Republic, Poland, Austria, Ukraine, etc.). The technology will also facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private sector (creation and development of forestry infrastructure; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of GIS/GPS technologies, remote sensing; digital systems for monitoring and recording forest management works and elements; dendrometric equipment and systems, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of technology requires at the initial stage an extensive analysis of regulatory and political barriers, but also a list of activities aimed at solving them (developing and/or strengthening the institutional framework for forest management activities; revising the technical norms regarding forest management (including taking into account climate change); amending the technical regulations regarding the choice and application of forestry treatments; contractual arrangements with the definition of

	roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the rural environment, including within the different categories of SMEs. These are related to a wide spectrum of activities: carrying out forest management works (plot descriptions; designing technical solutions; development of management maps; development of forest management, etc.); carrying out auxiliary forestry works (materialization of borders; creation/rehabilitation of forestry infrastructure; transport and logistics services, etc.).
investment	The investment is a priority within the forestry sector, and attracting funding for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 2.1 million with the possibility of expansion by about 30-50%. From that amount, the external financing will constitute approximately EUR 1.4 million.
Public and private spending	The expenses will be borne predominantly through the public institution Agency "Moldsilva". The contribution of LPA, MIDR and the private sector related to the development of expenses in the respective activity of the forestry sector is an insignificant one, which will gradually increase, starting with the increase of income from forest management activities.
Social benefits	
Income	The implementation of the technology will contribute to increasing revenues in the state budget, local budgets and for the population, especially in rural areas. Thus, the respective revenues will come as a result of the implementation of forest management plans, which will generate significant volumes of wood products (about 70% of revenues), non-wood products and services (about 30%), their financial value will constitute on average about 80 EUR/ha/year or about 10 million EUR annually. Also, certain revenues in the budget will be obtained from the realization of the primary investment in forest management (2.1 million EUR primary investment; 0.2 million EUR – maintenance and management) through related fees and taxes.
Learning	The technology includes the implementation of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (digital technologies (including GIS/GPS) for recording land and works; climate projections and evolution of the state of forest vegetation, etc.). Climatic aspects will also be included within the technical norms regarding forest management, the choice and application of forestry treatments, care and management works, etc.; tested and perfected the mechanism for carrying out works through the interconnection of central public authorities (MM; Moldsilva, etc.), LPA, MIDR, companies and private individuals, etc.).
Health	As a result of the implementation of the technology, it will contribute to the improvement of the state of the forest ecosystems managed by LPA, MIDR, individuals and private companies, with direct consequences on the health of the population in the neighboring towns. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The development of forest management plans (forest management) will contribute to the essential improvement of the management of forests and forest vegetation, the inclusion of aspects of adaptation to climate change in forestry practice for lands owned by LPA, MIDR, companies and private individuals. The forestry arrangements will contain concrete measures to ensure the resilience of forests to climate change, improve the condition of degraded and inadequate forests, etc.
Others, if any	Another important result of the technology will be the provision of credible and truthful up-to-date information on the state and evolution of forests and forest vegetation throughout the country. The respective data will be used in the processes of developing

	inter-sectoral policies and cooperations (agriculture; territorial organization, etc.), international reporting (state of forest resources; climate change; biodiversity), etc.

General information	
Section	The forestry sector
Climate impact	2. Changing the rate of forest regeneration, degradation and reduction of forested areas
Category	2.1. Rehabilitation of degraded and inadequate stands
The name of the technology	*2.1.1. The ecological reconstruction of inadequate and vulnerable stands in order to adapt to climate change, based on the ecosystem approach (EbA)*
Brief description of the technology option	The technology provides for the application of ecological reconstruction practices of degraded and inappropriate stands (totally derived, branched, inappropriate for seasonal conditions, poorly productive, etc.), vulnerable to climate change, aiming at the replacement of single-species stands with mixed and multi-species stands , the unaltered preservation of the internal environment of the forest by making maximum use of the shelter of degraded stands. All interventions silvotechnics within this system will be carried out in full correspondence with the place and role of each component element of the ecosystem (trees, shrubs, animal kingdom, etc.), applying the ecosystem approach. As methods of intervention, priority will be applied to substitutions and restorations.
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding increasing the potential ecoprotective and bioproductive of natural forests, the conservation of biological diversity of forests, as well as ensuring the resilience of forests to climate change. The rehabilitated forests will constitute stands made up of flexible and long-lived tree and shrub species, resilient / resistant to adverse factors (disease and pest attacks; weather and climate change, etc.). Also, the technology foresees the conversion from the grove regime to the forest regime, ensuring regeneration from the seed, creating long-lived stands capable of adapting to climate changes.
Implementation assumptions and applicability scale	The implementation will be carried out with the participation of MM, "Moldsilva" Agency (including territorial entities), NGB, companies and private individuals. For the immediate implementation, the mechanisms established by the legislation in the field will be used (Forestry Code; Technical norms for the ecological reconstruction of forests, etc.). The coverage area will be approximately 25 thousand ha of degraded, inadequate and vulnerable to climate change trees , located throughout the country within the forest fund managed by the "Moldsilva" Agency. The respective indicator constitutes about 21% of the current ecological reconstruction needs (substitutions; restorations) of degraded/inappropriate stands managed by the "Moldsilva" Agency.
Technology features	
Capital costs	The estimated value of the investments will be around EUR 50.0 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.9 million annually (guarding; protection; forestry; forest management, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in similar fields does not report important cases of environmental damage as a result of the appropriate application according to the rules and technical regulations of the replacement/restoration operations of stands.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	In the implementation process, MM, "Moldsilva" Agency, NGB, companies and private individuals will be trained. The main implementation obligations fall to the "Moldsilva" Agency, which has a certain capacity, experience and tools to apply the technology through its territorial subdivisions. At the same time, certain capacity building actions will be implemented in certain areas (technical equipment; personal

	training in the field of designing technical solutions; personal training regarding the application of technical solutions and new technologies, etc.) to ensure the success of the activities.
Scale of applicability	The technology provides for the ecological reconstruction of about 25 thousand ha of degraded and inadequate stands . The works will be carried out from the account of public lands managed by the "Moldsilva" Agency and its territorial structures, located throughout the country. As direct beneficiaries, there will be 25 entities subordinate to the "Moldsilva" Agency.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best-expressed effect is long-term (over 20 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the forestry sector. Moldsilva has some experience in the application of similar technologies/technical elements that will contribute to the successful implementation of the new promoted activities. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects foreseen in the technology are the use in reconstruction/regeneration activities of only flexible and long-lived tree and shrub species, able to adapt to climate changes; conservative tillage technologies; digital technologies (including GIS/GPS) for records of land and works, etc.
Acceptability for locals	Most of the inhabitants of rural settlements support the need to improve the general condition of forests, including due to the expected environmental and social benefits. Among the basic conditions are the application of the optimal technical solutions, the inclusion of fruit/honeybee species in the composition of forest crops, the timely information and consultation of stakeholders, the involvement of the local workforce as possible, etc. At the same time, cases are recorded when the local population requests the stopping of forestry works in the forests bordering the localities due to the damage to the local infrastructure, the landscape, the interests of the communities, etc. Those situations are overcome through communication companies, increasing the quality of works and results, as well as strengthening security and protection activities.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely involved in the implementation process in most stages and activities: harvesting tree and shrub seeds; growing saplings in forest nurseries; planting seedlings; care and maintenance of forest crops; harvesting of non-wood products (fruits, berries, medicinal plants), etc. Also, the wood production harvested as a secondary result of the works contributes to the improvement of living conditions and household comfort in the neighboring towns. The degree of direct involvement in technology is estimated at 60% men and 40% women.
Other country-specific characteristics related to the technology (such as market potential)	Within the country there is sufficient potential for ecological reconstruction activities of degraded and inadequate stands . Thus, according to current estimates, about 40% or 120 thousand ha of the forests managed by the "Moldsilva" Agency have certain elements of degradation that affect their capacities to adapt to climate change, which require reconstruction/consolidation measures. At the same time, it is mentioned the increase in the market potential of forest products and services from the increase of forest biomass and wood production, the creation of new jobs, recreation, ecological services, etc.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand in the future to the level of achieving the entire current ecological reconstruction of degraded and inappropriate stands (from 25 thousand ha to about 120 thousand ha). Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The technology contributes to the strengthening of the capacities of the "Moldsilva" Agency and its territorial structures to apply a high-performance forest management, innovative technical solutions for the ecological reconstruction of degraded and inadequate stands , to manage forests in a sustainable way and in accordance with the new climatic conditions. The activity includes exchange of experience between the national institutions involved in the process, but also with similar institutions from

	neighboring countries (Romania, Ukraine, etc.). The technology will also facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private sector (harvesting and processing wood/non-wood products; planting and caring for forest crops; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of digital technologies (including GIS/GPS); machines and equipment for conservation tillage, planting and care of forest crops, exploitation/harvesting of wood mass; equipment for monitoring accumulated/sequestered carbon, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires at the initial stage an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (consolidation of the institutional framework for forest management activities; updating of technical norms/regulations aimed at ecological reconstruction, biodiversity conservation, etc.; arrangements contracts with the definition of roles and responsibilities for the parties involved, etc.), which will partly change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the rural environment and especially in the different categories of SMEs. These are related to a wide spectrum of activities: the development of forest nurseries; afforestation/reforestation works; development of sustainable forest management; forest exploitations; wood processing; sale of firewood; collecting and selling non-wood forest products (fruits and berries; medicinal plants; beekeeping, etc.), handicrafts, etc.
investment	The investment is a priority of the forestry sector, and attracting financing for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 50.0 million, of which the sources from the wood mass exploited in the rehabilitated stands will constitute approximately EUR 20 million, and external financing – approximately EUR 25.0 million, other sources – EUR 5.0 million.
Public and private spending	The expenses will be borne predominantly through the public institution Agency "Moldsilva". The contribution of the private sector related to the development of expenses in the respective activity of the forestry sector is an insignificant one, it relates in particular to the development of capacities for participation in forest exploitation in the stands intended for rehabilitation, which will gradually increase starting with the management activities of the rehabilitated forests, as well as the expansion activity on the entire potential area, including forests owned by LPA and privately.
Social benefits	
Income	The implementation of the technology will contribute to increasing revenues in the state budget, local budgets and for the population, especially in rural areas. Thus, it is estimated that the forests rehabilitated within the technology will generate on average about 80 EUR/ha/year or an income of about 2.0 million EUR annually. The main revenues will be obtained from the sale of wood mass (about 70%) harvested in the process of sustainable management of rehabilitated forests, as well as from services and non-wood products (about 30%: forest fruits; medicinal plants; hunting; beekeeping; recreation ; carbon sequestration, etc.). Certain revenues in the budget will also be obtained from the realization of the primary investment of EUR 50.0 million, as well as the operating and management costs (about EUR 0.9 million annually) through the related fees and taxes.
Learning	The technology includes the realization of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (digital technologies (including GIS/GPS); innovative technical solutions for substituting unsuitable species and stands; carbon monitoring; growing and planting seedlings with roots protected etc.). Also, mechanisms for carrying out works will be tested and perfected through the interconnection of central public authorities (MM; Moldsilva, etc.), companies and private individuals.

Health	As a result of the implementation of the technology, the rehabilitated forests will improve the rural landscape and will be a supplement to the expansion of the leisure, sanitation and recreation areas of the population. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The main environmental benefit will be the creation of stands resistant to adverse factors (disease and pest attacks; weather and climate change, etc.). The state of forest habitats and biodiversity will also improve. The reconstruction will contribute to increasing the carbon sequestration capacities of the targeted stands by 40-50%, maximizing the available seasonal potential.
Others, if any	The rehabilitated forests will ensure the protection of agricultural land, localities and neighboring infrastructure. They will also contribute to the improvement of energy and food security, providing means to diversify production systems, raw materials, conservation of soil moisture resources, etc.

General information	
Section	The forestry sector
Climate impact	2. Changing the rate of forest regeneration, degradation and reduction of forested areas
Category	2.2. Growth of reproductive forest material
The name of the technology	*2.2.1. The use of modern biotechnologies for propagating vegetative material in providing the forestry sector with reproductive material in the new climatic conditions*
Brief description of the technology option	The technology provides for the adaptation of the sub-sector of the production of reproductive forest material to the evolution of climate change through activities to consolidate and modernize the production process of reproductive forest material along the entire productive chain: the identification, legalization and care of seed source stands (including forest genetic resources/ FGR); harvesting, processing and certification of forest seeds; industrial growth and exploitation of reproductive forest material, etc. That process will include the use of biotechnologies for the production of planting material (multiplication, rooting, in vitro growth, etc.), including with protected roots (about 50-60%). Also, for the regeneration and afforestation works in the Republic of Moldova, the assortment of tree and shrub species that grow in the forests of the Republic of Moldova (more than 85 species) will be ensured. Another important compartment will be the review of the normative base aimed at the management and conservation of forest genetic resources, including in the aspect of adaptation to climate change.
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding the intensification of the process of afforestation/reforestation of land, ensuring the resilience of forests to climate change, increasing the potential ecoprotective and bioproductive of natural forests, preservation of biological diversity of forests, etc. In the context, the production of forest material in the requested assortment, qualitatively and in the necessary quantities, which will contribute to increasing the success of forestry crops and adapting regeneration and afforestation works to climate change. Improving the management and conservation process of seed source stands, as well as forest genetic resources, especially in terms of adaptation to climate change.
Implementation assumptions and applicability scale	The implementation will be carried out with the participation of MM, MAIA, "Moldsilva" Agency (including territorial entities), NGB, IGFPP, companies and private individuals. For the immediate implementation, the mechanisms established by the legislation in the field will be used (Forestry Code; guidelines and recommendations regarding the care and maintenance of seed source stands; guidelines and recommendations regarding the organization of the activity of forest nurseries, etc.). The technology includes the establishment and commissioning of some basic elements of the reproductive forest material production sub-sector: the creation of 2 regional centers for the industrial growth of forest reproductive material (CRCIMFR) usable in the new climatic conditions (northern and southern areas; appropriate technical endowment;

	primary operational activity; personal training, etc.), creation and appropriate technical endowment of the National Forestry Genetics and Seminology Center (center area; management of seed base, certification of regeneration material; processing and COMPLIANCE forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro multiplication; primary operational activity; seed processing equipment, nursery equipment and laboratory equipment for quality assessment, etc.). The coverage area will be the stands of seed sources and those designated as forest genetic resources (about 8-10 thousand ha), as well as the forest nurseries (about 900 ha; over 30 forest nurseries) within the "Moldsilva" Agency and its territorial structures, located throughout the country.
Technology features	
Capital costs	The estimated value of the investments will be around EUR 7.8 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 1.1 million annually (guarding; protection; forestry; forest management, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in the field of the production of reproductive forest material does not detect important cases of environmental damage as a result of the appropriate application of technical operations in the nursery production process.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	”Moldsilva" Agency, companies and private individuals will be trained in the implementation process . The main implementation obligations rest with the "Moldsilva" Agency, which has the capacity, experience and tools to apply the technology through its territorial subdivisions. At the same time, in certain areas (technical equipment; personal training in the field of designing technical solutions for the care of seed source stands and those designated as forest genetic resources; personal training regarding the application of technologies for growing forest reproductive material, etc.) will be implemented certain actions to strengthen the capacities of Moldova (including with the consultation of specialists and specialized companies from Poland, the Czech Republic, Hungary, etc. to ensure the success of the activities.
Scale of applicability	The technology covers seed source stands and those designated as forest genetic resources (about 5-7 thousand ha), as well as forest nurseries (about 900 ha; over 30 forest nurseries) within the "Moldsilva" Agency and its territorial structures (24 entities) , located throughout the country.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best-expressed effect is long-term (over 10 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the country. Moldsilva has some experience in the application of similar technologies/elements, which will contribute to the successful implementation of the new promoted activities. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the measure, the following are mentioned: biotechnologies; processing and COMPLIANCE forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro multiplication; automated irrigation systems; technical solutions for the care of seed source stands and those designated as forest genetic resources; digital technologies (GIS/GPS) for records of land and works, etc.
Acceptability for locals	Most of the inhabitants of rural settlements support the need to improve the area of growth of reproductive forest material, including due to the social and environmental benefits brought. Among the basic conditions are the growth in nurseries, including fruit/honey-bearing forest species, the timely information and consultation of stakeholders, the involvement of local labor if possible, the allocation at a reasonable price of decorative forest material for the greening of localities, etc.

The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely involved in the implementation process in most stages and activities: harvesting tree and shrub seeds; growing saplings in forest nurseries; growing and harvesting non-wood products (fruits, berries, medicinal plants), etc. The degree of direct involvement in technology is estimated at 55% men and 45% women.
Other country-specific characteristics related to the technology (such as market potential)	Within the country there is sufficient potential for the growth of forest reproductive material. Thus, according to preliminary estimates, in the event of the relaunch of afforestation activities on new lands, the national needs would constitute approximately 50-70 million small and medium-sized saplings per year. At the same time, it is mentioned the increase of the market potential (including at the international/regional level) of medium and large saplings that can be used for green spaces/areas, forest curtains/alignments for the protection of agricultural fields, infrastructure, etc.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand to the level of realization of the entire current need of forest reproductive material: from the annual production of 15-20 million saplings to about 50-70 million saplings. Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The technology contributes to the strengthening of the capacities of the "Moldsilva" Agency and its territorial structures for the application of a high-performance forest management, of innovative technical solutions for the growth of reproductive forest material both for regeneration works within the existing forest fund (including ecological reconstruction of degraded stands and inadequate), as well as for afforestation works on new lands (extension of forests). The strengthening of institutional capacities includes the creation of 2 CRCIMFR for the north and south areas, the CNGSF for the center area (management of the seed base, certification of regeneration material; processing and COMPLIANCE forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro multiplication etc.). The activity includes exchange of experience between the national institutions involved in the process, but also with similar institutions from neighboring countries (Hungary, Poland, Czech Republic, etc.). The technology will also facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private sector (harvesting and processing of forest seeds; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of digital technologies (including GIS/GPS); machines and equipment for the mechanized cultivation of soil, sowing and care of seedlings, plant protection; automated irrigation equipment and systems; plant multiplication biotechnologies, including forestry genetic research and in vitro multiplication; processing, conditioning and multi-year storage of forest seeds, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires at the initial stage an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (developing and/or strengthening the institutional framework for forest nursery activities; updating some technical rules and regulations regarding the harvesting and movement of forest seeds , care and maintenance of seed stands and those designated as FGR; contractual arrangements with the definition of roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	By means of the activities planned within the technology, new jobs will be created in the rural environment, for CRCIMFR and CNGSF, as well as in different categories of SMEs. These are related to a wide spectrum of activities: harvesting and primary

	processing of forest seeds; the development of forest nurseries; collection and sale of non-wood forest products (fruits and berries; medicinal plants; beekeeping), crafts, etc.
investment	The investment is a priority of the country, and the attraction of financing means for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 7.8 million, of which external financing will constitute approximately EUR 5.5 million.
Public and private spending	The expenses will be borne predominantly through the public institution Agency "Moldsilva". The contribution of LPA and the private sector related to the development of expenses in the respective activity of the forestry sector is an insignificant one, which will gradually increase starting with the expansion of the activity over the entire potential area.
Social benefits	
Income	The implementation of the technology will contribute to increasing revenues in the state budget, local budgets and for the population, especially in rural areas. Thus, it is estimated that the forest nursery activity within the technology (maximum capacity) will generate on average about 50-70 million lei annually. Certain revenues in the budget will be obtained from the realization of the primary investment of 7.8 million EUR, as well as the operating and management costs (about 1.1 million EUR annually) through the related fees and taxes.
Learning	Technology includes the realization of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (digital technologies (including GIS/GPS); growing seedlings with protected roots; plant protection; automated irrigation systems; plant multiplication biotechnologies; in vitro growth of forest species of trees and shrubs, etc.). Also, mechanisms for carrying out works will be tested and perfected through the interconnection of central public authorities (MM; Moldsilva, etc.), companies and private individuals.
Health	The saplings grown according to the new technologies will be planted within the new forests and green spaces, will improve the rural landscape and will be a supplement to the expansion of the leisure, sanitation and recreation areas of the population. At the same time, in the same context, the thermal and living comfort of the population will increase.
Developmental impacts, indirect benefits	
Environmental benefits	The main impact will focus on increasing the quantity and quality of forest seed material harvested from identified sources, with beneficial consequences on the quality of seedlings and future forest crops. Also, the respective centers will provide the entire assortment of tree and shrub species necessary for the regeneration and afforestation works based on the seasonal conditions (about 65 tree species and about 20 shrub species). The respective centers will ensure the production of 50-60% forest material with protected roots, which will contribute to increasing the success of forestry crops and adapting regeneration and afforestation works to climate change.
Others, if any	Another important result will be the revision of the normative base aimed at the management and conservation of forest genetic resources, including in the aspect of adaptation to climate change.

General information	
Section	The forestry sector
Climate impact	2. Changing the rate of forest regeneration, degradation and reduction of forested areas
Category	2.3. Research and technological development
The name of the technology	*2.3.1. Research to identify climate change interactions, forest species and appropriate forest ecosystem management strategies*
Brief description of the technology option	The technology foresees the initiation of fundamental research programs combined with application components regarding the adaptation capacities of native forest ecosystems to climate change, based on the ecosystem approach (EbA) and nature-based solutions (NBS). The respective programs will mainly focus on the following aspects:

	● Establishing climatic thresholds that correspond to the spatial distribution limits of forest types and/or forest species, with the development of bioclimatic models to predict future steady state forest distributions under a range of plausible climate change scenarios; ● Collecting and analyzing historical information on the migration of species and forests over certain distances to estimate how long it might take for the limit of existing forests to migrate a certain distance; ● Calibration of biogeochemical models for forecasting changes in the productivity of stands and carbon stocks in the main forest types, with and without the effects of increased CO_2 concentrations; ● Assessment of adaptive capacity, including the inherent adaptive capacity of forest species and ecosystems, as well as socio -economic factors that determine the ability to implement planned adaptation measures. The activity includes the development and promotion of new strategies/approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change, as well as the implementation of sustainable forest management principles.
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding the development and implementation of scientifically justified adaptation measures with clear mitigation co -benefits and sustainable development approaches, the promotion of new sustainable forest management practices, the use of tree species in forestry practices and climate resistant shrubs. In this context, the development and promotion of new technical approaches and regulations are foreseen to ensure the resilience of forest ecosystems to the effects of climate change, as well as the implementation of the principles of sustainable forest management. These documents and approaches will be based on a cycle of fundamental research combined with applied components regarding the adaptation capacities of native forest ecosystems to climate change (resilience of species and stands ; review of approaches in the process of applying forestry treatments and works, regeneration works of forests etc.).
Implementation assumptions and applicability scale	The implementation will be carried out with the participation of MM, MEC, NARD, "Moldsilva" Agency (including territorial entities), NGB, IEG, research institutions, universities, companies and private individuals. The process will include launching and carrying out a cycle of national research programs that will focus mainly on aspects related to the evolution/forecast of the spatial distribution of forest species and ecosystems; species and forest migration; bioclimatic and biogeochemical modeling; the adaptation capacities of forest species and ecosystems; socio-economic factors that determine the ability to implement sectoral adaptation measures, etc. Science Code and innovation; guidelines and recommendations on conducting scientific research, etc.). The coverage area will be the forests owned by the "Moldsilva" Agency and its territorial structures (337.6 thousand ha), located throughout the country.
Technology features	
Capital costs	The estimated value of the investments will be around EUR 0.8 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.1 million annually (technical servicing of equipment and research infrastructure; software modernization, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in the field of forestry-related research does not report important cases of environmental damage as a result of fundamental and/or applied scientific research.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the pilot project.
Country specific applicability	
Institutional capacity	NARD, "Moldsilva" Agency, NGB, IEG, research institutions, universities, companies and private individuals will be trained. The main implementation obligations fall to research institutions, universities, the "Moldsilva" Agency, which have a certain capacity, experience and tools to apply the technology. At the same time, actions will be

	implemented to strengthen the capacities of research institutions, universities, and the "Moldsilva" Agency in certain areas (technical equipment; personal training, etc.) to ensure the success of the activities.
Scale of applicability	The technology covers all the forests and forest vegetation owned by the "Moldsilva" Agency (337.6 thousand ha). The estimated number of direct beneficiaries are about 5550 owners of land with forests and other categories of forest vegetation, the total number of employees - about 3350 people (including about 25% women).
long term	The technology is foreseen in the medium and long term. The best-expressed effect is long-term (over 10 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the country. The experience held by research institutions and universities will contribute to the successful implementation of the newly promoted activities. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the technology, the aspects regarding the evolution/forecast of the spatial distribution of forest species and ecosystems are mentioned; species and forest migration; bioclimatic and biogeochemical modeling; the resilience of forest species and ecosystems to the effects of climate change, etc.
Acceptability for locals	Most of the inhabitants of rural settlements support the need to improve the management of local and national forest resources based on scientifically proven approaches, including due to the social and environmental benefits brought. The main condition is the application of optimal management solutions, the timely information and consultation of the interested parties, the involvement of the local workforce as possible, etc. Also, the population's expectations are focused on access to quality forest products and services, without harming the state of forest ecosystems.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely included in the implementation process in most stages and activities: carrying out field and office research; practical testing of new forest management approaches and technologies, etc., in compliance with occupational safety measures. The degree of direct involvement in technology is estimated at 45% men and 55% women.
Other country-specific characteristics related to the technology (such as market potential)	Within the country there is sufficient potential for research activities on forests and other types of forest vegetation. Within the forest fund managed by the "Moldsilva" Agency (337.6 thousand ha) there is a wide network of experimental sectors in which investigations/researches are carried out (forestry monitoring; silvopathological monitoring ; FGR, etc.) and can be co-opted under the activity of technology . Based on the studies and investigations carried out, the research institutions in the field (NGB; IEG; IZ; USM; UASM; FRMI, etc.) develop/produce a wide range of guides/technologies/goods that are approved and/or patented, being used in different branches of the national economy, contributing to increasing economic and technological efficiency, expanding the value chain, etc.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand at the level of carrying out research on the entire area covered with forests and other types of forest vegetation (about 425 thousand ha) owned by the state, LPA, companies and private individuals. Replicability and Applicability: Medium.
Potential for knowledge sharing and capacity building	The technology contributes to strengthening the capacities of research institutions in the field (NGB; IEG; IZ; USM; UASM; FRMI, etc.), the "Moldsilva" Agency and its territorial structures for the wider application/use of informational/digital technologies in the process of conducting investigations and processing the results (monitoring of carbon stocks; evolution/forecasting of the spatial distribution of forest species and ecosystems; bioclimatic and biogeochemical modeling; resilience of forest species and ecosystems to

	the effects of climate change; recording, monitoring and forecasting of forest species succession processes; migration of species and forests etc.) . The activity will include exchange of experience between national institutions, but also with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Poland, Czech Republic, Bulgaria, etc.), as well as with international forestry centers (EFI; IUFRO, etc.). The technology will also facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private sector (creating research infrastructure; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the evolution/forecast of the spatial distribution of forest species and ecosystems; species and forest migration; bioclimatic and biogeochemical modeling; the resilience of forest species and ecosystems to the effects of climate change; the use of GIS/GPS technologies; digital carbon stock monitoring systems; equipment and automated systems for collecting microclimatic/physiological/dendrometric parameters, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires at the initial stage an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (ensuring the development and/or strengthening of the institutional framework for research activities, including particularities for forest ecosystems; development of technical approaches and regulations new ones to ensure the resilience of forest ecosystems to the effects of climate change; contractual arrangements with the definition of roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry and research sectors.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the field of research and technological development, as well as in the rural environment, including within different categories of SMEs. These are related to a wide spectrum of activities: carrying out scientific forestry research and investigations; creation and maintenance of research infrastructure, experimental sectors/lots; transport and logistics services etc.
investment	The investment is a priority of the country, and the attraction of financing means for these actions will be achieved through national public funds and grants from foreign donors. The total investment value is estimated at 0.8 million EUR, annual needs of around 0.1 million EUR for operation and maintenance. The external financing will be approximately EUR 0.5 million. Also, the possibility of expansion by about 30-35% is anticipated.
Public and private spending	The expenses will be borne predominantly through the public institutions involved: MEC, NARD, "Moldsilva" Agency. The contribution of LPA and the private sector related to the development of expenses in the respective activity of the forestry sector is an insignificant one, which will gradually increase starting with the expansion of the activity over the entire potential area.
Social benefits	
Income	The implementation of the technology will contribute to increasing revenues in the state budget, local budgets and for the population, especially in rural areas. Thus, certain revenues in the budget will be obtained from the realization of the primary investment of EUR 0.8 million, as well as the operating and management costs (about EUR 0.1 million annually) through the related fees and taxes. At the same time, the practical involvement of new technical approaches and regulations to ensure the resilience of forest ecosystems to the effects of climate change developed within the technology will anticipate public and private expenses in the compartments related to the regeneration/extension of forests, the application of forestry treatments/works in the amount of approx. 2.5-3.5 million EUR annually.
Learning	The technology will contribute to the promotion of innovation in the forestry field, because it includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (GIS/GPS; application/use of informational/digital technologies in the process of conducting investigations and

	processing results; the evolution/forecast of forest species and forest ecosystems; the resilience of forest species and ecosystems; the recording, monitoring and forecasting of forest species succession. Also, based on the studies and investigations carried out, a wide range of guides/technologies/goods will be developed/produced which, being approved/homologated and/or patented, will be used in the forestry sector, increasing the economic and technological efficiency of forestry management; testing and perfecting the mechanism for carrying out works through the interconnection of central public authorities (MM; MEC; NARD; Moldsilva, etc.), companies and private individuals. etc.).
Health	Increasing the quality of forest management will contribute to improving the state of forest ecosystems with direct consequences on the health of the population. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The main impact will consist in the development and implementation of new approaches related to the process of adapting native forest ecosystems to climate change, based on basic and applied local research. The development of new technical regulations will be ensured to ensure concrete steps in achieving the resilience of forest ecosystems to the effects of climate change.
Others, if any	Another important result will be the consultation and adaptation of the results, the exchange of experience with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Poland, Czech Republic, Bulgaria, etc.), as well as with international forestry centers (EFI; IUFRO, etc.). The technology will identify the socio -economic factors that determine the ability to implement sectoral adaptation measures, as well as drawing solutions to overcome barriers and implementation problems.

General information	
Section	The forestry sector
Climate impact	2. Changing the rate of forest regeneration, degradation and reduction of forested areas
Category	2.3. Research and technological development
The name of the technology	*2.3.2. Consolidation of the information system about the state and evolution of forests in the Republic of Moldova by creating the National Forest Inventory (IFN)*
Brief description of the technology option	The technology aims at the adequate monitoring of the evolution of the state of forests, in particular, the interconnection with climate changes, by consolidating and modernizing the forest information system in the Republic of Moldova based on the creation of the National Forest Inventory (IFN). The IFN will be carried out through a network of permanent sample areas in continuous mode and will be updated every 4 years, it includes the collection of field data (about trees, groves, dead wood, forest soils, etc.), digital photogrammetry, laboratory analyzes and statistical data processing. Also, the IFN includes the preparation of studies and scenarios regarding the development of the forestry sector to be used, especially, in the processes of developing the forestry policy and inter-sectoral cooperation, as well as for providing data for the reporting of sustainable forest management indicators, according to the international commitments assumed by the country.
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding the adequate monitoring of the evolution of the state of forests, in particular, the interconnection with climate change. In this context, the National Forest Inventory will contribute to the preparation of studies/scenarios regarding the development of forest ecosystems to be used, mainly, in the processes of developing the forest policy with an emphasis on adaptation to climate change, as well as to provide data for reporting indicators of sustainable management of forests, according to the international commitments assumed by the country.

Implementation assumptions and applicability scale	The implementation will be carried out with the participation of MM, MEC, NARD, "Moldsilva" Agency (including territorial entities, FRMI), NGB, IEG, LPA, MIDR, companies and private individuals. Also, certain involvements and consultations will be with the European institution authorized in the field of IFN - ENFIN (European National Forest Inventory network). Moldsilva (FRMI) has some similar experience for over 30 years (forest management; forest monitoring; carbon monitoring in CDM projects, etc.). The IFN will be carried out through a network of permanent and temporary test surfaces on a continuous basis and will be updated every 4 years. For the immediate implementation, the mechanisms established by the legislation in the field will be used (Forestry Code; technical rules, guides and recommendations regarding the performance of forest statistical inventories, etc.). The activity will include, at the initial stage, the development of national technical regulations regarding the performance of the IFN, the organization of the works, the interpretation and applicability of the results, etc. The coverage area will be the lands of the national forest fund (about 448 thousand ha), as well as the forest vegetation outside it (about 51 thousand ha), located throughout the country.
Technology features	
Capital costs	The estimated value of the investments will be around EUR 1.6 million.
Operation and Management (O&M) costs	The value of operation and management costs will constitute approximately 0.2 million annually (maintenance of infrastructure and equipment; technical revisions and improvements; modernization, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national forestry practice has some experience on similar technologies (forest monitoring; silvopathological monitoring; carbon monitoring in CDM projects, etc.).
Availability and Maturity	The proposed measures and activities are partially available on the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	”Moldsilva" Agency, NGB, IEG, MIDR, LPA, companies and private individuals will be trained . The main implementation obligations fall to the "Moldsilva" Agency (FRMI), which has a certain capacity, experience and tools to apply similar technologies (forestry management; forest monitoring; carbon monitoring, etc.). At the same time, extensive capacity building actions will be implemented in certain areas (technical equipment; personal training, etc.) to ensure the success of the activities. The appointed consultations and technical support will be with the European institution qualified in the field of IFN - ENFIN (European National Forest Inventory Network), as well as with institutions similar from neighboring countries (Romania, Ukraine, Hungary, Poland, Czech Republic, etc.).
Scale of applicability	The technology covers all the lands of the national forest fund (about 448 thousand ha), as well as the forest vegetation outside it (about 51 thousand ha) owned by the state ("Moldsilva" Agency, MIDR, etc.), other owners (LPA; companies and private individuals etc.). The estimated number of direct beneficiaries are about 5550 owners of land with forests and other categories of forest vegetation.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best expressed effect is in the medium and long term (over 5 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the forestry sector. The activity represents technology transfer according to ENFIN methodology and approaches (European National Forest Inventory network). Moldsilva (FRMI) has some experience on similar technologies/technical elements (forest management; forest monitoring; carbon monitoring, etc.), which will contribute to the successful implementation of the new promoted activities. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the technology are: informational/digital technologies for the record/inventory process of forest resources (remote sensing; digital photogrammetry; forest statistics; dendrometry; carbon stocks, etc.); data/information processing and interpretation

	software; network of permanent and temporary test areas covering the entire national forest fund and the forest vegetation outside it, etc.
Acceptability for locals	Technology poses no danger to the locals. Most of the inhabitants of rural settlements support the need to improve the records regarding the condition of forest lands owned by LPA and private, including due to the social and environmental benefits brought. The main condition is the exploitation of forest products and services (timber; ancillary products (medicinal plants; forest fruits; beekeeping, etc.); recreation, etc.) in the interest of the communities that own them, but without affecting the state of the environment. At the same time, certain conflicts may arise with parties interested in the non-transparent use of forest products and services, which will be highlighted and potentially reported/stopped. Those situations are overcome through communication companies, increasing the quality of works and results, as well as strengthening security and protection activities.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely included in the implementation process in most stages and activities: carrying out measurement activities in the field, data processing and analysis in the office; participation in data presentation and publication activities, etc. The degree of involvement in technology is estimated to be 60% male and 40% female.
Other country-specific characteristics related to the technology (such as market potential)	There is sufficient potential within the country for forest and other forest vegetation inventory/research activities. Within the forest fund managed by the "Moldsilva" Agency (337.6 thousand ha) there is a wide network of experimental sectors in which periodic investigations/researches are carried out (forestry monitoring; silvopathological monitoring ; FGR, etc.) and which can be partially co-opted under technology activity. The realization of the IFN will provide credible and truthful updated information about the state and evolution of the forest vegetation throughout the country, which will be used for the processes of developing the forestry policy and inter-sectoral cooperation, as well as reporting to different international institutions/conventions.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand at the level of carrying out works on the forest crops expected for planting in the coming years on new lands (about 75-100 thousand ha). Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The technology will contribute to the promotion of innovation in the forestry field, strengthening the capacities of the "Moldsilva" Agency (FRMI), NGB, IEG, LPA, companies and private individuals for the wider application/use of informational/digital technologies in the process of recording/inventory of forest resources (forestry statistics; dendrometry; carbon stocks, etc.) . The activity includes exchange of experience between national institutions (FRMI; NGB; IEG, etc.), but also with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Poland, Czech Republic, etc.), as well as with international forestry centers (EFI; IUFRO); FINALLY, etc.). The technology will also facilitate the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private sector (creation and development of forestry infrastructure; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of GIS/GPS technologies; digital systems for monitoring and recording the works and arboretum elements; dendrometric equipment and systems; data/information processing and interpretation software, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires at the initial stage an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (the development of the national regulatory framework regarding the performance of

	IFN, the organization of the works, the parties involved, the interpretation and applicability of the results, etc.; the revision of the normative acts and technical rules regarding the record of forests and other types of forest vegetation; contractual arrangements with the definition of roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the field of technical forestry investigations, as well as in different categories of SMEs in the rural environment. These are related to a wide spectrum of activities: specialists in the IFN office; carrying out auxiliary inventory works (materialization of SP borders; creation/rehabilitation of forest infrastructure; transport and logistics services, etc.).
investment	The investment is a priority of the forestry sector, and attracting financing for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 1.6 million for a 4-year cycle with the possibility of expansion by about 30-35%. The external financing will be approximately EUR 1.4 million
Public and private spending	The expenses will be mostly borne by the public institution "Moldsilva" Agency. The contribution of LPA and the private sector related to the development of expenses in the respective activity of the forestry sector is insignificant.
Social benefits	
Income	The implementation of the technology will contribute to increasing revenues in the state budget, local budgets and for the population, especially in rural areas. Thus, the respective revenues will come in the form of fees and taxes as a result of investments in the implementation of IFN activities (1.6 million EUR primary investment; 0.2 million EUR – maintenance and management). At the same time, the implementation of technology, which ensures a high level of transparency regarding the state and evolution of national/local forest resources, can generate investments in forest management from LPA and private companies, access to international funds, etc.
Learning	Technology includes the realization of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (information/digital technologies (including GIS/GPS; remote sensing; digital photogrammetry, etc.) in the process of forest inventory/recording; equipment and systems dendrometrics; data/information processing and interpretation software, etc.). Also, the national regulatory framework regarding the performance of IFN will be developed, as well as revised normative acts and technical norms regarding the record of forests and other types of forest vegetation, etc.; tested and perfected the mechanism for carrying out works through the interconnection of central public authorities (MM; MEC; NARD; MIDR, Moldsilva, etc.), LPA, companies and private individuals. etc.). The activity also includes an extensive exchange of experience between national institutions (FRMI; NGB; IEG, etc.), but also with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Poland, Czech Republic, etc.), as well as with international forestry centers (EFI; IUFRO; ENFIN, etc.)
Health	The technology contributes to improving the condition of the forest ecosystems managed by the "Moldsilva" Agency, LPA, MIDR, individuals and private companies, with direct consequences on the health of the population in the neighboring towns. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The realization of the IFN will essentially contribute to increasing the level of knowledge regarding the quality of forest management and the direct effects on the state of forests and other types of forest vegetation. IFN will provide credible and truthful up-to-date information on the basic parameters, condition and evolution of forests/forest vegetation throughout the country. The IFN reports will contain recommendations for improving the state of degraded and inadequate forests in terms of ensuring resilience to climate change. IFN data and results will be used in the processes of developing policies

	and inter-sectoral cooperation (agriculture; territorial organization, etc.), international reports, etc.
Others, if any	The implementation of the IFN ensures a high level of transparency regarding the state and evolution of national/local forest resources, possible benefits/profits and sectoral needs, contributing to the realization of investments in forest management by LPA and private companies, access to international funds, etc.

General information	
Section	The forestry sector
Climate impact	2. Changing the rate of forest regeneration, degradation and reduction of forested areas
Category	2.4. Capacity building, awareness and communication
The name of the technology	*2.4.1. Strengthening the institutional capacities of the forestry sector in forest management regarding the need and opportunity to implement climate change adaptation and mitigation measures*
Brief description of the technology option	The measure includes a complex of activities aimed at the understanding by forestry personnel and the factors involved in forest management of the influence of the phenomenon of climate change on the forest field and the awareness that adaptation is the most effective measure of management and sustainable development. In context, the measure provides: training modules, seminars, round tables, professional competitions, technical and thematic publications, etc. The capacity building process will include forestry personnel from all categories of forest land holders (state, LPA, companies and private individuals).
Adaptation needs. How technology contributes to adaptation	The measure corresponds, in particular, to the sectoral priorities regarding the strengthening of the capacities of the institutions and personnel of the forestry sector to implement effective activities to ensure the resilience of forests to climate change, the adequate monitoring of the state of forests, the adoption of new sustainable forest management practices, stopping the process of reducing forest areas and degradation of forest biodiversity, promotion of natural forest types, etc. In this context, the activity will have an important effect on the process of strengthening the capacities of forestry specialists, including in the field of anticipation and management of changes and evolutions in the state of forests generated by climatic aspects. Consequently, the strengthening of staff capacities will directly contribute to the adaptation of forest ecosystems to climate change by improving the quality of forest management.
Implementation assumptions and applicability scale	The implementation of the activities will be carried out with the participation of MM, MEC, MIDR, "Moldsilva" Agency (including territorial entities), AM, IPM, CFM, ASD, LPA, companies and private individuals. Moldsilva (FRMI) has some similar experience (refresher courses; thematic seminars; individual technical training/improvement sessions, etc.). Capacity building activities will be carried out through training modules, thematic seminars, round tables, professional competitions, technical and thematic publications; creation of practical -didactic subdivisions and networks of experimental groups, etc. For the immediate implementation, the mechanisms established by the legislation in the field will be used (Forestry Code; Code regarding science and innovation; technical rules, guidelines, guides and recommendations regarding the forestry theme, etc.). The activity will include the development of didactic materials on the forestry theme, focused on detailing aspects related to climate change (adaptation/mitigation). At the same time, the national regulatory framework will be developed regarding the organization of the forestry personnel training process and the key topics to be addressed. The capacity-building process will include forestry personnel at different levels of skills and specializations (managers; technologists; sub-engineers; foresters, etc.) from all categories of forest land holders (state, LPA, companies and private individuals). Estimated, within the respective process, about 2500 people with a forestry profile will be trained (Moldsilva – 1800; LPA – 500; other institutions and organizations – 200).

Technology features	
Capital costs	The estimated value of the investments will be around EUR 0.3 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.03 million annually (maintenance of infrastructure and equipment; revisions and improvements of didactic materials; modernization, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. Similar national experience will contribute to the successful implementation of the newly promoted activities.
Availability and Maturity	The proposed measures and activities are partially available on the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	In the process of implementing the activities, MM, MEC, "Moldsilva" Agency, MIDR, LPA, companies and private individuals etc. will be trained. The main implementation obligations fall to the "Moldsilva" Agency (FRMI), which has a certain capacity, experience and tools to apply the technology . At the same time, certain capacity building actions will be implemented in certain areas (technical equipment; training staff, etc.) to ensure the success of the activities. Certain consultations and technical support will be carried out with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Bulgaria, etc.).
Scale of applicability	The measure covers all forestry personnel at different levels of skills and specializations (managers; technological engineers; sub-engineers; foresters, etc.) from all categories of forest land owners (state, LPA, companies and private individuals). Approximately 2,500 people will be trained in the respective process ("Moldsilva" Agency, MIDR; AM; IPM; LPA; companies and private individuals, etc.).
Time horizon - Short / medium / long term	The measure is intended for the medium and long term. The best expressed effect is in the medium and long term (over 5 years, with a well-expressed inertia).
Status of technology in the country	The measure is a priority for the forestry sector. Moldsilva (FRMI) has some similar experience (refresher courses; thematic seminars; individual technical training/improvement sessions, etc.). At the same time, the national regulatory framework will be developed regarding the organization of the forestry personnel training process and the key topics to be addressed. The measure is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the measure are the new methods and approaches in the application of forest management, correlated with climate changes and the requirements of contemporary society; informational/digital technologies in the process of recording/inventory of forest resources; application of forestry treatments and works; forest regeneration and afforestation of new land; promoting the participatory management of forest resources, etc.
Acceptability for locals	The measure does not pose a danger to local residents. The majority of the inhabitants of rural settlements support the need to increase the skills of forestry personnel, realizing the influence on the condition of forest lands owned by the state, LPA and private, including due to the social and environmental benefits brought. The main condition is the involvement of the local workforce in forest land management activities, as well as the valorization of forest products and services (timber; ancillary products: medicinal plants; forest fruits; beekeeping, etc.; recreation, etc.) in the interest of the communities that they own or adjoin them. At the same time, certain conflicts may arise with parties interested in the non-transparent use of forest products and services, which will be highlighted and potentially stopped by trained personnel. Those situations are overcome through communication companies, increasing the quality of works and results, as well as strengthening security and protection activities.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it	The measure does not affect gender equality. Women are widely included in the implementation process in most stages and activities: organization of staff training activities; participation in events to increase professional skills and abilities, etc. The degree of involvement in technology is estimated to be 70% male and 30% female.

contribute to achieving gender equality? What is the expected magnitude of the impact?	
Other country-specific characteristics related to the technology (such as market potential)	Within the Republic of Moldova, there is sufficient potential for activities to strengthen the capacities of forestry personnel, especially in terms of adapting to climate change. During the last decade, the process was a fluctuating one, and starting from 2018, it was practically stopped. The staff within the LPA, the territorial forestry entities have limited access to information about climate change or benefit only from general data, which do not reflect in detail the influence of climate change on the state of forests. Improvement activities will fill this information deficit with beneficial consequences on the quality of forest management.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand at the level of carrying out the consolidation works on all the personnel necessary for the administration of the forest lands and silvopastoral practices owned by LPA (about 1200 people), but also for the forest crops expected to be planted in the coming years on new lands (about 75-100 thousand ha/about 400 people). Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The measure contributes to the strengthening of the capacities through the exchange of knowledge of MM, MEC, MIDR, "Moldsilva" Agency (including territorial entities), AM, IPM, CFM, ASD, LPA, companies and private individuals regarding new methods and approaches in the application of forest management, correlated with climate change and the requirements of contemporary society (information/digital technologies in the process of recording/inventory of forest resources; application of forestry treatments and works; regeneration of forests and afforestation of new lands; involvement of society in the management of forest resources; communication of sectoral problems and solutions etc.). The activity includes exchange of experience between national institutions (Moldsilva; IPM; AM; CFM; ASD; FRMI; NGB; IEG; LPA, etc.), but also with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Bulgaria, etc.), as well as with the European forestry centers (EFI; IUFRO; ENFIN, etc.). Also, the measure will facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private sector (creation and development of training infrastructure; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	The measure includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of GIS/GPS technologies; digital monitoring and record systems in forestry; dendrometric equipment and systems; data/information processing and interpretation software; the application of forestry treatments and works, forest regeneration works and land afforestation in new climatic/microclimatic conditions, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the measure requires, at the preparatory/initial stage, an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (development of the national regulatory framework regarding the training and continuous improvement of forestry personnel; revision of normative acts and technical norms regarding the application of the regime forestry in conditions of climate change; contractual arrangements with the definition of roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs (permanent and temporary) will be created within the " Moldsilva " Agency (including subordinate structures), LPA, within different categories of SMEs in the rural environment. These are related to a wide range of activities: capacity building specialists/trainers; carrying out works for the

	creation/rehabilitation of the staff training infrastructure; transport and logistics services etc.
investment	The investment is a priority of the forestry sector, and attracting financing for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 0.3 million for a 5-year cycle with the possibility of expanding the participants by about 30-35%. The external financing will be approximately EUR 0.2 million.
Public and private spending	The expenses will be borne mainly through the public institutions "Moldsilva" Agency IPM, AM, MIDR. The contribution of LPA and the private sector related to the development of expenses in the respective activity of the forestry sector is insignificant.
Social benefits	
Income	The implementation of the measure will contribute to increasing revenues in the state budget, local budgets and for the population. Thus, certain revenues in the budget, in the form of taxes and fees, will come as a result of investing in the implementation of capacity building activities (0.3 million EUR primary investment; 0.03 million EUR – maintenance and management). At the same time, the implementation of activities that ensure the increase in the efficiency of forest management and the application of the forestry regime can generate an annual financial effect of about 2.5-3.0 million EUR or about 10-15% of the annual budget of the "Moldsilva" Agency.
Learning	The activity includes the realization of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (GIS/GPS; informational/digital technologies in the process of inventory/recording and management of forests; application of forestry treatments and works; regeneration of forests and afforestation new lands; the organization of the participatory management of forest resources, etc.). Also, the activity provides exchange of experience between national institutions (Moldsilva; IPM; AM; CFM; ASD; FRMI; NGB; IEG; LPA, etc.), but also with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Bulgaria, etc.), as well as with European forestry centers (EFI; IUFRO; ENFIN, etc.). The measure will include the development of didactic materials on the forestry theme focused on the interconnection of forest ecosystems and climate change (adaptation/mitigation). At the same time, the national regulatory framework will be developed regarding the organization of the forestry personnel training process and the key topics to be addressed ; tested and perfected the mechanism for carrying out works through the interconnection of central public authorities (MM; MEC; MIDR; Moldsilva; IPM; AM, etc.), LPA, companies and private individuals, etc.).
Health	The implementation of the measure will contribute to improving the condition of the forest ecosystems managed by different categories of owners ("Moldsilva" Agency, LPA, MIDR, individuals and private companies, etc.), reducing emissions and damages from forest management activities, etc., with direct consequences on the health status of the population in the neighboring towns.
Developmental impacts, indirect benefits	
Environmental benefits	Carrying out activities to strengthen the capacities of forestry personnel will essentially contribute to increasing the quality of forest management with direct effects on the condition of forests and other types of forest vegetation. Also, an important result is the reduction of pressure on forests and other types of forest vegetation, with severe consequences regarding their capacities to adapt to climate change. Another indirect effect will be the reduction of emissions from forest management activity, as well as the strengthening of national greenhouse gas sequestration capacities.
Others, if any	The measure will also contribute to the implementation of the participatory management of forest resources and the transparency of the activity of the forest sector. As an indirect effect – stimulating investments in forest management from LPA and private companies, accessing international funds, etc.

General information	
Section	The forestry sector
Climate impact	2. Changing the rate of forest regeneration, degradation and reduction of forested areas
Category	2.4. Capacity building, awareness and communication
The name of the technology	*2.4.2. Population awareness of forests and climate change, contribution to management and consumption of wood products and services at individual and community level*
Brief description of the technology option	The measure includes a complex of activities aimed at understanding the influence of the climate change phenomenon on the forestry sector and making the population aware that adaptation is the most effective measure of survival. In this context, the measure provides for: the development and implementation of an extensive medium and long-term sectoral communication plan aimed at all social strata in the country; development and testing of sectoral training modules, awareness campaigns, seminars, round tables, specialized competitions, publications, TV /radio shows, etc.
Adaptation needs. How technology contributes to adaptation	The measure corresponds, in particular, to the sectoral priorities regarding the intensification of the process of afforestation/reforestation of land, ensuring the resilience of forests to climate change, adopting new sustainable forest management practices, stopping the process of reducing forest areas and the degradation of forest biodiversity . In this context, the implementation of the activities will contribute to reducing the anthropogenic pressure on forests and other types of forest vegetation, with severe consequences regarding the condition, volume and quality of the products/services delivered, as well as their capacities to adapt to climate change.
Implementation assumptions and applicability scale	The implementation of the measure will be carried out with the participation of MM, "Moldsilva" Agency (including territorial entities), AM, IPM, LPA, companies and people specialized in communication and public awareness. Within the technology, the similar experience of the "Moldsilva" Agency will be used (training sessions; participation in broadcasts in the mass media; communication of forestry activities and issues through the web page www.moldsilva.gov.md, etc.), which will be developed /improved/updated. The measure includes the development and implementation of an extensive medium and long-term sectoral communication plan targeting all social strata in the country. Awareness activities will be carried out through training modules, awareness campaigns, seminars, round tables, specialized contests, advertising media, publications, TV /radio shows, etc. It is estimated that around 250 awareness events will be held (seminars, round tables, contests, shows, etc.).
Technology features	
Capital costs	The estimated value of the investments will be around EUR 0.2 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.02 million annually (maintenance of infrastructure and equipment; revisions and improvements of advertising materials; modernization, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. Similar national experience will contribute to the successful implementation of the newly promoted activities.
Availability and Maturity	The proposed measures and activities are partially available on the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	Moldsilva " Agency, IPM, AM, LPA, companies and people specialized in communication and public awareness will be trained. The main implementation/organization obligations fall to the "Moldsilva" Agency, which has a certain capacity, experience and tools to apply similar measures (training sessions; participation in mass media shows; communication of forestry activities and issues through the web page www.moldsilva.gov.md etc.). The respective experience and capacities will be taken over and developed/improved, and certain capacity building actions will be implemented in certain areas (technical equipment; training staff; communication organization; communication directions, etc.) to ensure the success of the activities. Certain consultations and technical support will be carried out with similar

	institutions in neighboring countries (Romania, Ukraine, Hungary, Bulgaria; Poland, etc.).
Scale of applicability	The measure covers key groups across different social strata, skill levels and specializations. Within the respective process, as promoters (distribution of information, thematic messages, advertising materials, etc.), the staff from the institutions and organizations that have direct attributions to the forestry sector will be trained: "Moldsilva" Agency, MIDR; AM; PMI; LPA; companies and private individuals etc.
Time horizon - Short / medium / long term	The measure is intended for the medium and long term. The best-expressed effect is long-term (over 10 years, with a well-expressed inertia).
Status of technology in the country	The measure is a priority for the forestry sector. Moldsilva has some similar experience (training sessions; participation in media shows; communication of forestry activities and issues through the web page www.moldsilva.gov.md, etc.) which will contribute to the successful implementation of the newly promoted activities. The measure is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the measure, the promotion of participatory management of public forest resources is mentioned; the implementation of the medium and long-term sectoral communication plan; development and testing of training/sectoral communication modules, etc.
Acceptability for locals	The measure does not pose a danger to local residents. The majority of the inhabitants of rural settlements support the need to reduce the anthropogenic pressure on forests and other types of forest vegetation, with severe consequences regarding the condition, volume and quality of the products/services delivered, as well as their capacities to adapt to climate change. At the same time, certain conflicts may arise with parties interested in the non-transparent use of forest products and services, which will be highlighted and potentially stopped by forestry personnel or aware persons. The respective situations are overcome by amplifying communication companies, increasing the quality of works and results, as well as consolidating security and protection activities.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	The measure does not affect gender equality. Women are widely included in the implementation process in most stages and activities: organizing awareness activities; participation in events to increase skills and abilities, etc. The degree of involvement in technology is estimated to be 60% male and 40% female.
Other country-specific characteristics related to the technology (such as market potential)	Within the Republic of Moldova, there is sufficient potential for ecoforestry awareness activities, including in the aspect of adaptation to climate change. During the last decades the process was a fluctuating one, in some periods communication plans were implemented, which partially solved the problem of lack of information and co-opting of forest supporters. Public control over the forest sector, access to information about forests are still limited or general. Expanding and deepening awareness activities will fill this information deficit with beneficial consequences on the quality of forest management.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to extend the level of carrying out the communication/awareness activity on an ongoing basis. Replicability and applicability: high.
Potential for knowledge sharing and capacity building	The measure contributes to strengthening the communication capacities of institutions and organizations within the forestry sector (MM, "Moldsilva" Agency, AM, IPM, CFM, ASD, LPA, companies and private individuals, etc.) regarding new methods and approaches in the application/use of systems and communication and awareness technologies; organization of communication campaigns; stimulating the participation of the general public in forest management decision-making, correlated with climate change and the demands of contemporary society; communication of sectoral problems and

	solutions, etc.). The activity includes exchange of experience with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Bulgaria, Poland, etc.). Also, the included activities will facilitate the involvement in the development of companies and people specialized in communication/awareness (creation and promotion of informative and advertising materials; development and implementation of communication plans; organization of ecoforestry trainings, etc.).
Potential for enabling environment for technology diffusion	The measure includes a relatively broad spectrum of transfer and diffusion of innovative technologies in the forestry sector of the Republic of Moldova: the use of communication systems and technologies; organization of communication campaigns; stimulating the participation of the general public in forest management decision-making, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the measure requires, at the preparatory/initial stage, an extensive analysis of the regulatory and political barriers, but also a list of activities intended for resolution (development of the national regulatory framework regarding the communication of activity and sectoral information, etc.; revision of normative acts and technical norms at the departments that related to access to information, etc.), which will partially change approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs (permanent and temporary) will be created within the "Moldsilva" Agency (including subordinate structures), LPA, companies and people specialized in communication/awareness (communication specialists/trainers, etc.), editing of publications and advertising materials, etc.
investment	The investment is a priority of the forestry sector, and attracting financing for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 0.2 million for a 5-year cycle with the possibility of expanding the participants by about 30-35%. The external financing will be approximately EUR 0.1 million.
Public and private spending	The expenses will be borne mainly through public institutions "Moldsilva" Agency IPM, AM, MIDR, etc. The contribution of LPA and the private sector related to the development of expenses in the respective activity of the forestry sector is insignificant.
Social benefits	
Income	The implementation of the technology will partially contribute to the increase of revenues in the state budget, local budgets and for the population. Thus, certain revenues, in the form of fees and taxes, will come as a result of investing in the implementation of ecoforestry awareness activities and strengthening communication capacities (0.2 million EUR primary investment; 0.02 million EUR – maintenance and management). At the same time, a certain financial effect (about EUR 0.5-1.0 million annually) in the forestry budget will be generated by avoiding the damage caused to the forestry sector by various forestry conflicts and contraventions.
Learning	The measure ensures the achievement of a broad spectrum of transfer and diffusion of new technologies in the forestry sector of the Republic of Moldova related to communication and awareness (new methods and approaches in the application/use of communication and awareness systems and technologies; organizing communication campaigns; stimulating the participation of the general public to forest management decision-making, correlated with climate change and contemporary society requirements; communication of sectoral problems and solutions, etc.). The activity includes exchange of experience with similar specialists and institutions from neighboring countries (Romania, Ukraine, Hungary, Bulgaria, Poland, etc.). The measure envisages the development and implementation of an extensive medium and long-term sectoral communication plan targeting all social strata in the country. Also, the included activities will facilitate the involvement in the development of companies and people specialized in communication/awareness (creation and promotion of informative and advertising materials; development and implementation of communication plans; organization of ecoforestry trainings, etc.).

Health	The activity will have the effect of improving the state of the forest ecosystems managed by different categories of owners ("Moldsilva" Agency, LPA, MIDR, individuals and private companies, etc.), reducing emissions and damages from forest management activities, etc., reducing human pressure on forests (recreation, uses, etc.) with direct consequences on the health of the population in the neighboring towns.
Developmental impacts, indirect benefits	
Environmental benefits	The major benefit will be the reduction of anthropogenic pressure on forests and other types of forest vegetation, with severe consequences regarding their capacities to adapt to climate change.
Others, if any	The measure will also contribute to the implementation of the participatory management of forest resources and the transparency of the activity of the forest sector. As an indirect effect – stimulating investments in forest management from LPA and private companies, accessing international funds, etc.

General information	
Section	The forestry sector
Climate impact	3. Deterioration of the phytosanitary condition of forest ecosystems and increase in the incidence of forest fires
Category	3.1. Forest condition monitoring
The name of the technology	*3.1.1. Consolidation of the system of detection, monitoring and liquidation of forest fires*
Brief description of the technology option	The technology provides for the consolidation and modernization of the system for detecting and extinguishing forest fires, including through the wider use of information/digital technologies and the implementation of a fire prevention design project for all forests in the Republic of Moldova, regardless of the nature of the property (creation of the digital forest fire monitoring system with connecting to international and spatial resources in the field; classification of forests and other types of forest vegetation in fire hazard categories; identification of forest sectors with strict implementation of fire prevention measures . As part of the activity, the revision of the normative base related to the prevention and liquidation of forest fires, post-fire adaptation and restoration of forests will be carried out. It is also foreseen to develop a set of fire detection and intervention protocols , including in the aspect of coordinating and unifying the efforts/resources of forestry personnel and that of the General Inspectorate for Emergency Situations (IGSU).
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding stopping the reduction of forested areas, the degradation of forest biodiversity, increasing efficiency security activities and protection of the forest fund , as well as ensuring the resilience of forests to climate change. In this context, technology contributes to the reduction of forest areas affected by fires by creating a viable system of digital anti-fire monitoring of forests with the connection to international and spatial resources in the field, the classification of forests and other types of forest vegetation in categories of fire danger, the elaboration forest fire prevention measures , etc.
Implementation assumptions and applicability scale	The implementation of the technology will be carried out with the participation of MM, "Moldsilva" Agency (including territorial entities), IGSU, companies and private individuals. The technology includes carrying out a project for fire prevention management of all forests in the Republic of Moldova, regardless of the nature of the property (classification of forests and other types of forest vegetation in categories of fire danger; development of measures for fire protection management of forests; identification of forest sectors with strict implementation needs anti-fire measures, etc.). Also, the creation of the digital forest fire monitoring system with connection to national, international and spatial resources in the field (IGSU; GFMC, etc.) is foreseen. For immediate implementation, the mechanisms established by the legislation in the field will be used (Forestry Code; guides and recommendations regarding forest fire

	protection, etc.). The coverage area will be all forests and forest vegetation in the Republic of Moldova, regardless of the nature of the property (about 425 thousand ha), located throughout the country.
Technology features	
Capital costs	The estimated value of the investments will be around EUR 2.2 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.25 million annually (security; technical service; modernization, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in the field of fire safety for forest lands does not detect important cases of environmental damage as a result of the creation and maintenance of forest fire protection systems , the appropriate application of technical operations, as well as the information/consultation of institutions/stakeholders, etc.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	Moldsilva " Agency, LPA, companies and private individuals will be trained in the implementation process. The main implementation obligations fall to the "Moldsilva" Agency, which has a certain capacity, experience and tools to apply similar technologies/technical elements through its territorial subdivisions. The General Inspectorate for Emergency Situations (IGSU) will be involved in certain areas (revision of the normative basis related to the prevention and liquidation of forest fires; development of a set of fire detection and intervention protocols, etc.). At the same time, certain actions will be implemented to strengthen Moldsilva's capacities to ensure the success of the activities. In the same context, the activity includes exchange of experience with similar institutions from neighboring countries (Romania, Ukraine, Greece, North Macedonia, etc.).
Scale of applicability	The technology covers all forests and forest vegetation in the Republic of Moldova regardless of the nature of the property (about 425 thousand ha). The estimated number of direct beneficiaries are about 5550 owners of land with forests and other categories of forest vegetation.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best expressed effect is in the medium and long term (over 5 years, with a well-expressed inertia).
Status of technology in the country	Technology is a priority for the forestry sector. Moldsilva has some experience in the application of similar technologies that will contribute to the successful implementation of the new promoted activities. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided for in the technology, the fire protection of forests and other types of forest vegetation is mentioned; the use of GIS/GPS technologies, digital forest fire monitoring and detection systems, automated/ semi-automated fire intervention equipment and systems, etc.
Acceptability for locals	Technology poses no danger to the locals. The majority of the inhabitants of rural settlements support the need to improve the field of monitoring, detection and liquidation of forest fires, including due to the social and environmental benefits brought, as well as the anticipation of damages caused by fires to the economy and rural infrastructure (destruction of agricultural crops, perennial plantations, agricultural infrastructure, road etc.). Among the basic conditions are the application of optimal monitoring solutions, which do not generate new degradation processes, the timely information and consultation of stakeholders, the involvement of the local workforce as possible, etc.
The impact on gender. Does this technology have the potential to address gender	Technology does not affect gender equality. Women are widely included in the implementation process in most stages and activities: carrying out the fire protection project of all the forests in the Republic of Moldova; creation of the fire-fighting

inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	infrastructure; creation of the digital forest fire monitoring system, etc. The degree of involvement in technology is estimated to be 75% male and 25% female.
Other country-specific characteristics related to the technology (such as market potential)	Within the country there is sufficient potential for fire protection activities. Thus, according to estimates, in the case of relaunching afforestation activities on new lands, the national needs would increase by about 75-100 thousand ha of land needed to be monitored and protected. Also, the respective system can be partially or fully extended for fire protection of meadows (about 350 thousand ha).
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand at the level of achieving fire protection for forest crops planted on new lands (about 75-100 thousand ha), but also for meadows (about 350 thousand ha) . Replicability and applicability: high.
Potential for knowledge sharing and capacity building	Technology contributes to strengthening the capacities of the "Moldsilva" Agency, its territorial structures, IGSU, LPA, etc. of wider application/use of informational/digital technologies in the process of forest fire protection, carrying out the fire protection of all forests (creation of the digital forest fire monitoring system with connection to international and spatial resources in the field) . The activity includes exchange of experience between the national institutions involved in the process (Moldsilva; IGSU, etc.), but also with similar institutions from neighboring countries with rich experience in the field (Romania, Ukraine, Greece, North Macedonia, etc.). The technology will also facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private sector (creation of forest fire-fighting infrastructure ; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: fire protection of forests and other types of forest vegetation; the use of GIS/GPS technologies, digital systems for monitoring and detecting forest fires; automated/ semi-automated fire intervention equipment and systems, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires at the initial stage an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (developing and/or strengthening the institutional framework for fire management activities in the forest field; updating some technical rules and regulations regarding the prevention and liquidation of forest fires, post-fire adaptation and restoration of affected forests; contractual arrangements with the definition of roles and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created within the forestry service and IGSU, as well as in the rural environment, including within different categories of SMEs. These are related to a wide spectrum of activities: the creation of forest fire prevention infrastructure; transport and logistics services etc.
investment	The investment is a priority of the forestry sector, and attracting financing for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 2.2 million with the possibility of expansion by about 30-35%. External financing is estimated at around EUR 1.6 million.
Public and private spending	The expenses will be borne predominantly through the public institutions "Moldsilva" Agency and IGSU. The contribution of LPA and the private sector related to the development of expenses in the respective activity of the forestry sector is an insignificant one, which will gradually increase starting with the taking over of the operational management functions and the expansion of the activity over the entire potential area.

Social benefits	
Income	The implementation of the technology will contribute to increasing revenues in the state budget, local budgets and for the population, especially in rural areas. Thus, certain revenues to the budget in the form of fees and taxes will come as a result of the implementation of activities for the creation and management of the forest fire protection system (2.2 million EUR primary investment; 0.2 million EUR – maintenance and management). At the same time, the forest fire protection system created within the technology will anticipate public and private expenses for the rehabilitation of forests affected by fires in the amount of around 0.4-0.5 million EUR annually.
Learning	The technology includes the realization of a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (GIS/GPS; digital systems for monitoring and detecting forest fires; automated/ semi-automated fire intervention equipment and systems ; detection and intervention protocols anti-fire etc.). Also, the normative basis related to the prevention and liquidation of forest fires, post-fire adaptation and restoration of affected forests will be revised, the mechanism for carrying out works through the interconnection of central public authorities (MM; Moldsilva, IGSU, etc.), companies will be tested and perfected and private individuals.
Health	Decreasing the incidence and areas affected by forest fires will contribute to the reduction of noxious emissions in the atmosphere with direct consequences on the health of the population. At the same time, it will increase the thermal and living comfort of the population.
Developmental impacts, indirect benefits	
Environmental benefits	The reduction of forest areas affected by fires will contribute to the preservation of biodiversity in forest ecosystems. The proper functioning of the system for detecting and extinguishing forest fires will contribute to strengthening the domestic capacities for GHG sequestration and/or reduction of GHG emissions.
Others, if any	Another important result will be the development of a set of fire detection and intervention protocols, including the aspect of coordinating and unifying the efforts/resources of the forestry staff and that of the General Inspectorate for Emergency Situations in increasing the capacities to extinguish forest fires.

General information	
Section	The forestry sector
Climate impact	3. Deterioration of the phytosanitary condition of forest ecosystems and increase in the incidence of forest fires
Category	3.1. Forest condition monitoring
The name of the technology	*3.1.2. Consolidation of the system of detection, monitoring and liquidation of outbreaks of forest diseases and pests*
Brief description of the technology option	Silvopathological monitoring network , including the creation of the digital forest health subsystem with connection to international and spatial resources in the field. By implementing the technology, timely detection and identification of combat measures will be ensured for new species of forest pests that migrate to the Republic of Moldova, including due to climate change. Also, the activity includes the adoption of new technologies and equipment for land and air combat , the revision of the Sanitary Rules for the forests of the Republic of Moldova (including taking into account changes in the key pest profile and associated dangers), the amendment of import or domestic phytosanitary regulations for forestry, as well as the development of a set of detection and intervention protocols in the field of forest protection and other categories of forest vegetation.
Adaptation needs. How technology contributes to adaptation	The technology corresponds, in particular, to the sectoral priorities regarding stopping the reduction of forested areas, the degradation of forest biodiversity, increasing efficiency forest fund protection activities , as well as ensuring the resilience of forests

	to climate change. In this context, the technology contributes to reducing the area of stands weakened and degraded as a result of disease and pest attacks, the timely detection and identification of countermeasures for new species of forest pests that migrate to the Republic of Moldova, including due to climate change. The activity includes the adoption in forestry practice of new technologies and equipment for land and air combat, the amendment of import or domestic phytosanitary regulations for the forest field, as well as the development/testing/implementation of a set of detection and intervention protocols in the field of forest protection and other categories of forest vegetation.
Implementation assumptions and applicability scale	The implementation will be carried out with the participation of MM, MAIA, "Moldsilva" Agency (including territorial entities), IGFPP, IZ, companies and private individuals. For the immediate implementation, the mechanisms established by the legislation in the field will be used (Forestry Code; guidelines and recommendations regarding the protection of forests from diseases and pests, etc.). The coverage area will be all forests and forest vegetation in the Republic of Moldova, regardless of the nature of the property (about 425 thousand ha), located throughout the country.
Technology features	
Capital costs	The estimated value of the investments will be around EUR 1.2 million.
Operation and Management (O&M) costs	The value of operating and management costs will constitute approximately 0.15 million annually (security; technical service; modernization, etc.).
Safety, Reliability	The proposed measures and activities are safe and reliable. The national experience in the field of combating diseases and pests does not detect important cases of environmental damage as a result of the appropriate application of technical operations, consultation/information of institutions/stakeholders, etc. in the process of forest protection.
Availability and Maturity	The proposed measures and activities are available in the local market and are being matured for use in the project.
Country specific applicability	
Institutional capacity	”Moldsilva" Agency, IGFPP, IZ, companies and private individuals will be trained in the implementation process . The main implementation obligations fall to the "Moldsilva" Agency, which has a certain capacity, experience and tools to apply the technology through its territorial subdivisions. Also, for the components related to the use of phytosanitary materials, MAIA institutions and companies specialized in the delivery of products and services in the respective field will be involved. At the same time, in certain areas (technical equipment; personal training in the field of designing technical solutions to prevent and combat forest diseases and pests; application of combat equipment and new generation phytosanitary materials, etc.) certain actions will be implemented to consolidate Moldsilva's capabilities to ensure the success of the activities.
Scale of applicability	The technology covers all forests and forest vegetation in the Republic of Moldova regardless of the nature of the property (about 425 thousand ha). The estimated number of direct beneficiaries are about 5550 owners of land with forests and other categories of forest vegetation.
Time horizon - Short / medium / long term	The technology is foreseen in the medium and long term. The best expressed effect is in the medium and long term (over 5 years, with a well-expressed inertia).
Status of technology in the country	Due to the importance and benefits generated, the technology is a priority for the forestry sector. Moldsilva has some experience in the application of similar technologies/technical elements that will contribute to the successful implementation of the new promoted activities. The technology is in a continuous process of improvement, increasing its efficiency and profitability. Among the main innovative aspects provided in the framework of the technology , the use of digital technologies (including GIS/GPS) for recording land and protection works is mentioned; creation of the digital forest health subsystem with connection to international and spatial resources in the field; new technologies and equipment for land and air combat; amending import or domestic

	phytosanitary regulations for the forestry sector; the development and primary testing of the set of detection and intervention protocols in the field of forest protection and other categories of forest vegetation, etc.
Acceptability for locals	Technology poses no danger to the locals. Most of the inhabitants of rural settlements support the need to improve the protection of forests from diseases and pests, including due to the social and environmental benefits brought. The main condition is the application of optimal control solutions, the timely information and consultation of stakeholders (beekeepers, animal breeders, etc.), the use of approved preparations, the involvement of the local workforce, if possible, etc.
The impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Technology does not affect gender equality. Women are widely included in the implementation process in most stages and activities: carrying out prevention and anticipation activities, ground combat, etc., with respect to work safety measures. The degree of involvement in technology is estimated to be 65% male and 35% female.
Other country-specific characteristics related to the technology (such as market potential)	Within the country, there is sufficient potential for activities to protect forests and other types of forest vegetation (425 thousand ha). The respective service can be integrated with similar services from neighboring countries (Romania, Ukraine) with the organization of joint missions.
The potential for a paradigm shift	
Extensibility, replicability and applicability	Extensibility: It is possible to expand to the level of achieving protection against diseases and pests of forest crops planted on new lands (about 75-100 thousand ha). Replicability and Applicability: Medium.
Potential for knowledge sharing and capacity building	The technology contributes to the strengthening of the capacities of the "Moldsilva" Agency, its territorial structures, IGFPP, IZ of wider application/use of informational/digital technologies in the process of protecting forests from diseases and pests (creating the digital subsystem of forest health with connection to international resources and space in the field), the adoption of new technologies and equipment for land and air combat , the amendment of import or domestic phytosanitary regulations for the forestry field, the development and primary testing of the set of detection and intervention protocols in the field of forest protection and other categories of forest vegetation etc. The activity includes exchange of experience between the national institutions involved in the process (MM, MAIA, Moldsilva, IGFPP, IZ, etc.), but also with similar institutions from neighboring countries (Romania, Ukraine; Bulgaria, Russia, Republic of Belarus, etc.). Also, the technology will facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within the LPA and private (creating infrastructure; delivery of phytosanitary products; transport and logistics services, etc.).
Potential for enabling environment for technology diffusion	It includes a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova: the use of GIS/GPS technologies; digital systems for monitoring and detecting outbreaks of diseases and pests; new phytosanitary preparations with increased effectiveness and environmental safety; automated/ semi-automated silvopathological intervention equipment and systems; detection and intervention protocols in the field of protection of forests and other categories of forest vegetation, etc.
Potential contribution to setting the regulatory and policy framework	The implementation of the technology requires at the preparatory/initial stage an extensive analysis of the regulatory and political barriers, but also a list of activities aimed at the solution (developing and/or strengthening the institutional framework for forest management activities; revising the Sanitary Rules in the forests of the Republic of Moldova (including taking into account consideration of changes in the key pest profile and the associated dangers); the amendment of the phytosanitary regulations for

	the forest field; the development of a set of protocols for the protection of forests and other categories of forest vegetation; and responsibilities for the parties involved, etc.), which will partially change the approaches and the situation in the forestry sector.
Economic benefits	
Employment	Through the planned activities, new jobs will be created in the field of forest protection, as well as in the rural environment, including within different categories of SMEs. These are related to a wide spectrum of activities: land and air control of diseases and pests; creation of silvopathological protection infrastructure ; transport and logistics services; delivery of technical equipment, preparations for phytosanitary use, etc.
investment	The investment is a priority of the forestry sector, and attracting financing for these actions will be achieved through national public funds and grants from foreign donors. The total value of the investments is estimated at EUR 1.2 million with the possibility of expansion by about 30-35%. The external financing will be approximately EUR 0.4 million.
Public and private spending	The expenses will be borne predominantly through the public institution "MoldSilva" Agency. The contribution of LPA and the private sector related to the development of expenses in the respective activity of the forestry sector is an insignificant one, which will gradually increase, starting with taking over the operational management functions and expanding the activity over the entire potential area.
Social benefits	
Income	The implementation of the technology will contribute to increasing revenues in the state budget, local budgets and for the population, especially in rural areas. Thus, certain revenues to the budget will come in the form of fees and taxes as a result of the implementation of the creation and management activities of the silvopathological forest protection system (1.2 million EUR primary investment; 0.1 million EUR – maintenance and management). At the same time, the silvopathological forest protection system created within the technology will anticipate public and private expenses for the rehabilitation of forests affected by diseases and pests in the amount of approximately EUR 0.3-0.5 million annually.
Learning	The technology includes the realization of a wide spectrum of transfer and diffusion of new and innovative technologies in the forestry sector of the Republic of Moldova (GIS/GPS; digital systems for monitoring and detecting outbreaks of diseases and pests; automated/ semi-automated silvopathological intervention equipment and systems; protocols of silvopathological detection and intervention; new phytosanitary preparations with increased environmental security, etc.). Also, the sanitary rules of the forests of the Republic of Moldova will be revised (including taking into account the changes in the key profile of the pests and the associated dangers), the amendment of the import or domestic phytosanitary regulations for the forestry sector , the mechanism for carrying out the works through the interconnection of the authorities will be tested and perfected central public authorities (MM; MAIA; Moldsilva; IGFPP, etc.), companies and private individuals, etc.).
Health	Decreasing the incidence and areas affected by diseases and pests will contribute to improving the state of forest ecosystems with direct consequences on the health of the population. The operation of the silvopathological protection system (including the signaling of activities to fight with chemical preparations) will avoid affecting the health of the population in the localities bordering the forests.
Developmental impacts, indirect benefits	
Environmental benefits	The main impact will focus on the reduction of forest areas affected by diseases and pests, which will contribute to the improvement of health and the preservation of biodiversity in forest ecosystems. It will also contribute to the reduction of the area of weak stands and vulnerable to various unfavorable factors, including climate. The proper functioning of the system for detecting and liquidating outbreaks of forest diseases and pests will contribute to reducing biomass losses and strengthening local GHG sequestration capacities.

Others, if any	Another important result will be boosting the process of approval and delivery of new phytosanitary preparations with a forestry profile, as well as the development of private services to combat forest diseases and pests.

Annex 3: List of SWG members on forestry sector for prioritization of climate change adaptation technologies/measures

As a participatory process at country level, Technology Need Assessment (TNA) requires broad representation from different stakeholders to adapt the approach to the specific context of the country and its economic sectors. The NAP2 project creates an inclusive space for actors with local capacities and knowledge that could significantly contribute to the TNA process in the forest sector in Moldova.

According to the established procedures, in order to facilitate the TNA process in the field of adaptation to climate change in the forestry sector, a specialized working group of representatives of the stakeholders is envisaged. In the initial phase of the project by UNDP Moldova, the relevant requests were sent to the stakeholder institutions/agencies for the delegation of representatives to the forest sector working group. Most of the institutions responded to the invitation by delegating 16

persons, who have certain experience and attributions in administrative, practical, research and communication fields. The Sector Working Group (SWG) represents the core sectoral actors who will be part of the development and implementation of the sector TNA process and will generate the sector ownership and responsibility approach. The LGA actors are to be actively involved in the consultation process at all stages of the TNA. Through a consultative and participatory process, the members of the LFA will link the elements or steps of the ENT process with locally implemented projects, sustainable development programs and plans, actions implemented at forest sector level. In this way it will be possible to generate synergies and avoid duplication of efforts and resources.

Table 2.1 shows the concrete composition of the forest sector working group by categories of institutions/authorities.

Table 2.1: Composition of the Forest Sector Working Group

Nr. Crt.	Institution	Contact dates	Delegated persons
1.	Ministry of Agriculture, Regional Development and Environment	address: MD-2005, mun. Chisinau, Constantin Tanase str. 9; tel: 022-20-45-79; email: cancelaria@madrm.gov.md;	Dumitru Gorelco, Head of Biodiversity Policy Directorate of MADRM as secondary focal point, contact phone 022 204 511, e-mail: dumitru.gorelco@madrm.gov.md;
2.	Ministry of Agriculture, Regional Development and Environment	address: MD-2005, mun. Chisinau, Constantin Tanase str. 9; tel: 022-20-45-79; email: cancelaria@madrm.gov.md;	Ala Rotaru, senior consultant in the Biodiversity Policy Directorate of MADRM, as primary focal point, contact phone: 022 204 537, e-mail: ala.rotaru@madrm.gov.md;
3.	Agency "Moldsilva"	address: MD 2001, Chisinau, b-d Stefan cel Mare 124; tel: 022- 27-23-06, 27-73-49; email: msilva@gov.md	Petru Rotaru, Head of the Forest Fund, Protected Areas and Forest Regeneration Directorate, e-mail: petru.rotaru58@gmail.com
4.	Agency "Moldsilva"	address: MD 2001, Chisinau, b-d Stefan cel Mare 124; tel: 022- 27-23-06, 27-73-49; email: msilva@gov.md	Victoria Covali, Deputy Head of the Forest Fund, Protected Areas and Forest Regeneration Directorate, e-mail: covali.victoria@moldsilva.gov.md; victoriakovali@gmail.com
5.	Strășeni Silvicultural Forestry Enterprise	address: MD 3700, or. Strășeni, Str. Stefan cel Mare 1; email: straseni@moldsilva.gov.md;	Sergiu Chihai, chief forestry engineer, contact: tel: 069500306, e-mail: straseni@moldsilva.gov.md; chihai.maria@yahoo.com; straseni@moldsilva.gov.md
6.	"Codrii" Nature/Scientific Reserve	address: MD 3721, r. Straseni, com. Lozova; email: codrii@moldsilva/gov.md;	Dr. Jardan Natalia, Deputy Director, e-mail: jardan.natalia@gmail.com
7.	Telenesti Forestry Enterprise	address: MD 5801, or. Telenesti, str. M. Sadoveanu 5; email: telenești@moldsilva.gov.md;	Macari Arcadie Macari, chief forestry engineer, tel: 079940801; email: arcadie.macari@gmail.com
8.	Institute for Forest Research and Management (ICAS)	or. Chisinau, 69 Calea Ieșilor St., tel: 022-59-33-51; email: icas@moldsilva.gov.md;	Dr. Valeriu Caisin, Deputy Scientific Director; contact: tel: 060102396; email: valeriu.caisin68@gmail.com
9.	Environment Agency	address: str. Albișoara 38, Chisinau 2005; tel: 022-820-770; email: am@mediu.gov.md;	Raisa Leon, Head of Environmental Policy Implementation, e-mail: r_leon@mediu.gov.md; tel: 022 820 788;
10.	Environmental Protection Inspectorate	address: MD-2005, mun. Chisinau, 9 Constantin Tanase St.; tel: 022-22-69-41; email: mediu@ipm.gov.md;	Cristina Gheorghiță, senior inspector of the Directorate of Management, Water

Nr. Crt.	Institution	Contact dates	Delegated persons
			Resources and Atmospheric Air, e-mail: apa@ipm.gov.md; tel: 022 22 69 22 22
11.	Environmental Protection Inspectorate	address: MD-2005, mun. Chisinau, 9 Constantin Tanase St.; tel: 022-22-69-41; email: mediu@ipm.gov.md;	Valentina Moisei, senior inspector of the Forest Fund, Protected Natural Areas and Green Spaces Control Department, tel: 022 24 23 26, moisei@ipm.gov.md;
12.	National Botanical Garden (Institute) "Al. Ciubotaru"	address: str. Pădurii 18, MD-2002, mun. Chisinau; tel: 022-55-04-43; 52-38-98; email: gradinabotanicachisinau@gmail.com;	dr. șt. biol. Miron Aliona, deputy director for scientific activity; contact: tel.: 079643166; alionamiron@yahoo.com;
13.	Stefan Voda District Council	address: or. Stefan Voda, Libertății str. 1, MD 4201; tel: 0242-2-20-58, 2-20-57; email: aparatcrsv1@rambler.ru;	Olesea Bădilă, Head of the European Integration and Investment Service of the Stefan Voda District Council, contact: tel: 0242 22081, 060309667, email: economie.sv@gmail.com, tel: 0242 22081, 060309667, email: economie.sv@gmail.com
14.	Ciuciuleni City Hall, Hâncești rayon	address: s. Ciuciuleni, r. Hincesti, MD 6422; tel: 0269-33236, 332238; email: ciuciuleni@hincesti.md;	Gheorghe Grigoraș, mayor; contact: tel: 0269-33236, 332238; email: ciuciuleni@hincesti.md;
15.	AO Silva Millennium III	or. Durlești 22, str. Codrilor, of. 3, tel: 069036806; email: silvamileniu3@gmail.com;	Andrei Cerescu, President; contact details: tel: 069036806; e-mail: cerescu.andrei@yahoo.com; silvamileniu3@gmail.com;
16.	SE Biotica	address: mun. Chisinau, str. N. Dimo 17/4, of.22; tel: 022498837, 022495625; email: biotica.md@gmail.com;	Petru Vinari, communication specialist, tel. mob. 068693818, e-mail: vinari@list.ru

The involvement of stakeholders in the NCD process is crucial for these reasons:

- SWG members are encouraged to contribute to the development of strong partnerships and form the basis for future collaboration to implement prioritized technologies;
- LGAs have the opportunity to get involved in the process by asking questions and voicing concerns, thus helping to shape the outcomes of the NCD process;
- It is expected that SWG members, through their technical expertise, scientific rigor and use of the best available data, will provide legitimacy to the TNA process;
- As data availability is sometimes a problem, some steps of the TNA will need the opinion and vision of experts, therefore, the opinion of sectoral experts, institutional specialists in the given process is highly beneficial for the purpose of the process;
- The TNA process aims to identify technology options to support climate resilient and low-emission development pathways.

BARRIER ANALYSIS and ENABLING ENVIRONMENT REPORT/BAEF (2)

REPORT II. BA&EF FORESTRY SECTOR

Executive Summary

Based on the climate change adaptation technologies identified, evaluated and selected for the forestry sector in the Republic of Moldova at the previous stage of the project, the sectoral working group (SWG) performed the analysis of the barriers to the transfer and diffusion of the respective technologies. At the same time, the said process was continued with the offering of solutions to overcome the barriers to the transfer and diffusion of selected technologies for adaptation to climate change in the national forestry sector.

In the previous phase, which focused on the prioritization of adaptation technologies as a component part of the TNA process, the sectoral working group selected 3 top technologies with the greatest impact on the adaptation potential of the national forestry sector and the transfer and diffusion capacity of technology: (i) Ecological reconstruction of inappropriate and vulnerable arboretums for the purpose of adapting to climate change; (ii) The use of modern biotechnologies for propagating vegetative material in providing the forestry sector with reproductive material in the new climatic conditions; (iii) Considerations regarding the impact of climate change, forest species and appropriate forest ecosystem management strategies.

Project activities were implemented in consultation with institutionalized stakeholders through SWG, as representatives of MoEnv, Moldsilva, NBG, FRMI, territorial forestry entities, NGOs, etc. (Annex no. 3). During the implementation of the current phase, SWG received guidance and consultation from representatives of the TNA working group: The National Forest Sector Consultant, the National Adaptation Team Leader in the TNA project and the National Capacity Development Consultant in the TNA component. For the process of identifying barriers to the transfer and diffusion of technologies, as well as offering solutions to overcome them, the national consultant on the forestry sector and SWG applied the methodological guide "Overcoming barriers to the transfer and diffusion of climate technologies" (Nygaard I., Hansen U. E., 2015), other relevant guidance and documents. The barrier analysis process was carried out in stages, starting with the establishment of preliminary sectoral targets. Sectoral development policies, development plans and programs, the characteristics of each technology were taken into account in establishing technology transfer targets in the field of restoring the Eco protective and bio productive potential of existing forests, especially degraded and inadequate ones, ensuring regeneration activities, reconstruction and expansion of forests with reproductive forest material in the appropriate quantity, assortment and quality, as well as supporting the adaptation process of the forestry sector to climate change through relevant technical-scientific arguments.

For each of the technologies, an analysis of the barriers was carried out and the development of a support framework based on the recommendations of the second edition of the methodological guide "Overcoming barriers to the transfer and diffusion of climate technologies" (Nygaard I., Hansen U. E., 2015). That process primarily included the following steps:

- Characterization of the technology, identification of its type (non-market and public goods, etc.).
- Collection of available information on prioritized technologies.
- Identification of potential barriers, root causes, prioritization of barriers.

- Identification of measures to overcome barriers, prioritization of measures.
- Further analysis of measures to group measures for different technologies.

The analysis of barriers included the study of policy documents, normative and regulatory acts, technical-scientific studies, other information relevant to the topic, and based on the previous results of the technology selection process, the main causes were identified for which they are not implemented in present or have restricted deployment areas. The barriers listed in the long list of barriers were screened for their significance to technology transfer and prioritized based on the degree of influence on technologies and processes. During the work process, a close collaboration was carried out with the representatives of the interested parties in order to reach a common agreement on the meaning of a certain barrier. After reaching a relatively comprehensive consensus, a list of key barriers was produced, and non-essential items were removed from the list.
Within that process, in the initial phase, a total of 52 barriers/needs were identified for the technologies prioritized in the forestry sector. An essential part of the identified barriers is a consequence of the natural conditions (soils, resorts, hydrology, etc.), in which an important part of the forests of the Republic of Moldova were created by artificial methods during the last 70 years. Others refer to the capacities limited institutional and personnel in the forestry field, the deficit of public and private investments, etc. The financial barriers are also due to the perception at the political decision-making level (Government, Parliament) of the forestry sector in terms of the overall contribution to GDP, which is low and varies within the limits of 0.2-0.3%. These barriers or needs seriously affect the activity of the national forestry sector, essentially diminishing the sectoral capacities for intervention in order to ensure a sustainable and controlled process of adaptation of forest ecosystems to climate change. At the same time, it is mentioned that the analysis of the links between the different barriers/needs faced by the technologies prioritized for the forest sector identified 15 common barriers of the top three technologies (Table 1.7). This aspect partially facilitates the overcoming process by identifying measures with increased degree of synergism and efficiency.
Logical problem analysis (ALP/LPA) was applied to understand the underlying issues in technology transfer. Cause/effect relationships were organized into problem trees on each selected top technology, with the main problem set as the starting problem, as well as their causes and effects (Appendix No. 1). Using ALP/LPA it was possible to bring together the key elements of the problems, applying the logical analysis of the interconnected elements and identify the links between the elements of the problem and the external factors. Thus, problem trees were used to understand the causal relationships of the barriers, their connections, etc.
An important aspect to mention is that according to the classification within the guide "Overcoming barriers to the transfer and diffusion of climate technologies" (Nygaard I., Hansen U. E., 2015) all 3 technologies selected for the forest sector are attributed to the category "Non-market goods - publicly provided goods". The respective assignment was made because all 3 sectoral technologies are procured/fulfilled and disseminated by public entities (Agency "Moldsilva"; MECR, etc.) to a large population of users and beneficiaries. Major investments in the respective technologies tend to be decided at the governmental level and depend, to a large extent, on the policies adopted in the field of forestry and/or environmental protection.

The next step was to identify measures to support technology transfer as actions that could be taken to improve that transfer. The process of identifying and describing the measures to overcome the barriers was carried out by the sector consultant in collaboration with SWG in the same context as the analysis of the barriers, applying ALP/LPA. The causal relationships of barriers to technology transfer were also seen as opportunities for stakeholder intervention to fully realize the technology's economic-

social potential. Applying LPA analyzed the circumstances under which these opportunities could be achieved and set objectives for each technology, organizing them in the objective tree. This tool helped visualize a logically organized presentation of objectives for improving technology transfer. In this context, 65 measures/solutions to overcome barriers were identified for the prioritized technologies for adapting the forestry sector to climate change. The proposed measures were discussed according to their economic profile, the incentives used and the effects obtained.

The implementation of each analyzed technology falls under the jurisdiction of several normative acts and technical regulations, the process including exposure to the political environment and operating regulations that influence technology transfer. Among the policies, normative acts and technical regulations analyzed, the documents that have a direct impact on the implementation of the technology were identified. Compressed information about this is presented in the information sheets of each technology.

Chapter 1 Forestry Sector

In the phase of prioritizing adaptation technologies as a component part of the TNA process, the sectoral working group (SWG) selected 3 top technologies with the greatest impact on the adaptation potential of the national forest sector and the transfer and diffusion capacity of technology:

- The ecological reconstruction of inadequate and vulnerable arboretums in order to adapt to climate change.
- The use of modern biotechnologies for propagating vegetative material in providing the forestry sector with reproductive material in the new climatic conditions.
- Climate change impact considerations, forest species and appropriate management strategies for forest ecosystems.

Thus, it is found that SWG in the forestry sector prioritized technologies aimed at restoring the Eco protective and bio productive potential of existing forests, especially degraded and inadequate ones through the application of special measures - ecological reconstructions. It is also recognized as essential the adaptation to the evolution of climate change of the subsector aimed at the production of reproductive forest material through activities to consolidate and modernize the process throughout the productive chain: Identification, legalization and care/maintenance of seed source arboretums (including seed source arboretums seeds, FGR, etc.); harvesting, processing and certification of forest seeds; industrial growth and exploitation of reproductive forest material, etc.

Both the first 2 technologies, as well as the entire process of adapting the forestry sector to climate change, must be supported by an appropriate technical-scientific argument. In this context, in support and consolidation of the results of the first two technologies, it is envisaged to initiate some fundamental research programs combined with application components regarding the adaptation capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature-based solutions (NBS).

During stage II of the TNA process, the respective technologies were subjected to the analysis of the barriers and the activity framework. The analysis of the barriers and their screening, along with the development of the measures, required knowledge of the specifics and the application of the appropriate tools.

1.1 Preliminary objectives for the transfer and diffusion of climate change adaptation technologies in the forestry sector

A number of national and international policy documents and reports find that the rapid pace of climate change due to human activity is outstripping the natural capacity of forest ecosystems to adapt. At the same time, forests represent the main element for ensuring the ecological balance in the Republic of Moldova, and the problem of conservation and sustainable development of existing forests, as well as the expansion of forest lands through the afforestation of new territories, is a problem of national interest.

The national policy framework includes a wide set of documents that relate to forestry, set objectives and measures in terms of addressing climate change, promoting technological innovations, etc. Those

documents include the forestry sector among the vulnerable sectors, but among the sectors that can make an important contribution to reducing the effects of climate change, including for other sectors of the national economy (health, agriculture, water resources, etc.). Thus, the Strategy for the sustainable development of the forestry sector for the years 2001-2020 provides that the main strategic directions of the sustainable development of the forestry sector are:

- Restoring the ecoprotective and bioproductive potential of forests.
- Expansion of areas with forest vegetation.

The following aspects were drawn as objectives, most of them being connected with climate change:

- Increasing the ecoprotective and bioproductive potential of natural forests.
- Preservation of biological diversity of forests.
- Expansion of the areas covered with forest vegetation.
- Increasing the efficiency of guarding and protection activities of the forest fund.
- Increasing the contribution of the forestry sector to solving social-economic problems.
- Preservation of the national rural landscape.

That document very clearly mentions the role of forests as an invaluable source of various benefits through its products and contribution to the development of society, as well as major importance in maintaining the ecological balance. The strategic framework favors the expansion of the areas covered with forest vegetation by afforestation of degraded lands, affected by landslides, afforestation of riparian strips for the protection of river waters and water basins, creation of green islands of trees and shrubs, interconnection corridors between forested massifs, etc. In this context, it is necessary to cover at least 130 thousand ha with forest vegetation and to create new forest bodies, expanding the areas of the existing ones.

The main impact of the implementation of that document is the increase of forested areas up to 15% of the territory, the reduction of greenhouse gas emissions, the reduction of the degree of soil degradation; reducing and stopping landslides, etc. Implementation costs are estimated at 345.9 million lei (US$25.5 million) by GD 739/2003.

The environmental strategy, for the years 2014-2023, specifies that forest resources represent important strategic natural resources. Forests have a special role in maintaining the ecological balance, in combating desertification and land and soil degradation, in preserving biodiversity, protecting the landscape, waters and hydrographic basins, in food and energy security, in mitigating the impact of climate change, and, last but not least, in the prevention and reduction of the risk of natural disasters. Thus, it is required, through Specific Objective 6.4: The expansion of forest areas up to 15% of the country's territory, of the natural areas protected by the state up to 8% of the territory and ensuring the efficient and sustainable management of natural ecosystems. At the same time, it is foreseen to improve the quality of at least 50% of the surface waters by implementing the watershed management system; the restoration of about 150 thousand ha of degraded wetlands, with their inclusion in the economic circuit of the country. The forestry sector must also make certain contributions to this process (river strips; water source protection strips, etc.).

The strategy on biological diversity for 2015-2020 and the action plan for its implementation (GD no. 274/2015), contains in specific objective C. Implementation of measures to stop threats to biodiversity, Specific objective 1. Implementation of measures to stopping soil degradation and

reducing the effects of climate change. In Section 3 Direct threats to biological diversity, 1. Climate change, it is stipulated that: "Climate change is a global phenomenon that endangers natural, social and economic systems through their sensitivity and vulnerability to climate factors." In order to assess the problem of adaptation of biological resources to climate change. The strategy included actions to develop the study on the relationship between ecosystems, biodiversity and the aspect of climate change in the Republic of Moldova and technologies to ensure the adaptability of forest ecosystems to climate change.

The country's climate priorities consist in the implementation of climate change adaptation measures, by incorporating the climate component in medium and long-term strategic planning, encouraging adaptation actions to mitigate climate risks in the investment decision-making process and in business planning, with the aim to increase the resilience of the national economy, land use and ecosystem sectors, as well as to accelerate the country's transition to LOW carbon and resilient development. For the forestry sector, the objectives and actions aimed at adapting to climate change include scientifically justified adaptation measures with clear mitigation co-benefits and approaches to sustainable development, maintenance and adequate monitoring of the state of forests, with the intensification of the afforestation/reforestation process using species of climate resistant trees and shrubs. It is also foreseen to promote new sustainable forest management practices to stop the reduction of forested areas, stop the degradation of forest biodiversity by promoting natural forest types; reducing the fragmentation of forest massifs; combating illegal exploitation of forests and related trade by implementing methods to ensure wood traceability and forest certification.

Based on what was presented in the given chapter, the following are provided as preliminary objectives and targets for the transfer and diffusion of climate change adaptation technologies in the forestry sector:

1) The ecological reconstruction of inappropriate and vulnerable arboretums to climate change, with the main target being the total area of about 120,000 ha, of which for the first stage the reconstruction of 25,000 ha (21% of current needs) of degraded arboretums, totally derived, branched, inappropriate for stationary conditions, low productivity, etc., including the development of new appropriate and implementable technical regulations, the testing and adjustment of new technologies, etc., and for the next stages, about 100,000 such trees remain to be covered with works.
2) Boosting research on the adaptation capacity of forest ecosystems to climate change, with the main aim of developing and implementing at least 4 national research programs that will aim to identify the interactions related to climate change, species and forest ecosystems (climate thresholds corresponding to the limits spatial distribution of forest types and/or forest species; biogeochemical modeling for forecasting changes in the productivity of arboretums and carbon stocks, etc.); the promotion of new strategies and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change, the effective management of disease and pest attacks, as well as the implementation of sustainable forest management principles.
3) Revision of the assortment of forest species (trees and shrubs) intended for the process of regeneration and expansion of forests, with the main purpose of regeneration/planting of species that will constitute functionally stable and sustainable arboretums and/or will benefit from the new environmental conditions and will achieve superior accumulations of biomass throughout the production cycle (about 20-40% more than the accumulation that would be achieved under normal conditions).

4) Adaptation to the evolution of climate change in the sub-sector of the production of reproductive forest material through activities to consolidate and modernize the process throughout the productive chain: Identification, legalization and care of seed source arboretums (including forest genetic resources/FGR); harvesting, processing and certification of forest seeds; industrial growth and exploitation of reproductive forest material, etc. That process will include the creation of at least 3 centers for the industrial growth of forest reproductive material with a total capacity of 65-70 million saplings per year (including with protected roots - about 50-60%) with an assortment of tree and shrub species of about 85 species.
5) Expansion of forested areas, as well as those with protective forest curtains, by planting forest crops resilient to climate change. For the stage up to the year 2030/2035, the target indicators represent about 100,000 ha forested/reforested/rehabilitated. The respective forest plantations will significantly contribute to the reduction of soil erosion processes, landslides, will lead to the reduction of torrent flows, the protection of agricultural crops and other social and economic objectives, the improvement of the general living environment.
6) The full implementation of the forestry regime in the forest fund and other types of forest vegetation outside it (forest curtains; green spaces; silvopastoral and agroforestry practices, etc.) by drawing up forest management plans (forest management) for forest lands owned by other owners than Agency "Moldsilva" (LPA; MIDR; companies and private individuals, etc.). The activities must include the realization of works for about 140,000 ha (forest fund owned by owners other than Agency "Moldsilva" - about 86,000 ha; forest vegetation outside it - about 51,000 ha).
7) Consolidation of the capacities of the forestry sector, aiming at the sustainable management of forests and the increase of transparency on the entire wood flow, the creation of a competitive forest market, the increase of the degree of valorization of wood and non-wood products, the correct use of wood according to its quality.
8) Improving forest management, with the main purpose of revising the normative and regulatory acts aimed at forest management (Forestry Code; rules for releasing wood on foot; technical rules regarding forest management, the choice and application of forestry treatments, etc.), strengthening institutional capacities (technical equipment; new technologies; digitization of operations and works, etc.) and personnel (forestry design; simulation of interaction between forest ecosystems and climate change; use of digital technologies in forestry, etc.).

At the same time, for the technologies prioritized in the forestry sector, the following are provided as preliminary objectives and targets:

- The ecological reconstruction of inappropriate and vulnerable arboretums in order to adapt to climate change - the replacement/restoration of 25,000 ha of degraded arboretums, totally derived, branched, unsuitable for seasonal conditions, poorly productive, etc.; testing and adjusting ecological forest reconstruction technologies/approaches; revision/update of technical regulations dedicated to ecological reconstruction; exchange of experience at national and international level, etc.
- The use of modern biotechnologies for propagating vegetative material in providing the forestry sector with reproductive material in the new climate conditions - strengthening the institutional framework in the field by setting up and putting into operation the National Center for Forestry Genetics and Seminology (NCFGS) and 2 regional industrial growth centers of reproductive forest material (RCIBFRM); the use of biotechnologies for the production of planting material (multiplication, rooting, in vitro growth, etc.), including with protected roots;

management of the forest seed base (seed source trees and FGR) with harvesting, industrial processing and conditioning of tree and shrub seeds; certification of the regeneration material; carrying out forest genetic research and in vitro propagation; revision of the normative base aimed at the management and conservation of forest genetic resources, including in the aspect of adaptation to climate change.

- Considerations regarding the impact of climate change, forest species and appropriate strategies for managing forest ecosystems - initiating and carrying out programs (at least 4) of fundamental research combined with applied components on the adaptation capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature-based solutions (NBS); the development of solutions/approaches and new technical regulations to ensure the resilience of forest ecosystems to the effects of climate change; promoting sustainable forest management practices under climate change conditions; the exchange of experience with similar institutions in neighboring countries and with international forestry centers.

1.2 Analysis of barriers and possible support measures for the technology "Ecological restoration of unsuitable and vulnerable arboretums for adaptation to climate change"

1.2.1 General description of the technology "Ecological restoration of unsuitable and vulnerable arboretums for the purpose of adapting to climate change"

The technology "Ecological reconstruction of inappropriate and vulnerable arboretums in order to adapt to climate change" was selected by SWG as the main activity aimed at strengthening the Eco protective and bio productive potential of existing natural and/or artificial forests. Because, about 1/3 of the arboretums within the forest fund are made up of artificially introduced species, which do not belong to the natural ecosystems of the Republic of Moldova. The area of forests has increased during the last decades with a considerable increase in the proportion of acacias and resinous trees. At the same time, it is found that the majority of natural arboretums are of vegetative origin: From shoots (56.5%). According to estimates, at the moment about 40% or 120 thousand ha of the forests managed by Agency "Moldsilva" have certain elements of degradation that affect their capacities to adapt to climate change and that require reconstruction/consolidation measures.

The technology corresponds, in particular, to the sectoral priorities regarding increasing the Eco protective and bio productive potential of natural forests, preserving the biological diversity of forests, as well as ensuring the resilience of forests to climate change. Rehabilitated forests will constitute arboretums made up of flexible and long-lived tree and shrub species, resilient/resistant to adverse factors (disease and pest attacks; weather and climate change, etc.). Also, the technology foresees the conversion from the grove regime to the forest regime, ensuring regeneration from the seed, creating long-lived arboretums capable of adapting to climate changes.

The implementation will be carried out by Agency "Moldsilva" (including territorial entities) with the participation of MoEnv, companies and private individuals. The technical-scientific aspects will be ensured by the relevant institutions: FRMI, NBG, etc. For the immediate implementation, the

mechanisms established by the legislation in the field will be used (Forestry Code; Technical norms for the ecological reconstruction of forests, etc.). Technology activities include exchange of experience between the national institutions involved in the process, but also with similar institutions from neighboring countries (Romania, Ukraine, etc.). The technology will facilitate involvement in the development of small and medium-sized forest enterprises (SMEs) within the LPA and private sector (harvesting and processing wood/non-wood products; planting and caring for forest crops; logistics services, etc.).

The given technology provides for the application of ecological reconstruction practices on a total area of 25.0 thousand ha for degraded and inappropriate arboretums (totally derived, branched, inappropriate for seasonal conditions, poorly productive, etc.), vulnerable to climate change, aiming to replace the arboretums with a single species with mixed and multiple arboretums, maximum use of the shelter of the existing stand, etc. Thus, the respective quantitative indicator constitutes about 21% of the current ecological reconstruction needs (substitutions; restorations) of the degraded/inappropriate arboretums managed by Agency "Moldsilva".

All silvitechnical interventions within this system will be carried out in full accordance with the place and role of each component element of the ecosystem (trees, shrubs, animal kingdom, etc.), applying the ecosystem approach. Due to the current state of the arboretums intended for the application of the technology, priority will be given to replacements and restorations as methods of intervention.

Ecological reconstructions are very complex operations and are qualified as an indispensable component of the adaptation process of the forestry sector to climate change. The main effects/benefits of the implementation of the respective operations being:

a) Environmental benefits:
   - The conversion from the grove regime to the woodland regime, ensuring regeneration from the seed, creating long-lived arboretums capable of adapting to climate changes.
   - Taking a decisive step in the conservation of biological diversity, forest vegetation providing refuge and habitats for various species of plants and wild animals on the way to extinction due to anthropogenic impact.
   - Reducing soil degradation processes through erosion, landslides, etc.
   - The qualitative improvement of aquatic resources, the forest vegetation contributing to the efficient feeding of the water table, the reduction of the solid flow and the concentration of pollutants.
   - Reducing atmospheric pollution by capturing carbon dioxide and various pollutants that endanger people's health and the vitality of biological ecosystems, ensuring the increase of the carbon capture capacities of the targeted arboretums by 40-50%, making the most of the available seasonal potential.

b) Social-economic benefits:
   - Increasing the potential of products and services of rehabilitated forests (wood, medicinal plants, forest fruits, etc.).
   - Increasing revenues in the state budget, local budgets and for the population, especially from rural areas (estimated around EUR 80/ha/year or an income of around EUR 2.0 million annually: Commercialization of wood mass (around 70%) harvested in the process of sustainable management of rehabilitated forests, services and non-wood products (about

30%: forest fruits; medicinal plants; hunting; beekeeping; recreation; carbon sequestration, etc.).

- The creation of new jobs (about 6250 people) in the rural environment related to a wide spectrum of activities: Afforestation/reforestation works; development of sustainable forest management; forest exploitations; Woodworking; sale of firewood; collecting and selling non-wood forest products (fruits and berries; medicinal plants; beekeeping, etc.), handicrafts, etc.

c) Capacity building, technology transfer and diffusion:

- Strengthening the capacities of the "Moldsilva" Agency and its territorial structures to apply efficient forest management, innovative technical solutions for the ecological reconstruction of degraded and inadequate arboretums, to manage forests in a sustainable way and in accordance with the new climatic conditions.
- Realizing a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector of the Republic of Moldova (digital technologies (including GIS/GPS); innovative technical solutions for substituting inappropriate species and arboretums; carbon monitoring; planting saplings with protected roots, etc.).
- Testing and perfecting the mechanisms for carrying out works through interconnection in the implementation process of central public authorities (MoEnv; Moldsilva, etc.), companies and private individuals.

1.2.2 Identification of barriers for technology transfer "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change"

According to the classification of the guide "Overcoming barriers to the transfer and diffusion of climate technologies" (Nygaard I., Hansen U. E., 2015) the technology "Ecological reconstruction of unsuitable and vulnerable arboretums for the purpose of adaptation to climate change" is assigned to the category "Non - market - publicly provided goods", because that technology is procured/performed and disseminated by a public entity (Agency "Moldsilva") to a large population of users and/or beneficiaries. Major investments in the respective technology tend to be decided at the governmental level and depend, to a large extent, on the policies adopted in the field of forestry and/or environmental protection. It is also mentioned that the main result of the technology consists in ensuring the amplification and sustainability of the ecosystem services (protection of agricultural lands, localities and infrastructure; reduction of GHG emissions; biological diversity, etc.) provided to society by forests intended for reconstruction and in public ownership.

Identifying barriers to the diffusion of non-market technologies involves distinguishing between barriers to technology acquisition decisions, the costs and benefits of the technology. This is because, for non-market technologies, it is generally not the user who decides to invest in the technology in question, and consequently it is difficult to predict that the user will actually see a benefit in using the technology after it has been acquired. /implemented. The conclusion is supported by the experience that the Government of the Republic of Moldova and/or foreign donors invested in many cases in programs and pilot projects that the beneficiaries did not find very useful or that had a series of undesirable consequences for some groups in society (regulation of watercourses; afforestation of pastures, etc.). It also notes that the costs and benefits for most non-market technologies are not

experienced by the same person or entity. On the contrary, the benefits are often experienced by one group in society and the costs by other groups.

These examples show that a simple analysis of the barriers is not enough to make decisions regarding the implementation of these types of projects. Such decisions are extremely political, because they will favor some groups in society, while having negative economic impacts on other groups and not least environmental impacts, which at the current stage are still difficult to evaluate in monetary terms. While in general the social and spatial distribution of costs and benefits should be considered in cost-benefit analysis and environmental impact assessments, a political choice that weighs the costs and benefits of different groups against each other is ultimately inevitable.

The direct process of identifying barriers for the technology "Ecological reconstruction of unsuitable and vulnerable arboretums for adaptation to climate change" was based on the aspects and methodological approaches of the guide "Overcoming barriers to the transfer and diffusion of climate technologies" (Nygaard I., Hansen U.E., 2015). Thus, at the initial stage, a study of policy documents (strategies, programs, etc.) and other relevant documents related to the forestry sector was carried out to identify the main reasons why the technology in question is currently not widely used, and public investment and/or private are limited/insufficient etc. As a result, it was possible to identify the long list of barriers that prevent the large-scale application of ecological reconstruction of unsuitable arboretums. After this, the establishment of the short list of barriers and the decomposition/detailing of the barriers was carried out. This step was followed by the screening of barriers according to their significance for technology transfer. Another tool used in the barrier analysis process was logical problem analysis (ALP/LPA) for analyzing causal relationships and underlying issues in technology transfer. The problems were arranged in a hierarchy of causes and effects, with a central/generic starting problem for technology transfer. The problem tree highlighted the main links between causes and effects and organized them into some logical interrelationships, addressing the underlying issues and highlighting the links to external factors. The problem tree for this technology is included in Appendix no. 1. As a fundamental cause of the problem was identified the presence of excessive areas of inappropriate and vulnerable arboretums to climate change in the forests managed by Agency "Moldsilva" (about 40% or 120 thousand ha) and, consequently, the LOW interest in technology. In that exercise, 17 barriers and/or needs were identified and described. The results of the exercise to identify, detail and rank the barriers are presented in Table 1.1.

Table 1.1: Long list and hierarchy of barriers to technology transfer for Ecological restoration of unsuitable and vulnerable arboretums for Climate Change Adaptation

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	Barriers importance
I. Financial barriers	1.1. Funding gap for activities to maintain, improve/rehabilitate the condition of existing forests	The means allocated annually in the state budget for forest management constitutes only about 2-3% of the budget of the state forestry sector, the rest have their own revenues from commercial activity. For activities to improve/restore the condition of existing forests, the principle of 'residual financing' applies. The LPA and private forestry sectors are outside state support.	Very important

Identified barriers			
	1.2. Lack of viable financial mechanisms to stimulate actions to improve the condition and productivity of forests	The current normative framework does not include concrete provisions on financial facilitation of rational use, regeneration, guard and protection of forests. The Forestry Code (Article 45) exposes certain general provisions on this subject, but both the criteria and the method of economic stimulation are not developed either in the Code or in any other normative document.	Important
	1.3. Costly technical equipment needs for forest regeneration and ecological restoration works	The forestry sector lacks an operational list of equipment and techniques required for forest management technology. In order to ensure the volume, success and quality of ecological regeneration and reconstruction works, a wide range of equipment and techniques (tractors, deforesters, milling cutters, planters, etc.) are required, which far exceed the current financial possibilities (incomes) of forest managers.	Insignificant
	1.4. Increased costs of substitution and restoration works of inadequate and vulnerable arboretums	Due to the high degree of difficulty and major complexity (include a wide spectrum of interdependent operations, etc.), ecological restoration works (restorations/substitutions) are laborious and expensive, exceeding 5-10 times the costs of ordinary regeneration.	Insignificant
II. Technological barriers	2.1. Weak technical capacities and facilities in the field of forest regeneration and reconstruction	The forestry sector is provided with technology and equipment for technological processes in a proportion of about 30-40%. Most works/operations are performed by primary labor or mechanization.	Very important
	2.2. Low implementation of new technologies in the process of forest regeneration and reconstruction	Most of the existing technical facilities in the forestry sector are morally and physically obsolete, with a period of use of more than 20 years. The forestry sector lacks an operational programme to promote new technologies and innovations.	Important
	2.3. High periodicity of fruiting years in the main tree species (especially oak stands)	Due to a combination of factors (origin from shoots; pedoclimatic conditions; management deficiencies, etc.), oak stands (especially fluffy oak) have a fruiting periodicity of 8-15 years.	Important
	2.4. Reduced capacity of degraded and unsuitable arboretums to regenerate and adapt to climate change	Due to functional parameters (phytosanitary status; regeneration mode; productivity; consistency, etc.), degraded and inadequate arboretums bear fruit much less often than normal arboretums. Abnormal drying processes due to climatic factors occur mostly in degraded and improper arboretums.	Important
III. Institutional and social barriers	3.1. Shortage of personnel and expertise in the field of regeneration and ecological reconstruction	Forest design institutions, but also forest management institutions (territorial forestry entities) are facing the shortage of qualified personnel specialized in forest regeneration/reconstruction.	Very important

Identified barriers			
	of inadequate and vulnerable arboretums	The spectrum of forestry experts specialized in forecasts and modelling related to the evolution of forest status under climate change conditions is very limited.	
	3.2. Abandoning the process of training forestry staff	Since 2018, the process of training forestry staff has been abandoned. Lack of an operational program for continuous improvement of forestry personnel.	Important
	3.3. Low quality of graduates of forestry institutions	Most graduates of forestry institutions find it difficult to fit into the service, because training and motivation do not cope with the current goals and challenges of the forestry sector.	Insignificant
	3.4. Low remuneration level of forestry staff	The average salary in the forestry sector (shared with the agricultural sector) is the lowest in the national economy. The average salary in the country is about 40% higher than the average salary in forestry.	Important
	3.5. Forestry staff face image and communication problems	Image problems of forestry staff are due to poor behavior and communication with society and public authorities. According to various studies and reports, forestry personnel are involved in corruption and conflicts of interest.	Less important
IV. Policy and regulatory framework barriers	4.1. Low degree of implementation of forest policy documents and regulatory framework	Most forest policy documents adopted over the last two decades have an implementation rate of 50-70%, not ensuring a decisive qualitative and quantitative leap. An important part of the provisions of the forest regulatory framework remain (seed regeneration of forests; forest planning of all forests, regardless of departmental affiliation and ownership, etc.) at the level of "good intention", without practical implementation.	Important
	4.2. Ambiguous legislative provisions on ensuring the improvement of the condition of inadequate and vulnerable arboretums	The Forestry Code includes only general provisions (Articles 27-30) aimed at improving the condition of forests. Concrete criteria/parameters for improving the condition of forests as well as secondary legislation are not developed.	Important
	4.3. Regular deviation from key priorities in the activity of the forestry sector	The fluctuating evolution of the implementation process of the main forest desiderata (forest regeneration and extension; forest guard and protection, etc.) determined by the political conjuncture.	Important
	4.4. Forest normative basis poorly updated to the current state and perspective of forests in climate evolution	Technical regulations in the forestry field require profound updates to cover the full spectrum of measures to adapt forests depending on climate risks.	Important

According to the analysis of the data in Table 1.1, the main barriers to be addressed in the process of assessing technology transfer "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change" relate to different directly or indirectly related areas and are quite

complex. An essential part of these barriers is a consequence of the natural conditions (soils, resorts, hydrology, etc.) in which an important part of forests have been artificially created over the last 50-70 years, others relate to limited institutional and personnel capacities in forestry, lack of public and private investment, etc. Financial barriers are also due to the perception at the level of political decision-making (Government, Parliament) of the forestry sector in terms of the general contribution to GDP, which is low and varies within the limits of 0.2-0.3%. Finally, these barriers or needs seriously affect the activity of the national forestry sector, essentially diminishing sectoral intervention capacities for the purpose of ecological reconstruction of unsuitable arboretums.

1.2.3 Identification of measures to ensure technology transfer "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change"

The main obligations of technology implementation belong to the Agency "Moldsilva", which has a certain capacity, experience and tools for applying technology through its territorial subdivisions. At the same time, on certain areas (technical equipment; staff training on designing technical solutions; staff training on the application of technical solutions, new technologies, etc.) certain general sectoral capacity building actions will be implemented to ensure the success of forest management activity.
Logical problem analysis was used as a tool to identify measures to overcome barriers. The tree of objectives of this technology is presented in Annex 2. The measures were assessed on their economic profile, the incentives used and the effects achieved. In context, as mentioned in the previous paragraph, financial barriers are relatively significant for the technology in question. At the same time, it is mentioned that about 30-40% of the costs of the works can be redirected from the revenues obtained as a result of carrying out the initial phase of the reconstruction works – the extraction of the pre-existing stand. In order to implement a large-scale pilot project, the necessary costs cannot be covered only from internal sources of the Agency "Moldsilva", being necessary the support of the state budget and especially external sources working in the forestry field (WB; GCF; GEF, etc.). However, non-financial aspects prevail and require special attention. In total, 19 actions were identified as measures aimed at overcoming barriers (except for insignificant ones) and ensuring the transfer of technology "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change". Most of them relate to the following categories:

- Review and completion of the existing regulatory framework (Forestry Code; Law on public finances and budgetary-fiscal responsibility, etc.) and development of technical aspects through secondary legislation (increasing the public financial contribution to forest management; increasing the level of remuneration of forest staff; directions for sustainable forest development; choosing and applying forestry treatments; forest regeneration and expansion, etc.).
- Development and implementation of new sectoral programs/plans for the development of technical and institutional capacities (staff development and communication; forest design capacity development; cooperation with university and technical vocational education institutions; promotion of research and innovation; creation of capacities to carry out ecological restoration works, etc.).

The results of the process of identifying and detailing measures to overcome barriers are presented in Table 1.2.

Table 1.2: Measures to overcome barriers to technology transfer for the ecological restoration of unsuitable and vulnerable arboretums for adaptation to climate change

Broad categories of barriers	Barriers within the category	Exceedance measures
I. Financial barriers	Funding gap for activities to maintain, improve/rehabilitate the condition of existing forests	Establishing within the Law on Public Finance and Budgetary-Fiscal Responsibility (no. 181 of 25.07.2014) a share of GDP for sustainable management of forest resources in public ownership (state; ATU).
		Establishing within the Forest Code concrete criteria regarding the need to improve/rehabilitate the condition of forests. Development of technical aspects in this compartment through secondary legislation.
	Lack of viable financial mechanisms to stimulate actions to improve the condition and productivity of forests	Completing in the Forest Code aspects aimed at economic stimulation of the activity of improving the condition and productivity of forests. Development of technical aspects in this compartment through secondary legislation.
II. Technological barriers	Weak technical capacities and facilities in the field of forest regeneration and reconstruction	Creating new sectoral capacities to carry out ecological restoration works by setting up a specialized entity, equipped with special equipment and equipment for the initial phase of the ecological restoration process (extraction of pre-existing stand; deforestation; tillage, care/maintenance of forestry crops, etc.).
	Low implementation of new technologies in the process of forest regeneration and reconstruction	Development and implementation of a sectoral program/action plan on promoting new technologies and innovations.
	High periodicity of fruiting years in the main tree species (especially oak stands)	Review of technical regulations related to the care/maintenance of seed source arboretums, especially in terms of ensuring constant fruiting.
		Amplification of works for the care/maintenance of seed source arboretums (irrigation, fertilization, protection, etc.).
	Reduced capacity of degraded and unsuitable arboretums to regenerate and adapt to climate change	Review of technical regulations related to the implementation of the forestry regime in terms of ensuring timely interventions in the condition and development of arboretums (choosing and applying forestry treatments; carrying out care and management works; forest regeneration and extension, etc.).
III. Institutional and social barriers	Shortage of personnel and expertise in the field of regeneration and ecological reconstruction of inadequate and vulnerable arboretums	Revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the salary level of highly qualified personnel participating in research and development activities.
		Development and implementation of an operational program for continuous improvement of forestry personnel.
	Abandoning the process of training forestry staff	Development and implementation of an operational program for continuous improvement of forestry personnel.
	Low level of remuneration of forestry staff	Review the regulatory framework on labor remuneration in the forestry sector in order to increase the level of wages and labor productivity.
	Forestry staff face image and communication problems with society	Development and implementation of a communication plan of the forestry sector with society and public authorities.
		Amplifying corruption prevention activities in the forestry sector. Revision of the internal regulatory framework (statute/operating regulations, job descriptions, etc.) for liquidating conflicts of interest/functional overlaps in the process of technological activity.
IV. Policy and regulatory	Low degree of implementation of forest	Review and amplify the monitoring activity on the implementation process by the central forestry authority of forest policy documents

Broad categories of barriers	Barriers within the category	Exceedance measures
framework barriers	policy documents and regulatory framework	and regulatory framework (governmental/parliamentary hearings; annual implementation reports, etc.).
	Ambiguous legislative provisions on ensuring the improvement of the condition of inadequate and vulnerable arboretums	Establishing concrete criteria within the Forest Code regarding the need to improve/rehabilitate the condition of forests. Development of technical aspects in this compartment through secondary legislation.
	Regular deviation from key priorities in the activity of the forestry sector	Reviewing and supplementing the Forest Code with concrete provisions on the directions of sustainable development of forests, as well as correlating with them the attributions of the central forestry authority.
	Forest normative basis poorly updated to the current state and perspective of forests in climate evolution	Initiating and implementing a sectoral plan for updating/reviewing the main technical regulations (forest planning; choice and application of forestry treatments; forest regeneration and extension, etc.) in the forest field regarding the adaptation of forests to climatic conditions and risks.

1.3 Analysis of barriers and possible support measures for the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions"

1.3.1 General description of the technology "The use of modern biotechnologies of propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions"

The technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in the new climatic conditions" provides for the adaptation of the subsector of production of forest reproductive material to the evolution of climate change through activities to strengthen and modernize the process throughout the production chain: Identification, legalization and care/maintenance of seed source arboretums (including forest genetic resources); harvesting, processing and certification of forest seed; industrial breeding and valorization of forest reproductive material, etc. Because, according to the data of various studies and national reports, it is found that forest nurseries created by forestry enterprises currently grow forest reproductive material, without relying on the requirements of EU standards and data of international treaties on adaptation to climate change. At the same time, the current requirements to increase forest productivity and the development of the forest economy in terms of adaptation to climate change make it necessary to ensure the production of high-quality propagating material.

The technology corresponds, in particular, to sectoral priorities on intensifying the process of afforestation/reforestation of land, ensuring forest resilience to climate change, increasing the Eco protective and bio productive potential of existing and/or natural forests, conservation of biological diversity of forests, etc. In this context, the production of forest material in the required assortment, qualitatively and in the necessary quantities, which will contribute to increasing the success of forestry crops and adapting regeneration and afforestation works to climate change. Improve the management

and conservation process of seed source arboretums as well as forest genetic resources, in particular in terms of adaptation to climate change.

The main implementation obligations belong to the Agency "Moldsilva", which has capacity, experience and tools to apply technology through its territorial subdivisions (forestry entities and FRMI). In the implementation process will participate MoEnv, MAFIA, NBG, IGPPP, companies and private individuals. For direct implementation, the mechanisms established by the legislation in the field will be used (Forest Code; guidelines and recommendations on the care and maintenance of seed source arboretums; guidelines and recommendations on the organization of forest nurseries activity, etc.). At the same time, on certain fields (technical equipment; staff training in designing technical solutions for the care of seed source arboretums and those designated as forest genetic resources; staff training on the application of technologies for growing forest reproductive material, etc.) certain actions will be implemented to strengthen Moldsilva's capacities (including with the consultation of specialists and specialized companies from Poland, Czech Republic, Hungary, etc.) to ensure the success of activities.

The technology covers seed source arboretums and those designated as forest genetic resources (about 5-7 thousand ha), as well as existing forest nurseries (about 900 ha; over 30 forest nurseries) within the "Moldsilva" Agency and its territorial structures (24 entities), located throughout the country. The process of implementing the prioritized technology will include the use of biotechnologies for the production of seedlings (multiplication, rooting, in vitro growth, etc.), including with protected roots (about 50-60% of production capacity). Also, for the regeneration, ecological reconstruction and afforestation works in the Republic of Moldova will be ensured the assortment of species of trees and shrubs growing in local forests (over 85 species). This assortment must be supplemented with tree and shrub species from the area bordering the Republic of Moldova (Romania, Ukraine, Bulgaria, Greece, Hungary, etc.), including in terms of tolerance limits to medium and maximum temperatures. This process will include about 20-30 species of trees and shrubs, including the barberry (*Quercus frainetto Ten*.), the sky (*Quercus cerris L*.), etc. This compartment will be completed with the revision of the normative basis aimed at the management and conservation of forest genetic resources, including in terms of adaptation to climate change.

The technology includes the establishment and commissioning of some basic elements of the subsector for the production of forest reproductive material: The creation of 2 regional centers for industrial breeding of forest reproductive material (RCIBFRM) usable in the new climatic conditions (northern and southern zones). The activity at this department provides for proper technical equipment, development of primary operational activities, staff training, etc.

Another important compartment of this technology is the creation and technical endowment of the National Center for Genetics and Forest Seminology/NCGFS (area of activity – center area). As basic tasks/activities of the NCFGS it is foreseen: Seed base management (arboretums, seed sources and FGR on 3-4 thousand ha); certification of regeneration material; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro breeding; primary operational activity; provision of seed processing equipment, nursery and laboratory equipment for quality assessment, etc.). The total production capacity of the 3 centers should be about 65-70 million seedlings per year with the corresponding assortment of species.

The main and direct benefits of implementing the technology in question are:

a) Environmental benefits:
   - Increasing the quantity and quality of forest seed material harvested from identified sources, with beneficial consequences on the quality of saplings and future forestry crops.
   - Production of forest material in the required assortment, quality and in the necessary quantities, which will contribute to increasing the success of forestry crops and adapting regeneration and afforestation works to climate change.
   - Improving the management and conservation process of seed source arboretums as well as GFR, in particular in terms of adaptation to climate change.

b) Socio-economic benefits:
   - Creation of new jobs in rural areas (about 525 people), related to a wide range of activities: primary harvesting and processing of forest seeds; development of forest nurseries with industrial capacities; research and biotechnology, etc.
   - Increase revenues in the state budget, local budgets and for population, especially in rural areas, generating on average about 65-70 million lei annually (when reaching the maximum production capacity).

c) Capacity building, technology transfer and diffusion:
   - Contributes to strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply innovative technical solutions for growing forest reproductive material both for regeneration works within the existing forest fund (including ecological restoration of degraded and inadequate arboretums) and for afforestation works on new lands (forest extension).
   - Implementation of innovative components foreseen within the measure: biotechnologies; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro breeding; automated irrigation systems; technical solutions for the care of seed source arboretums and those designated as forest genetic resources; digital technologies (GIS/GPS) for land and works records, etc.
   - Review the regulatory basis for the management and conservation of forest genetic resources, including adaptation to climate change.

1.3.2 Identification of barriers for technology transfer "Use of modern biotechnologies for propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions"

The process of identifying barriers for the transfer of technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions" was based on the same aspects and methodological approaches as in the case of the technology "Ecological restoration of inadequate and vulnerable arboretums for the purpose of adapting to climate change" (study of policy and other relevant documents; identification of the long list of barriers; establishing the short list of barriers; decomposition of barriers, etc.). Thus, according to the guide "Overcoming barriers to the transfer and diffusion of climate technologies" (Nygaard I., Hansen U. E., 2015), the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" is assigned to the category "Non-market goods – publicly supplied goods". Because this technology is procured/fulfilled and disseminated by a public entity (Agency "Moldsilva") to a large population of

users and/or beneficiaries. Major investments in the selected technology tend to be decided at government level and depend to a large extent on forestry and/or environmental policies adopted. It is also mentioned that the main result of the technology is to ensure the production of forest material in the required assortment, quality and in the necessary quantities, which will contribute to increasing the success of forest crops and adapting regeneration and afforestation works to climate change.

The main barriers to be addressed in the process of assessing the technology transfer "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" relate to various aspects related to this important subsector within the forestry field. Most barriers refer to the limited administrative, institutional and personnel capacities of the forestry sector in this chapter, the deficit of public and private investments, the deficit of forest seeds in terms of quantity, quality and assortment, etc. Another important aspect necessary to mention is that the capacities of the subsector aimed at increasing forest reproductive material are mostly required (over 90%) by the public afforestation/regeneration needs and programs of the national forestry sector, which over the last decades are limited and fluctuating. All these barriers seriously affect the capacity of the national forestry sector to ensure regeneration, ecological reconstruction and afforestation activities with quality planting material, the assortment of tree and shrub species corresponding to stationary conditions, etc.

Another tool used in the barrier analysis process was logical problem analysis (ALP/LPA) for analyzing causal relationships and basic problems in technology transfer. The problems were arranged in a hierarchy of causes and effects, with a central/generic startup problem for technology transfer. The problem tree outlined the main links between causes and effects and organized them into logical interrelations, addressing basic problems and highlighting links with external factors. The problem tree for this technology is included in Appendix No. 1. As a fundamental cause of the problem, the lack of forest reproductive material (saplings) in sufficient quantities and of adequate quality has been identified, and the total number of barriers and/or needs – 18 and, consequently, low interest in technology. The results of the barrier identification, detailing and ranking exercise are presented in Table 1.3.

Table 1.3: Long list and hierarchy of barriers to technology transfer for The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	The importance of the barrier
I. Financial barriers	1.1. Low profitability and increased costs of works to maintain fruiting capacities of seed source arboretums	Due to the current state, as well as pedoclimatic conditions, seed source arboretums require additional investments through care/maintenance works (irrigation, fertilization, protection, etc.). The shortage of labor force and the laborious nature of the works to maintain the fruiting capacities of the source arboretums increase the costs of care/maintenance works. The low natural productivity of seed source arboretums increases the cost of harvested reproductive material.	Very important
	1.2. Insufficient investment in identification and management of	The activity of identifying forest arboretums, seed sources and genetic resources has no direct and immediate economic effect, being ignored by holders and/or investors.	Important

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	The importance of the barrier
	arboretums, seed sources and forest genetic resources	Investing in the management of seed arboretums and forest genetic resources is not a priority, as the use of reproductive material from identified sources in the forest regeneration/reconstruction process is not yet mandatory.	
	1.3. Costly technical equipment needs for nursery and maintenance of seed source arboretums	The forestry sector does not have an operational list of equipment and technique required for the technological process for nurseries and work on the care and maintenance of seed source arboretums. In order to ensure the achievement of the volume and quality of nursery works and care/maintenance of seed source arboretums, a wide range of equipment and techniques (irrigation systems, solar, seed processing and control equipment, etc.) are required, which far exceed the current financial possibilities (incomes) of forest managers.	Insignificant
	1.4. High taxes, which suffocate forestry entities and diminish investment capacities in high-performance equipment and equipment for forest nursery activities	The share of taxes and fees in the total amount of expenditures and consumption of the forestry sector varies between 22-27%, having a fluctuating character. The share of the forestry sector in the national public budget is on average about 0.30% or more than 20% above the share of the sector in GDP. Due to the major degree of complexity, the forest nursery activity is laborious and expensive, the primary investments required in this compartment constitute about 20% of the annual budget of the forestry sector.	Important
II. Technological barriers	2.1. Acute deficit of forest seeds in terms of quantity, quality and assortment	The shortage of forest seeds is acutely felt, especially in years with poor fruiting at the oak stands. The forestry sector lacks seed deposits for multiannual storage and covering needs in years of poor fruiting.	Very important
	2.2. Laborious harvesting and processing/processing of forest seeds	Most of the existing technical facilities in the forestry sector are morally and physically obsolete, with a period of use of more than 20 years. Shortage of skilled and unskilled (seasonal) labor due to the minimum wage amount (the lowest in all sectors of the national economy) for workers in the forestry sector.	Important
	2.3. High periodicity of fruiting years in the main tree species (especially oak stands)	Due to a cumulation of biotic and abiotic factors (origin from shoots; pedoclimatic conditions; management deficiencies, etc.), oak stands (especially fluffy oak) have a fruiting periodicity of 8-15 years. Ignoring the identification works, as well as the care/maintenance of seed source arboretums (irrigation, fertilization, protection, etc.).	Important

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	The importance of the barrier
	2.4. Insufficient monitoring of the origin and quality of reproductive material for the production of seedlings in forest nurseries	Lack of a mechanism to stimulate the production and valorization of forest reproductive material with identity and quality authentication. The law on production, marketing and use of forest reproductive material was adopted only in March 2022.	Important
	2.5. Low access to new advanced technologies and equipment for forest nurseries and seed stand management	The local forestry market is poorly developed due to the low volume of production and demand. International suppliers of technologies and equipment collaborate only with accredited companies demanding economically profitable volumes.	Insignificant
III. Institutional and social barriers	3.1. Shortage of personnel and expertise in forest nursery and seed stand management	Forest design institutions, but also those of forest management (territorial forestry entities) are facing the shortage of qualified personnel specialized in forest nursery and management of seed source arboretums. The spectrum of experts specialized in the design of modern forest nurseries (industrial breeding centers) and/or industrial production of forest seeds is very limited or even lacking in the Republic of Moldova.	Very important
	3.2. Abandoning the process of training forestry staff	Since 2018, the process of training forestry staff has been abandoned. Lack of an operational program for continuous improvement of forestry personnel, including in the fields of nursery and seminology.	Important
	3.3. Insufficient collaboration of the forestry sector with forestry universities and research institutions	The intervention of the forestry sector in the process of training new specialists is minimal, without drawing common strategic directions. Most graduates of forestry institutions find it difficult to fit into the service, because training and motivation do not cope with the current goals and challenges of the forestry sector.	Insignificant
	3.4. Low remuneration level of forestry staff	The average salary in the forestry sector (shared with the agricultural sector) is the lowest in the national economy. The average salary in the country is about 40% higher than the average salary in forestry.	Less important
	3.5. Forestry staff face image and communication problems	Image problems of forestry staff are due to poor behavior and communication with society and public authorities. According to various studies and reports, forestry personnel are involved in corruption and conflicts of interest.	Less important
IV. Policy and regulatory framework barriers	4.1. Low degree of implementation of forest policy documents and regulatory framework	Most forest policy documents adopted over the last two decades have an implementation rate of 40-60%, without ensuring a decisive qualitative and quantitative leap. An important part of the provisions of the forest regulatory framework remains (regeneration of forests from seed; forest planning of all forests,	Important

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	The importance of the barrier
		regardless of departmental affiliation and ownership, etc.) at the level of "good intention", without implementation in practice.	
	4.2. Ambiguous legislative provisions regarding the provision of water resources to forest nurseries	The Forest Code does not include provisions that would address particularities regarding the functionality of forest nurseries. The legislation regulating water use, including for irrigation purposes (Water Law, no. 272 of 23.12.2011) does not contain concrete criteria/parameters for forest nurseries.	Important
	4.3. Poor monitoring of forest nursery production activities and processes	Part of the seedlings are grown in nurseries and planted within forestry crops without checking the quality of seed material (15-20%). The share of forest seeds harvested from identified sources accounts for up to 15%.	Important
	4.4. The regulatory basis related to the breeding and marketing of forest reproductive material is poorly developed and/or updated	The law on production, marketing and use of forest reproductive material was adopted only in March 2022. Technical regulations related to the rearing and marketing of forest reproductive material require profound creation and/or updating, including in terms of overcoming climate risks.	Important

The analysis of the data in Table 1.3 shows that the main barriers to be addressed in the process of assessing the technology transfer "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" are related to different directly or indirectly related fields and are quite complex. An essential part of these barriers refers to limited institutional and personnel capacities in forestry, public and private investment gaps, high taxes, which suffocate forestry enterprises and diminish investment capacities in high-performance technique/equipment for forest management activities, etc. The process is also influenced by insufficient supervision of the production process and quality of forest reproductive material in forest nurseries, without establishing its origin or provenance, without authenticating its identity, quality and resilience to climate change, etc. Finally, these barriers or needs seriously affect the activity of the national forestry sector, essentially diminishing the sectoral intervention capacities in order to ensure the process of regeneration/reconstruction/expansion of forests with high quality reproductive forest material, in the necessary volume and assortment.

1.3.3 Identification of measures to ensure technology transfer "Use of modern biotechnologies for propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions"

The next important step in the second phase of the TNA process was to identify the necessary measures to overcome the barriers identified in the context of ensuring the transfer of technology "The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions". Logical problem analysis was used as a tool to identify measures to overcome barriers. The tree of objectives of this technology is

presented in Annex 2. The measures were assessed on their economic profile, the incentives used and the effects achieved.

The problem of creating new forests solely from breeding material from arboretums, identified seed sources and/or genetic resources, adapted to natural conditions, areas and climate change, is a pressing and topical one. In this context, Directive 1999/105/EC of the Council of Europe of 22 December 1999 on the marketing of forest reproductive material and other sources of EU legislation with reference to the topic was developed at European level. With the establishment of legal instruments at European level, the quality of planting material for reproduction has significantly increased, which has allowed zoning and assessment of genetic resources, by selecting the most resistant trees and shrubs to the negative effects of climate change and stationary conditions. As a result of the efforts made, by implementing the mentioned EU Directive, reproductive propagating material has become more resistant to ecological conditions and to diseases and pests and as a result is an increase in the production volume and quality of harvested wood in the process of sustainable forest management. These EU norms are important for the Republic of Moldova both for forestry/environmental protection and for the development of the economic field by creating/renovating forest nurseries and obtaining benefits from the marketing/export of forest material resistant to ecological conditions and climate change. By adopting in March this year the Law on production, marketing and use of forest reproductive material, the Republic of Moldova produced the first decisive step in the context of solving these problems.

The main obligations of technology implementation belong to the Agency "Moldsilva", which has a certain capacity, experience and tools for applying technology through its territorial subdivisions. As mentioned in the previous paragraph, financial barriers are relatively significant for the technology in question. For the implementation of a large-scale sectoral or even national pilot project, the costs cannot be covered only from internal sources of the Agency "Moldsilva", being necessary the support of the state budget and especially sources allocated by external institutions working in the forestry field (WB; GCF; GEF, etc.). However, non-financial aspects prevail and require special attention. In total, 27 measures were identified as measures aimed at overcoming barriers (except for insignificant ones) and ensuring the transfer of technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions". Most of them relate to the following categories:

- Review and completion of the existing regulatory framework (Forestry Code; Law on public finances and budgetary-fiscal responsibility; Water Law, etc.) and development of technical aspects through secondary legislation (increasing public financial contribution to forest management; increasing the level of remuneration of forest staff; functionality of forest nurseries; provision of water resources to forest nurseries; subsidy of forest seed production, etc.);
- Development and implementation of new sectoral programs/plans for the development of technical and institutional capacities (staff development and communication; forest design capacity development; cooperation with university and technical vocational education institutions; promotion of research and innovation; creation of the network of forest seed deposits for multiannual storage, etc.).

The results of the process of identifying and detailing measures to overcome barriers are presented in Table 1.4.

Table 1.4: Measures to overcome barriers to technology transfer for The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions

Broad categories of barriers	Barriers within the category	Exceedance measures
I. Financial barriers	Low profitability and increased costs of works to maintain fruiting capacities of seed source arboretums	Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production.
		Amplification of works of care/maintenance of arboretums sources that stimulate seed production (irrigation, fertilization, protection, etc.).
		Implementation of procedures and processes for certification of forest seeds, including for marketing on the international market.
	Insufficient investment in identification and management of arboretums, seed sources and forest genetic resources	Implementation of procedures and processes for certification of forest seeds, including for marketing on the international market.
		Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production.
	High taxes, which suffocate forestry entities and diminish investment capacities in high-performance equipment and equipment for forest nursery activities	Establishing within the Law on Public Finance and Budgetary-Fiscal Responsibility (no. 181 of 25.07.2014) a share of GDP for sustainable management of forest resources in public ownership (state; ATU).
		Development and implementation of a sectoral program/action plan on promoting new technologies and innovations.
II. Technological barriers	Acute deficit of forest seeds in terms of quantity, quality and assortment	Amplification of works of care/maintenance of arboretums sources that stimulate seed production (irrigation, fertilization, protection, etc.).
		Creating within the forestry sector a network of seed deposits for multiannual storage and covering needs in years of poor fruiting.
	Laborious harvesting and processing/processing of forest seeds	Development and implementation of a sectoral program/action plan on promoting new technologies and innovations.
		Review the regulatory framework on labor remuneration in the forestry sector in order to increase the level of remuneration of forestry personnel.
	High periodicity of fruiting years in the main tree species (especially oak stands)	Review of technical regulations related to the care/maintenance of seed source arboretums, especially in terms of ensuring constant fruiting.
		Amplification of works for identification, care/maintenance of seed source arboretums (irrigation, fertilization, protection, etc.).
	Insufficient monitoring of the origin and quality of reproductive material for the production of seedlings in forest nurseries	Plenary implementation of the provisions of the Law on production, marketing and use of forest reproductive material.
		Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material.
		Establishment of the State Register of Producers of Forest Reproductive Material.
III. Institutional and social barriers	Shortage of personnel and expertise in forest nursery and seed stand management	Revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the salary level of low-qualified personnel participating in research and development activities.
		Development and implementation of an operational program for continuous improvement of forestry personnel.
	Abandoning the process of training forestry staff	Development and implementation of an operational program for continuous improvement of forestry personnel.

Broad categories of barriers	Barriers within the category	Exceedance measures
	Low remuneration level of forestry staff	Review the regulatory framework on labor remuneration in the forestry sector in order to increase the level of wages and labor productivity.
	Forestry staff experiences image and communication problems	Development and implementation of a communication plan of the forestry sector with society and public authorities.
		Amplifying corruption prevention activities in the forestry sector.
		Revision of the internal regulatory framework (statute/operating regulations, job descriptions, etc.) for liquidating conflicts of interest/functional overlaps in the process of technological activity.
IV. Policy and regulatory framework barriers	Low degree of implementation of forest policy documents and regulatory framework	Review and amplify the monitoring activity on the implementation process by the central forestry authority of forest policy documents and regulatory framework (governmental/parliamentary hearings; annual implementation reports, etc.).
	Ambiguous legislative provisions regarding the provision of water resources to forest nurseries	Supplementing the Forest Code with provisions that would target particularities regarding the functionality of forest nurseries.
		Supplementing the Water Law (no. 272 of 23.12.2011) with concrete criteria/parameters for forest nurseries.
	Poor monitoring of forest nursery production activities and processes	Plenary implementation of the provisions of the Law on production, marketing and use of forest reproductive material.
		Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material.
	The regulatory basis related to the breeding and marketing of forest reproductive material is poorly developed and/or updated	Update and completion of the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks.

1.4 Barrier analysis and possible support measures for the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

1.4.1 General description of the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

The technology "Climate Change Impact Considerations, Forest Species and Appropriate Forest Ecosystem Management Strategies" provides for the initiation and implementation of cumulative fundamental research programs with applied components on the adaptive capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature-based solutions (NBS). These programmes will focus mainly on:

- Establishing climate thresholds corresponding to the spatial distribution limits of forest types and/or forest species, with the development of bioclimatic models to predict future distributions of steady-state forests, in a range of plausible climate change scenarios.

- Collection and analysis of historical information about the migration of species and forests over certain distances to estimate how long it might take for the boundary of existing forests to migrate a certain distance.
- Calibration of biogeochemical models for forecasting changes in the productivity of arboretums and carbon stocks in the main forest types, with and without the effects of increased CO^2 concentrations.
- Assessment of adaptive capacity, including inherent adaptive capacity of forest species and ecosystems, as well as socio-economic factors determining the ability to implement planned adaptation measures.

The technology corresponds, in particular, to sectoral priorities for the development and implementation of scientifically justified adaptation measures with clear mitigation co-benefits and sustainable development approaches, the promotion of new sustainable forest management practices, the use of climate-resistant tree and shrub species in forestry practices. In this context, the development and promotion of new strategies/approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change is foreseen, as well as the implementation of sustainable forest management principles. These documents and approaches will be based on a cycle of fundamental research cumulated with applied components on the adaptive capacities of native forest ecosystems to climate change (resilience of species and arboretums; revision of approaches in the process of applying forest treatments and works, forest regeneration works, etc.).

The main implementation obligations belong to dedicated research institutions (NBG, IEG, IGPPP, etc.), universities, which have capacity, experience and tools to apply technology. MECR, Agency "Moldsilva" (especially FRMI), companies and private individuals will participate in the implementation process. The process will include the launch and implementation of a cycle of national research programmes focusing mainly on aspects related to the evolution/forecasting of the spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; adaptive capacities of forest species and ecosystems; socio-economic factors determining the capacity to implement sectoral adaptation measures, etc.

The activity will include consultation and adaptation of results, exchange of experience with similar institutions from neighboring countries (Romania, Ukraine, Hungary, Poland, Czech Republic, Bulgaria, etc.) as well as with international forest centers (EFI; IUFRO etc.). For direct implementation, the mechanisms established by the existing legislation in the field will be used (Forest Code; Code on Science and Innovation; guidelines and recommendations on conducting scientific research, etc.). The coverage area will be forests owned by Agency "Moldsilva" and its territorial structures (337.6 thousand ha), located throughout the country.

Technology is a priority for the forestry sector, and among the main innovative aspects foreseen within the technology are mentioned aspects regarding the evolution/forecasting of the spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; resilience of forest species and ecosystems to the effects of climate change, etc.

The main and direct benefits of implementing the technology in question are:

a) <u>Environmental benefits:</u>
   - Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change, based on fundamental and applied local research.

- Elaboration of new technical regulations to ensure concrete steps in achieving the resilience of forest ecosystems to the effects of climate change.
- Improving the management and conservation process of arboretums, especially in terms of adaptation to climate change.

b) Socio-economic benefits:
   - Creation of new jobs (directly about 135 people), related to a wide range of activities: conducting forestry scientific research and investigations; creation and maintenance of research infrastructure, experimental sectors/lots; transport/logistics services, etc.
   - The implementation in practice of new approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change developed within the technology will anticipate public and private expenditures for compartments related to forest regeneration/expansion, application of forest treatments/works worth about 2.5-3.5 million. EUR annually.

c) Capacity building, technology transfer and diffusion:
   - Contributes to strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply innovative technical solutions for forest ecosystem management in new climatic conditions.
   - Implementation of innovative components provided within the measure: application/use of informational/digital technologies in the process of conducting investigations and processing results; evolution/forecast of spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; resilience of forest species and ecosystems to the impacts of climate change; monitoring carbon stocks; recording, monitoring and forecasting the processes of succession of forest species, etc.
   - Development of new approaches and technical regulations to ensure resilience of forest ecosystems to climate change impacts.

1.4.2 Identification of barriers to technology transfer "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

The process of identifying barriers to technology transfer "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" was based on the same methodological aspects and approaches as for the technology "Ecological restoration of unsuitable and vulnerable arboretums for climate change adaptation" (study of policy and other relevant documents; identification of the long list barriers; establishing the short list of barriers; decomposition of barriers, etc.). Thus, according to the Guide "Overcoming barriers to the transfer and diffusion of climate technologies" (Nygaard I., Hansen U. E., 2015) the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" is assigned to the category "Non-market goods – publicly supplied goods". Because that technology is procured/fulfilled and disseminated by public entities (MECRs; Moldsilva; their subdivisions) to a large population of users and/or beneficiaries. Major investments in the selected technology tend to be decided at government level and depend to a large extent on forestry and/or environmental policies adopted. It is also mentioned that the main result of the technology is to support the process of adaptation of native forest ecosystems to climate change through an appropriate technical-scientific

argumentation through fundamental research programs cumulated with applied components, ecosystem based approach (EbA) and nature-based solutions (NBS).

The main barriers to be addressed in the technology transfer assessment process "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" refer to the limited administrative-institutional and personnel capacities of the forestry sector in this chapter, the deficit of public and private investments, insufficient development of forest R&D infrastructure, etc. These barriers seriously affect the capacity of the national forestry sector to ensure sustainable management activities of forest ecosystems, generational change in forests through regeneration, ecological restoration and afforestation operations, qualitative planting material, in the assortment of tree and shrub species corresponding to stationary conditions, etc. It is also mentioned that the topic of current scientific research does not cover the entire spectrum of problems and risks faced by the national forestry sector at the moment or are forecast for the future. This cumulation of barriers and/or needs seriously affects the capacity of the forestry sector to ensure a qualitative and efficient management of forest ecosystems, generates uncertainties regarding the future of the national forest heritage.

Another tool used in the barrier analysis process was logical problem analysis (ALP/LPA) for analyzing causal relationships and basic problems in technology transfer. The problems were arranged in a hierarchy of causes and effects, with a central/generic startup problem for technology transfer. The problem tree outlined the main links between causes and effects and organized them into logical interrelations, addressing basic problems and highlighting links with external factors. The problem tree for this technology is included in Appendix No. 1. As a fundamental cause of the problem, insufficient technical and scientific assurance of the process of adaptation to climate change of forest ecosystems was identified, and the total number of barriers/needs – 18 and, consequently, LOW interest in technology. The results of the barrier identification, detailing and ranking exercise are presented in Table 1.5.

Table 1.5: Longlist and hierarchy of barriers to technology transfer for Climate change impact considerations, forest species and appropriate forest ecosystem management strategies

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	Importance of barrier
I. Financial Barriers	1.1. Deficit in financial resources for forest research and development activity	The financial means allocated annually in the state budget for forest management constitute only about 2-3% of the budget of the state forestry sector, the rest have own revenues from commercial activity. The financial means allocated annually in the forestry budget for research and development activity represent on average only about 2.5% to a need of 7-8%.	Very important
	1.2. Lack of private investment in forest R&D	Due to institutional rigidity and insignificant market share, the forestry sector is of no interest to private investors. The results and/or products of forestry research are difficult to market on the local market.	Insignificant
	1.3. Lack of viable financial mechanisms to stimulate forest-related research and innovation	The Forestry Code (Article 12) exposes certain general provisions on this subject, but both the criteria and the method of economic stimulation are not developed either in the Code or in any other normative document.	Insignificant

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	Importance of barrier
	1.4. Low financial profitability of forest R&D	The involvement of expensive fixed assets in the forest research and development process makes products/services more expensive. Few results of forest R&D are created as commercial products. Large share of taxes and fees in the activity of forestry sector (about 22-27% of the total amount of expenditures and consumption).	Insignificant
II. Technological barriers	2.1. Insufficient technical endowment of forest research and development institutions	Most of the technical facilities existing in forest research and development institutions are morally and physically obsolete, with a period of use of over 25 years. Poor application of forest R&D institutions to international projects with technical endowment components.	Important
	2.2. Insufficient development of forest R&D infrastructure	Insufficiency of thematic experimental networks (sample areas, experimental lots, forestry-didactic/experimental bases, etc.) with forestry profile.	Important
	2.3. Increased needs in expensive equipment for carrying out forest research and design	In order to ensure the realization of fundamental and applied research, a wide range of high-performance equipment is required, which far exceeds the current financial possibilities of research and development institutions.	Important
	2.4. Limited access to the local market of new technologies and equipment for forest research and development	The local forestry market is poorly developed due to the low volume of production and demand, respectively. International suppliers of technologies and equipment collaborate only with accredited and demanding companies of economically profitable volumes.	Insignificant
III. Institutional and social barriers	3.1. Shortage of forestry personnel in the field of research and development	R&D institutions are facing shortages of highly qualified personnel. The spectrum of experts specialized in forest management and modelling on the evolution of forests under climate change conditions is very limited.	Very important
	3.2. Lack of a sustainable programme in the forestry sector to upskill and upskill staff	Since 2018, the process of training forestry staff has been abandoned. Lack of an operational program for continuous improvement of forestry personnel, including seasons at international research and development centers.	Important
	3.3. Insufficient collaboration of the forestry sector with forestry university institutions	The intervention of the forestry sector in the process of training new specialists is minimal, without drawing common strategic directions, practice programs, etc. Most graduates of forestry institutions find it difficult to fit into the service, because training and motivation do not cope with the current goals and challenges of the forestry sector.	Insignificant
	3.4. Low level of material stimulation within the forestry sector for research staff and high qualification	The average salary in the forestry sector (shared with the agricultural sector) is the lowest in the national economy. Forestry personnel do not have incentives to participate in research activities or high qualifications. The average salary in the country is about 40% higher than the average salary in forestry.	Less important

Identified barriers			
Broad categories of barriers	Barriers within the category	Detailed description of the barrier	Importance of barrier
	3.5. Lack of a consolidated and long-term research programme in the forestry sector	Research in the forestry sector is carried out mostly on the basis of short-term topics, developed and promoted ad hoc. There is a lack of a consolidated and long-term operational research programme that would address forestry issues (migration and/or species succession; forest regeneration; adaptation to climate change, etc.).	Less important
IV. Policy and regulatory framework barriers	4.1. Low degree of implementation of scientific research results in national forestry practice	The low quality and timeliness of the results and recommendations of scientific research in forestry. Limited access of forestry practitioners to information, reports and recommendations of forestry research. Most forest and environmental policy documents (strategies, programmes, action plans, etc.) adopted over the last two decades are mostly outdated, expired and have an average implementation rate of 40-60%.	Important
	4.2. Insufficient legislative regulation of the process of promoting research and innovations in forestry practice	The current version of the Forestry Code does not include provisions that would refer to concrete aspects regarding the provision of forest research, certain general aspects are mentioned in Articles 12 and 41, and aspects related to innovation are missing.	Important
	4.3. The topic of scientific research does not cover the entire spectrum of problems faced by the national forestry sector	Lack of initiative of institutions within the forestry sector in promoting forestry issues in national research programs. Inefficient application of the institutional approval mechanism by the forestry sector for research programs developed and implemented by NARD.	Important
	4.4. Insufficient collaboration of the forestry sector with R&D institutions	Deficit of institutionalized experimental objects on basic problems of national forestry within the forest fund. Lack of memoranda/agreements for collaboration, exchange of experience and data between research and development institutions and forestry entities.	Important
	4.5. The normative basis related to forest management is poorly updated through research activities	Technical regulations related to the forestry regime require profound creation and/or updates, including in terms of overcoming climate risks. The results of current forest research activities have a general character, little recommendations and regulatory.	Important

The analysis of the data in Table 1.5 shows that the main barriers to be addressed in the technology transfer assessment process "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" relate to different directly or indirectly related areas and are quite complex. An essential part of these barriers relates to limited institutional and staff capacities in R&D, the gap in public and private investment in R&D, etc. Finally, these barriers or needs seriously affect the activity of the national forestry sector, essentially diminishing the sectoral intervention capacities in order to ensure the sustainable forest management process based on the results, forecasts and recommendations of scientific research.

1.4.3 Identification of measures to ensure technology transfer "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

Identifying measures to overcome barriers/needs in the context of ensuring technology transfer "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" is an important step on which the success of this process largely depends. Logical problem analysis was used as a tool to identify measures to overcome barriers. The tree of objectives of this technology is presented in Annex 2. The measures were assessed on their economic/technological profile, the incentives used and the effects achieved.

The main obligations to implement this technology belong to MECR and "Moldsilva" Agency, which have a certain capacity, experience and tools for applying technology through subdivisions specialized in research and development (NBG; IEG; IGPPP; FRMI, etc.). As with previous technologies analyzed, financial barriers are relatively significant for the technology concerned. In order to implement a large-scale sectoral or even national pilot project, the costs cannot be covered only from the ongoing programs, and a targeted support of the state budget through the NARD is required. It is also necessary to mobilize internal sources of the Agency "Moldsilva", as well as from external institutions financing activities in the field of forestry (WB; GCF; GEF, etc.). However, non-financial aspects (institutional and personnel capacities; state of the regulatory framework; technological processes, etc.) prevail and require special attention. In total, 19 actions were identified as measures aimed at overcoming barriers (except for insignificant ones) and ensuring technology transfer "Identification of interactions related to climate change, forest species and appropriate forest ecosystem management strategies". Most of them relate to the following general categories:

- Review and completion of the existing regulatory framework (Forestry Code; Law on public finances and budgetary-fiscal responsibility, etc.) and development of technical aspects through secondary legislation (increasing public financial contribution to forest management; organization of forestry research; promoting forest-related innovation; increasing the level of remuneration of forestry personnel, especially highly qualified; development of the system of information, exchange of information and knowledge in the forestry field, etc.).
- Development and implementation of new sectoral programs/plans for the development of technical and institutional capacities (staff development and communication; forest design capacity development; cooperation with university and technical vocational education institutions; promotion of forestry research and innovation; technical endowment of forest research and development institutions; creation of national forest research infrastructure, etc.).

The results of the process of identifying and detailing measures to overcome barriers are presented in Table 1.6.

Table 1.6: Measures to overcome barriers to technology transfer for Climate change impact considerations, forest species and appropriate forest ecosystem management strategies

Broad categories of barriers	Barriers within the category	Exceedance measures
I. Financial Barriers	Deficit in financial resources for forest research and development activity	Establishing within the Law on Public Finance and Budgetary-Fiscal Responsibility (no. 181 of 25.07.2014) a share of GDP for sustainable management of forest resources in public ownership (state; ATU).

Broad categories of barriers	Barriers within the category	Exceedance measures
		Revision of the normative document regarding the methodology of forest budget formation, including the establishment of a minimum quota of 7-8% for research and development activity.
II. Technological barriers	Insufficient technical endowment of forest research and development institutions	Elaboration of a national program on technical endowment of research and development institutions with forestry profile.
		Amplifying the application activity of forest research and development institutions to international projects with technical endowment components.
	Insufficient development of forest R&D infrastructure	Development and implementation of a sectoral plan on the development of forest research and development infrastructure.
	Increased needs in expensive equipment for carrying out forest research and design	Amplifying the application activity of forest research and development institutions to international projects with technical endowment components.
III. Institutional and social barriers	Shortage of forestry personnel in the field of research and development	Revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the salary level of highly qualified personnel participating in research and development activities.
		Development and implementation of a sectoral program for continuous improvement of forestry personnel, including seasons/collaborations at international research and development centers (EFI; IUFRO).
	Lack of a sustainable programme in the forestry sector to upskill and upskill staff	Development and implementation of a sectoral program for continuous improvement of forestry personnel, including season/collaborations at international research and development centers (EFI; IUFRO).
	Insufficient collaboration of the forestry sector with forestry university institutions	Initiating and signing protocols for collaboration of the forestry sector with forestry university institutions with the drawing of common strategic directions, joint practice programs, internships, etc.
	Low level of material stimulation within the forestry sector for research staff and high qualification	Revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the salary level of highly qualified personnel participating in research and development activities.
	Lack of a consolidated and long-term research programme in the forestry sector	Elaboration and implementation of a consolidated medium-term and strategic sectoral research operational program that would target priority directions and forest issues (migration and/or species succession; forest regeneration; adaptation to climate change, etc.).
IV. Policy and regulatory framework barriers	Low degree of implementation of scientific research results in national forestry practice	Elaboration and implementation of a consolidated medium-term and strategic sectoral research operational program that would target priority directions and forest issues (migration and/or species succession; forest regeneration; adaptation to climate change, etc.).
		Establishing an efficient public information system on the state of forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems.
		Elaboration of a new program for sustainable development of the forestry sector that will incorporate the recommendations of scientific research in forestry.
	Insufficient legislative regulation of the process of promoting research and innovations in forestry practice	Supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as the promotion of innovation in the forestry field.
	The topic of scientific research does not cover the entire	Inclusion in the national program in the fields of research, innovation and development administered by NARD of strategic forestry issues

Broad categories of barriers	Barriers within the category	Exceedance measures
	spectrum of problems faced by the national forestry sector	(migration and/or species succession; forest regeneration; adaptation to climate change, etc.).
	Insufficient collaboration of the forestry sector with R&D institutions	Development and implementation of a sectoral plan on the development of forest research and development infrastructure.
	The normative basis related to forest management is poorly updated through research activities	Initiating and implementing a sectoral plan for updating/revising the main technical regulations (forest planning; choosing and applying forestry treatments; forest regeneration and expansion, etc.) based on the results/recommendations of national research institutions (NBG; IEG; IGPPP, etc.).

1.5 Links between identified barriers

This chapter analyses the links between the different barriers faced by technologies prioritized for the forest-based sector, so as to maximize synergies and optimize the effects of recommended measures. The links of barriers identified for the forestry sector are mainly related to non-financial ones. Although, economic and financial barriers are also important and barriers of all technologies include scarcity of finance, high costs, etc. As a result, 15 common barriers of the three leading technologies in the forestry sector have been identified and the results are presented in Table 1.7.

Table 1.7: Common barriers of prioritized technologies for climate change adaptation of the forest-based sector

Categories of barriers	Common barriers
I. Financial Barriers	Funding gap for forestry activities.
	Lack of viable financial mechanisms to stimulate forest management activities.
	Increased costs for ensuring the technological process in the forestry field with high-performance equipment and technique.
II. Technological barriers	Insufficient technical equipment in forestry.
	High periodicity of fruiting years in the main tree species (especially oak stands).
	Low implementation of new technologies in forestry technological processes.
III. Institutional and social barriers	Shortage of low-skilled personnel and expertise in priority areas within the forestry sector (research; forest regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.).
	Lack of a sustainable program to improve and increase the qualification of forest professionals.
	Insufficient collaboration of the forestry sector with forestry university institutions.
	Low level of remuneration of forestry personnel.
IV. Policy and regulatory framework barriers	Low degree of implementation of forest policy documents and regulatory framework.
	Insufficient legislative regulation of important processes in national forestry practice (research and innovation; ensuring improvement of the condition of inadequate and vulnerable arboretums; provision of water resources to forest nurseries, etc.).
	Poor degree of updating of the normative basis related to forest management.

Table 1.7 confirms that institutional and social barriers are the most common and efforts are needed to increase institutional and personnel capacities of key actors in the forestry sector. These aspects must be closely linked to knowledge and promotion of new technologies in forestry, including their importance in terms of adaptation to climate change of forest ecosystems. Barriers to the forest-related policy and regulatory framework are also closely linked to an insufficient number of experienced and

low-skilled specialists with knowledge of modern processes and technologies. The low level of remuneration of forestry personnel leads to increased labor migration to other sectors of the national or foreign economy, exhausting the already limited institutional capacity of the forestry sector.

Another important problem of the forestry sector is related to the poor implementation of policy documents and regulatory framework. Thus, most forest policy documents adopted during the last two decades have expired and an implementation rate of 40-60%, without ensuring a decisive qualitative and quantitative leap. Also, although during the independence period several stages of the process of establishing and improving the forest regulatory framework in the Republic of Moldova were consummated, there is still insufficient legislative regulation of important processes in national forestry practice (research and innovation; ensuring the improvement of the condition of inadequate and vulnerable arboretums; providing forest nurseries with water resources, etc.).

1.6 Enabling framework for overcoming barriers in the forestry sector

The enabling framework for overcoming barriers in the forestry sector is a key element in promoting selected top technologies. Among the main components of the facilitation framework for overcoming barriers in the forestry sector is the initiation and implementation of a sectoral plan for the gradual updating/revision of technical regulations that are basic components of the forestry regime (forest planning; choice and application of forest treatments; forest regeneration and expansion, etc.), including their correlation with aspects related to the adaptation of forest ecosystems to climatic conditions and risks. In the same context, it is foreseen the revision and completion of the Forestry Code (no. 887 of 21.06.1996) and the Water Law (no. 272 of 23.12.2011) with provisions that will regulate/promote research and innovation, ensuring the improvement of the condition of inadequate and vulnerable arboretums; provision of water resources to forest nurseries, etc. Once approved, these documents will create/strengthen the framework for more effective development and deployment of new technologies and approaches in the forestry sector, as well as boost the process of ecological restoration of unsuitable arboretums vulnerable to climate change.

The financial deficit in forestry is partially foreseen to be recovered by amending the Law on public finances and budgetary-fiscal responsibility (no. 181 of 25.07.2014), which will establish a fixed share of GDP allocated in the state budget for sustainable management of forest resources in public ownership (state; ATU). It will provide clarity in the contribution and interests of the state in the management and development of public forest capital. Also, the stimulation of research and development activity will be achieved by reviewing the regulatory framework aimed at the methodology of forest budget formation, by establishing a minimum quota of 7-8% for this activity.

Another important element of the facilitation framework is to increase the degree of providing the forestry sector with highly qualified personnel and expertise on key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.), which knows modern processes and technologies. This process will be based on a set of sectoral programs/plans aimed at continuous improvement of forestry personnel, forest research and development, development of forest research and development infrastructure, etc. The actions listed in this compartment will achieve the expected effect only by cumulating with the revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the level of

remuneration of forestry personnel, especially highly qualified and those involved in research and development.

The promotion of top technologies selected for the forestry sector will also be facilitated by the development of a new sustainable development program of the forestry sector for a period of 8-10 years. Because, existing documents are already expired and outdated.

Raising awareness about climate change risks and the importance of adaptation measures can also become an effective measure for technology diffusion, as currently most forestry staff and the population have a limited understanding of climate change patterns and potential impacts on activities, climate change risk, etc. This goal is to develop and implement a new communication plan of the forestry sector with society and public authorities, but also to establish an efficient public information system on the state of forests, exchange of information and knowledge about climate issues and sustainable management of forest ecosystems.

The enabling framework for forest-specific technologies is detailed in the following tables.

Table 1.8: Enabling framework for the technology "Ecological restoration of unsuitable and vulnerable arboretums for adaptation to climate change" as a tool for adaptation to climate change

Activity framework	Comments
Legislation	Establishing within the Forest Code the directions for sustainable forest development, concrete criteria on the need to improve/rehabilitate the state of forests, as well as the way of economic stimulation of this process will facilitate the more effective introduction in the forestry sector of new technologies and approaches, as well as boost the process of ecological restoration of inadequate arboretums vulnerable to climate change.
Financial policies	Amending the regulatory framework on public finances and budgetary-fiscal responsibility by establishing a fixed share of GDP allocated in the state budget for sustainable management of forest resources in public ownership (state; ATU) will contribute to the partial recovery of the financial deficit in forestry.
Sectoral policies	The elaboration and implementation of a program for the sustainable development of the forestry sector will ensure the promotion of the activity of improving the condition and productivity of forests, primarily through ecological restoration. At the same time, this process will be cumulated with the promotion of new technologies and innovations in the sector, as a primary condition for forest ecosystems to overcome climate risks.
Technical regulations	The revision of the technical regulations related to the implementation of the forestry regime in terms of ensuring timely interventions in the condition and development of arboretums (choosing and applying forestry treatments; carrying out care and management works; forest regeneration and extension, etc.) will contribute to the essential diminishing of the area of potentially degraded and inadequate arboretums, maintaining the stability and adaptation of forest ecosystems to climate change.
Qualified personnel and expertise	The development and implementation of an operational program for continuous improvement of forestry personnel, cumulated with the revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the level of wages, will contribute to increasing the degree of providing the forestry sector with highly qualified personnel and expertise in key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.), who knows modern processes and technologies.
Communication and awareness	Raising awareness of climate risks and the importance of forest adaptation measures is an effective measure for disseminating relevant technologies and approaches. This goal can be achieved by developing and implementing a new communication plan of the forestry sector with society and public authorities, but also by establishing an efficient public information system on the state of

Activity framework	Comments
	forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems.

Table 1.9: Enabling framework for the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions" as a tool for adaptation to climate change

Activity framework	Comments
Legislation	Supplementing the Forest Code with provisions that would target the particularities regarding the functionality of forest nurseries, as well as the Water Law with concrete criteria (parameters) for access to water resources of forest nursery will facilitate and boost the process of setting up centers for industrial growth of forest planting material, applying modern technologies and overcoming the main risks related to climate change. Another important condition for this department is the full implementation of the provisions of the Law on production, marketing and use of forest reproductive material recently adopted.
Financial policies	Amending the regulatory framework aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production activity will contribute to increasing the financial profitability of this activity, but also to constantly ensuring forest nurseries with the required quantity and assortment of reproductive material, including as a primary condition for timely forest regeneration/rehabilitation.
Sectoral policies	The new program for the sustainable development of the forestry sector will include the modernization of the activity of growing forest planting material by creating regional industrial centers, and this process must be cumulated with the promotion of biotechnologies and applied genetic research.
Technical regulations	The revision and implementation of technical regulations related to the care/maintenance of seed source arboretums will contribute in particular to ensuring the constant activity of regeneration and ecological restoration with reproductive forest material in terms of quality, quantity and in the necessary assortment.
Qualified personnel and expertise	The operational program for continuous improvement of forestry personnel, cumulated with the increase of the salary level, will contribute to increasing the degree of providing the forestry sector with qualified personnel, specialized in forest nursery and management of seed source arboretums.
Communication and awareness	Raising awareness of climate risks and the importance of forest adaptation measures is an effective measure for disseminating relevant technologies and approaches. This goal can be achieved by developing and implementing a new communication plan for the forestry sector with society and public authorities, but also by establishing an efficient public information system on the state of forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems.

Table 1.10: Enabling framework for the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" as a tool for climate change adaptation

Activity framework	Comments
Legislation	Ensuring the scientific framework for the forest ecosystem management process will be achieved by supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as promoting innovation in forestry.
Financial policies	Amending the regulatory framework regarding the methodology of forest budget formation by establishing a minimum quota of 7-8% for research and development activity will ensure adequate financial means to boost forest research and design on key sectoral areas.
Sectoral policies	The new medium-term and strategic sectoral research operational programme will target priority directions and forestry issues (migration and/or species succession; forest regeneration; adaptation to climate change, etc.).
Technical regulations	The initiation and implementation of a sectoral plan for updating/reviewing the main technical regulations (forest planning; choice and application of forestry treatments; forest regeneration and

Activity framework	Comments
	expansion, etc.) will have as main purpose the incorporation of results/recommendations of national research institutions (NBG; IEG; IGPPP, etc.) in the process of forest ecosystem management.
Qualified personnel and expertise	The collaboration of the forestry sector with forestry university institutions by drawing strategic directions and joint programs of practices, internships, etc., cumulated with the continuous improvement of forestry staff and increasing the salary level in the field of forest research and development, will contribute to increasing the degree of provision with highly qualified personnel and interdisciplinary expertise.
Communication and awareness	Increasing access of forest researchers and practitioners to relevant information, reports and recommendations on climate issues and sustainable management of forest ecosystems will be ensured by establishing an efficient public system of information, exchange of information and knowledge.

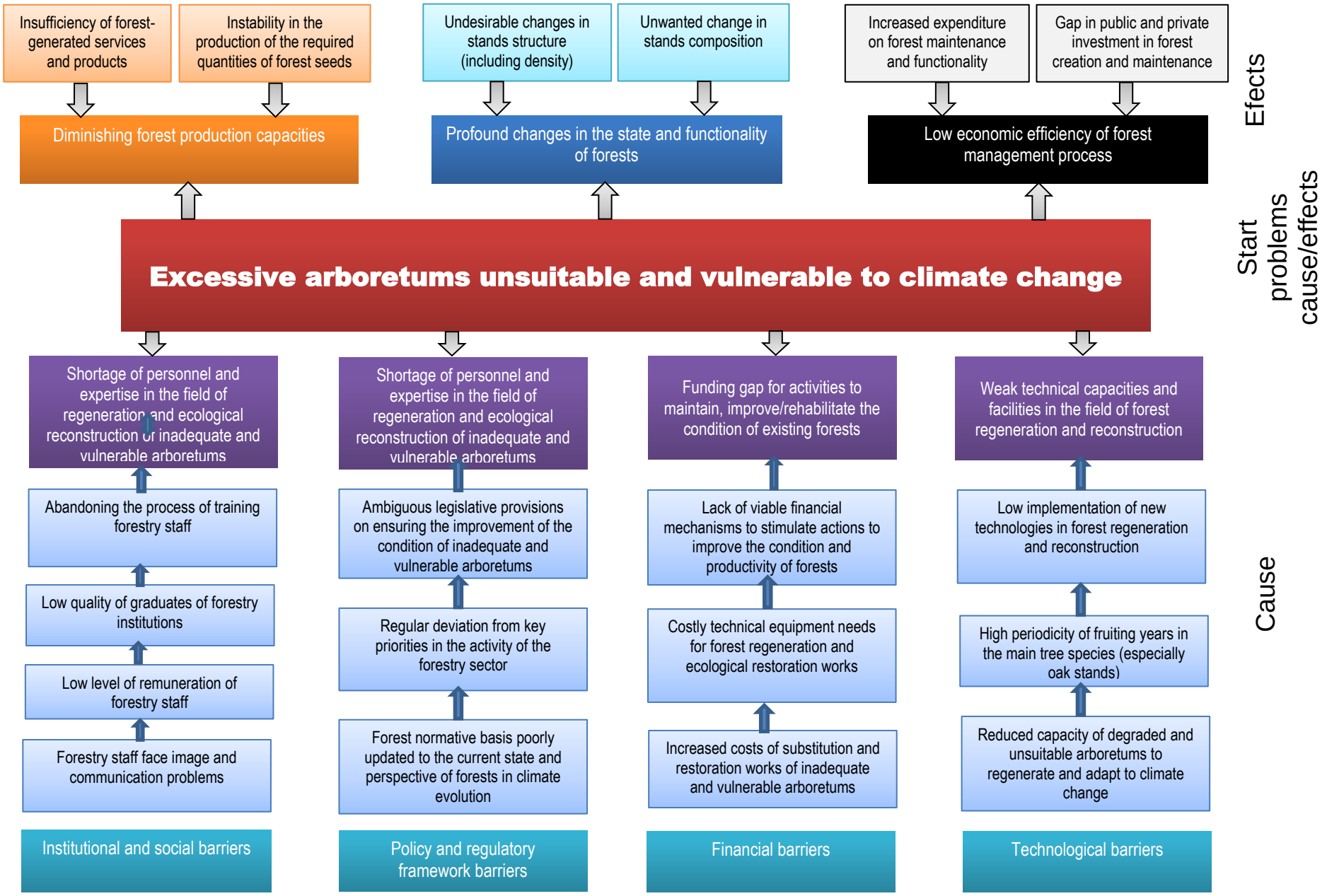
Bibliography

1. Agency "Moldsilva" (2020), *Materials of the Scientific-Practical Symposium "Ensuring sustainable forest management by implementing forestry treatments and promoting natural regeneration, afforestation"*. Chisinau, 61 p.
2. Agency "Moldsilva" (2016). *Strategy on adaptation of the forestry sector to climate change for 2017-2025 and Action Plan for its implementation, GD project*.
3. Andreev, O. Cazanteva et al. (2017). Forestry sector and ecosystem services - ENPI FLEG II in the Republic of Moldova. – Ch.: Elan Polygraph. – 240 p.
4. Andrew Mitchell, Arcadie Capcelea, Nina Rinnerberger [et al.] (2015), Republic of Moldova: Note on Forest Policy, – Ch.: I.E.P. Stiinta, 2015 (Printing House). – 68 p., ISBN 978–9975–67–892–6.
5. Daradur M., Cazac V., Josu V., Leah T., Lopotenco V., Rajendra P. Pandey, Shaker R., Talmaci I., Caisin V., Isac A. (2019), *National Drought Plan of the Republic of Moldova. United Nations Convention to Combat Desertification*, Ministry of Agriculture, Rural Development and Environment of the Republic of Moldova, State Hydrometeorological Service, Research and Project Centre "Eco Logistica". – Chişinău: Estetini, Tipogr. „Bons Offices". – 116 p.
6. Ion Talmaci, Erii Prosii, Ala Mardari, Alexandru Varzari, Alexandru Galupa (2018), *Forests of the Republic of Moldova, current state, qualitative and quantitative indicators*. Magazine Pădurelor, nr. 3/2018, SC Magic Print SRL, Oneşti. pp. 7–20. ISSN 1583-7890.
7. Transilvania University of Brasov (UTB), Faculty of Forestry and Forestry (2015), *Forest Ecosystem Services Assessment (SEF) of the Republic of Moldova.* Technical Report under the ENPI FLEG II Program, 89 p.
8. Official Gazette of RM no. 4-5/36 of 16.01.1997, *Forestry Code, no. 887-XIII of 21.06.96*.
9. Official Gazette no. 66-68/442 of 16.07.1998, *Law on the fund of state protected natural areas, no. 1538-XIII of 25.02.98*.
10. Official Gazette no. 141-143 of 09.11.2000, *Law on improvement through afforestation of degraded lands, no. 1041-XIV of 15.06.2000*.
11. *Official Gazette of the Republic of Moldova no. 090 of 02.08.2001, Parliament Decision approving the National Strategy and Action Plan in the field of conservation of biological diversity, no. 112-XV of 27.04.2001.*
12. *Official Monitor of the Republic of Moldova no. 133 of 08.11.2001, Parliament Decision no. 350 of 12.07.2001 approving the Strategy for sustainable development of the forestry sector in the Republic of Moldova.*
13. *Official Gazette of the Republic of Moldova no.126-131 of 27.06.2003, GD no. 739 of 17.06.2003 on the implementation of the Strategy for sustainable development of the national forestry sector.*

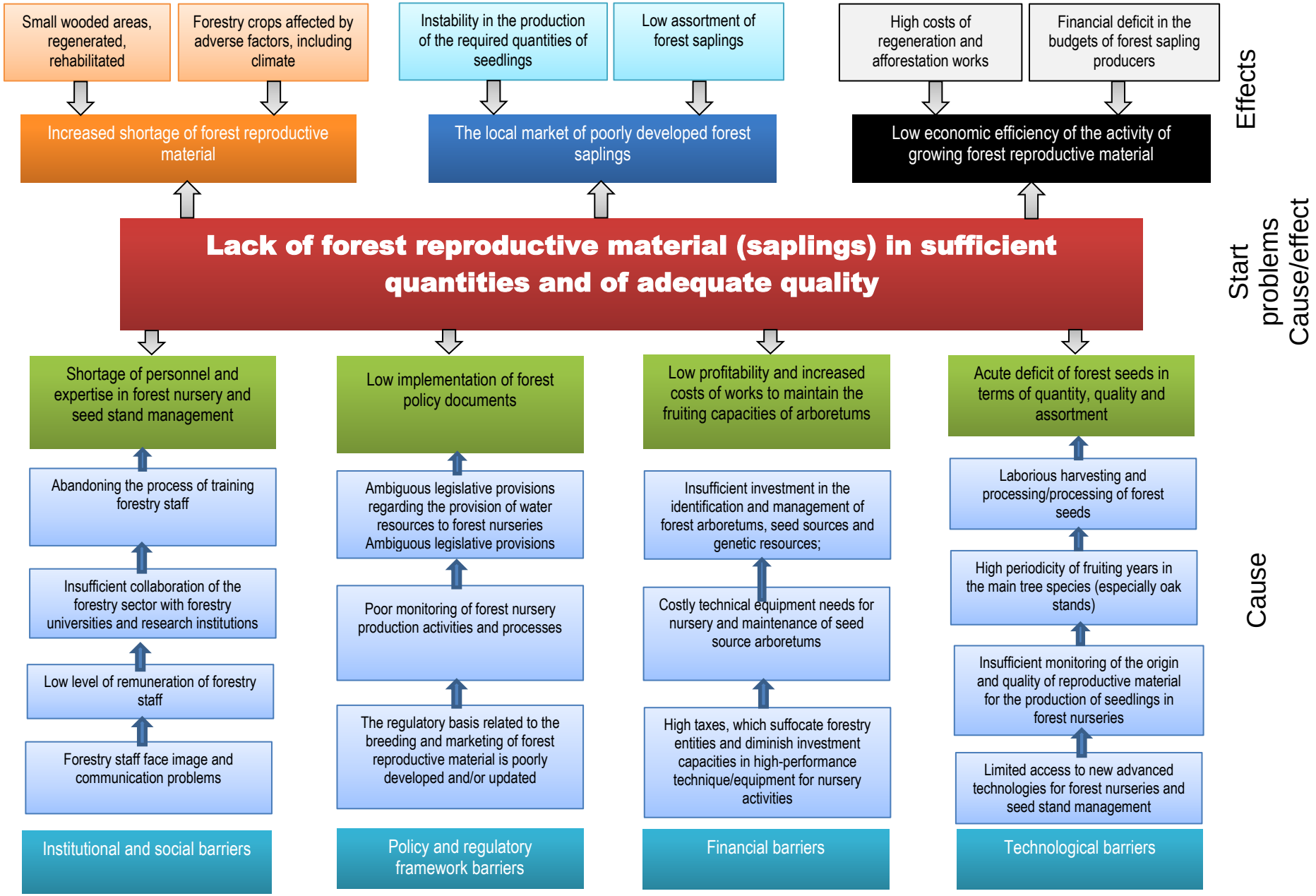
14. *Official Monitor of the Republic of Moldova no. 33 of 05.03.2010, GD no. 150 of 02-03-2010 approving the Regulation on organization and functioning of the Agency "Moldsilva", structure and staff limit of its central apparatus.*
15. *Official Gazette of the Republic of Moldova no. 81 of 26.04.2012, Water Law, no. 272 of 23.12.2011.*
16. *Official Gazette of the Republic of Moldova no. 104-109 of 06.05.2014, GD no. 301 of 24.04.2014 on the approval of the Environmental Strategy for 2014-2023 and the Action Plan for its implementation.*
17. *Official Gazette of the Republic of Moldova no. 223-230 of 08.08.2014, Law on public finances and budgetary-fiscal responsibility, no. 181 of 25.07.2014.*
18. *Official Monitor of the Republic of Moldova no. 372-384 of 19.12.2014, GD no. 1009 of 10.12.2014 on the approval of the Strategy of the Republic of Moldova for adaptation to climate change until 2020 and the Action Plan for its implementation.*
19. *Official Monitor of the Republic of Moldova no. 131-138 of 29.05.2015, GD no. 274 of 18.05.2015 on the approval of the Strategy on biological diversity of the Republic of Moldova for 2015-2020 and of the Action Plan for its implementation.*
20. *Official Monitor of the Republic of Moldova no. 85-91 of 24.03.2017, GD no. 1470 of 30.12.2016 on the approval of the Strategy for low-emission development of the Republic of Moldova until 2030 and the Action Plan for its implementation.*

Annex 1: Problem trees on selected technologies for the forestry sector

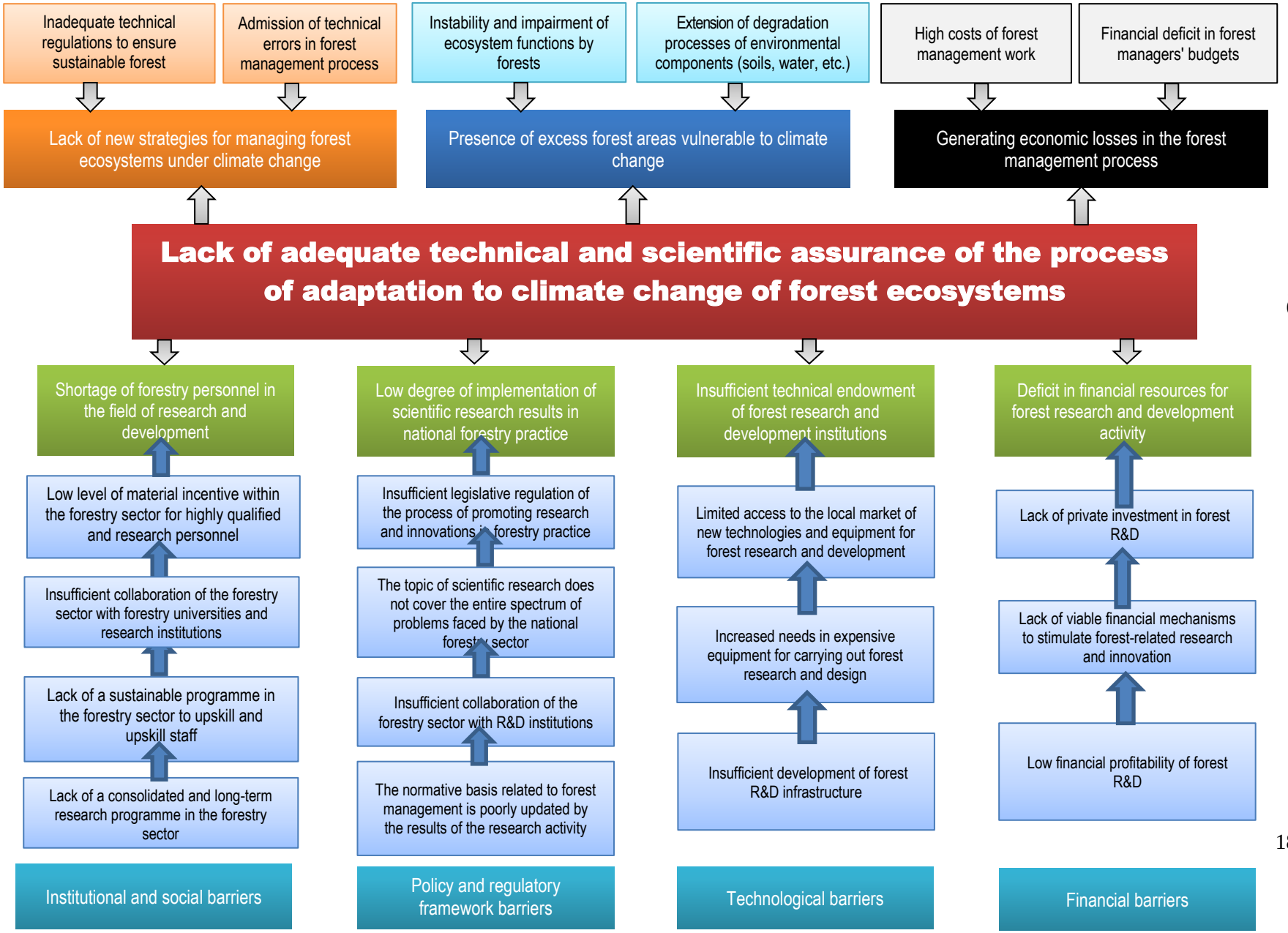
1.1 Problem tree for technology "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change"



1.2 Tree of problem for technology "Use of modern biotechnologies of vegetative material propagation in providing the forest sector with reproductive material in new climatic conditions"

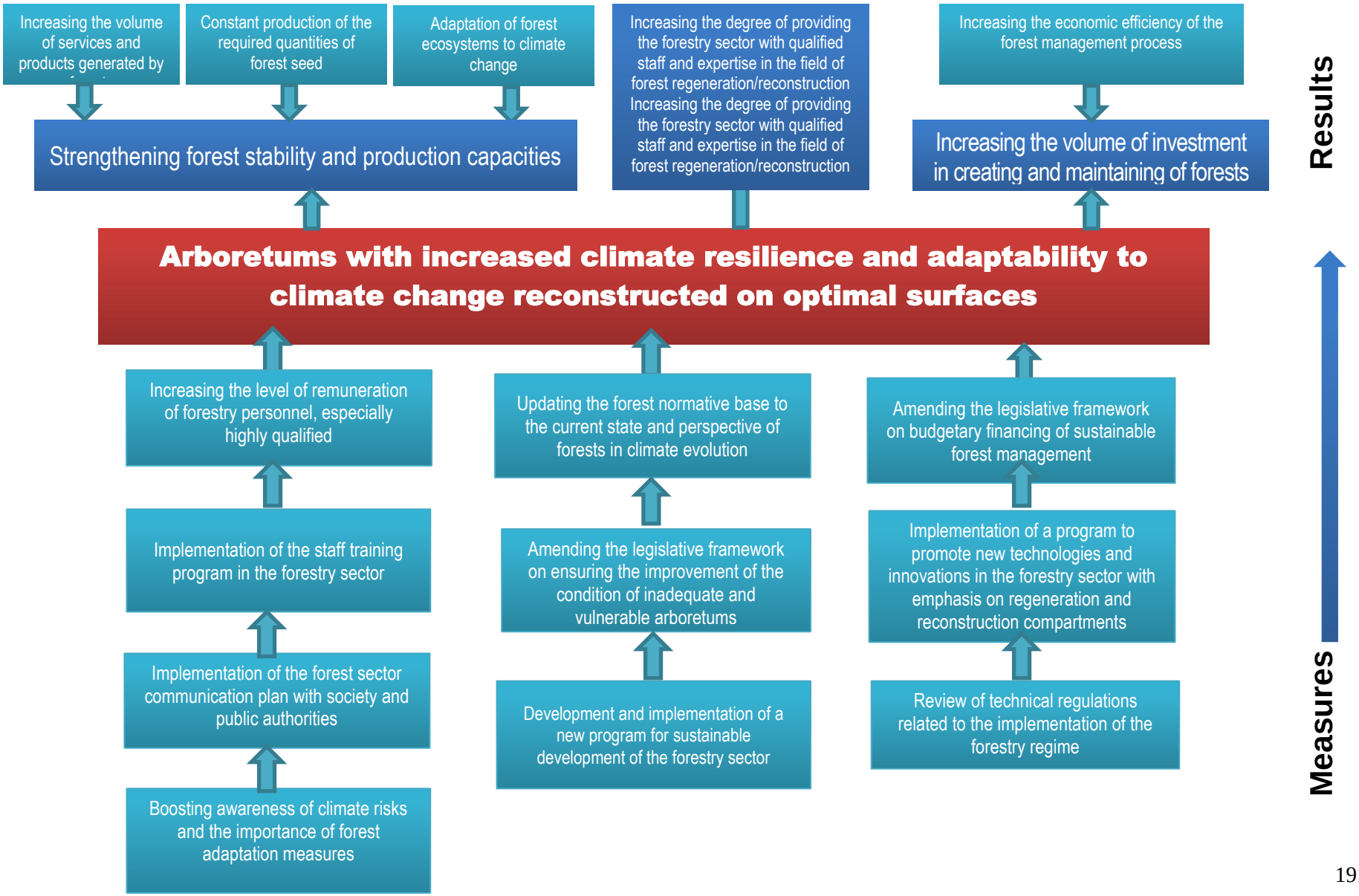


1.3 Problem tree for technology "Identifying interactions related to climate change, forest species and appropriate forest ecosystem management strategies"

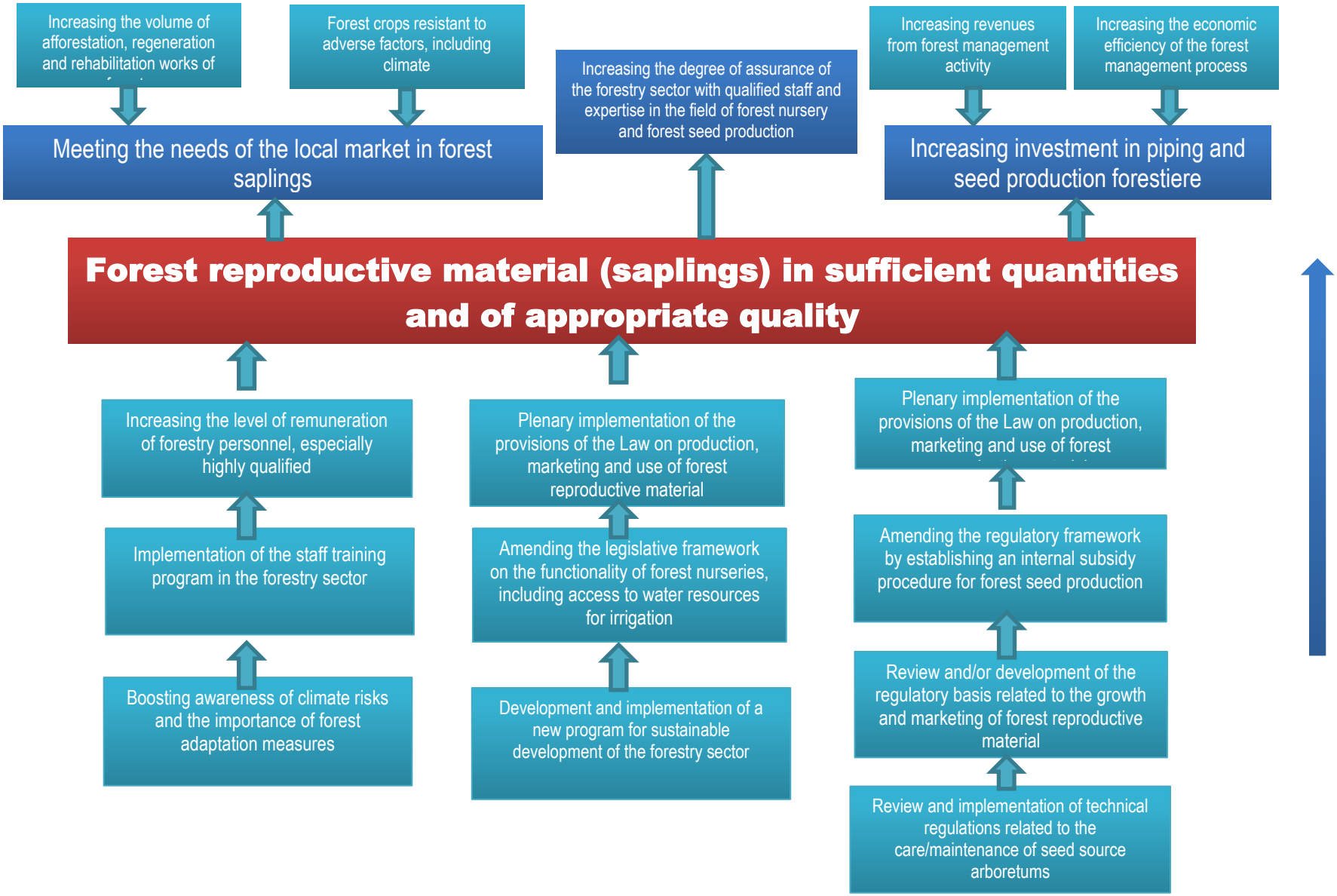


Annex 2: Objective trees on technologies selected for the forestry sector

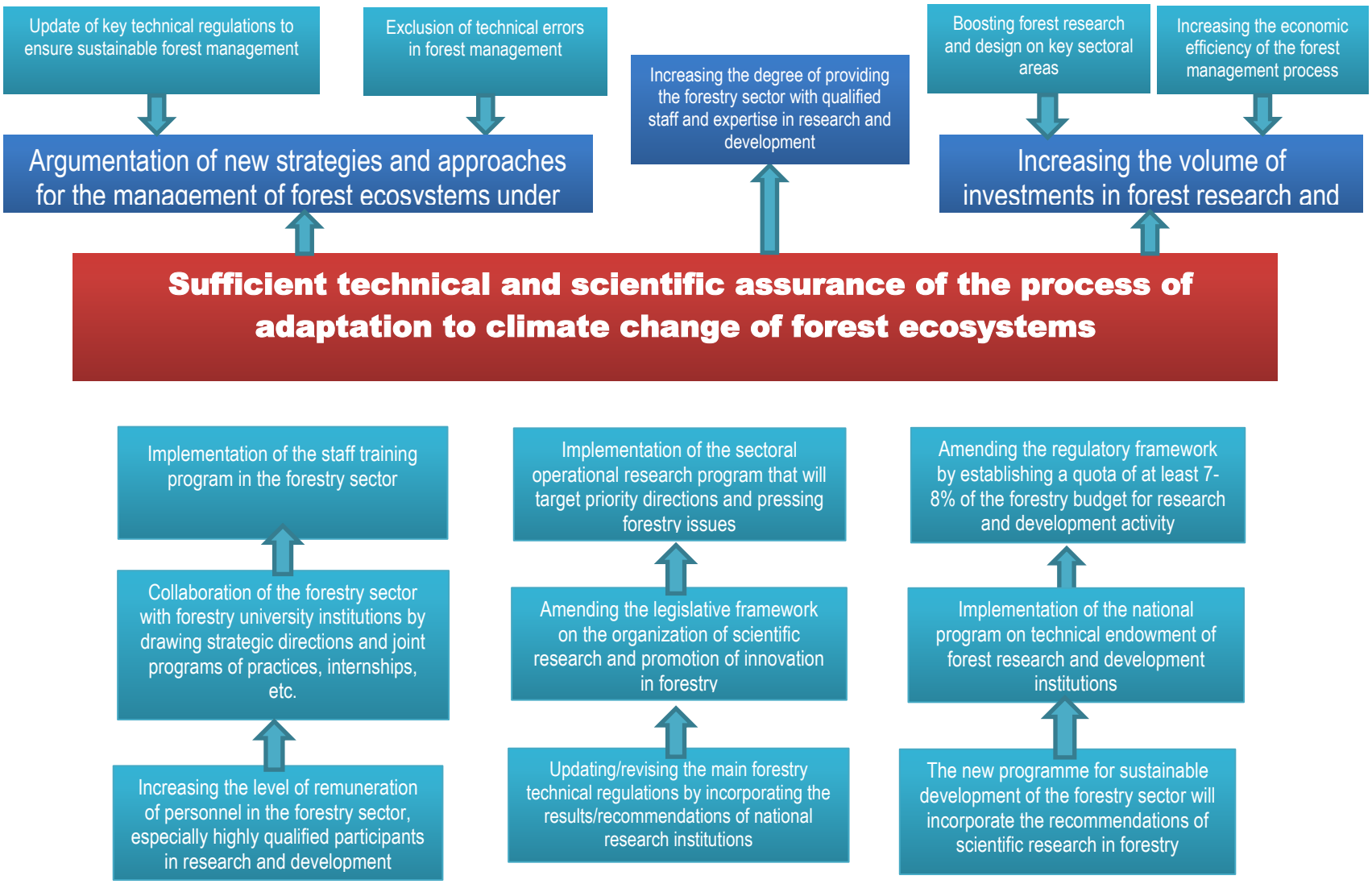
2.1 Tree of objectives for the technology "Ecological restoration of inadequate and vulnerable arboretums for the purpose of adapting to climate change"



2.2 Tree of objectives for the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions"



2.3 Tree of objectives for technology "Identification of climate change-related interactions, forest species and appropriate forest ecosystem management strategies"



Annex 3: List of SWG members on forestry sector for prioritization of climate change adaptation technologies/measures

List of SWG members by forestry sector depending on stakeholders

Nr. d/o	Institution	Delegates personal in SWG
1.	Ministry of Environment	Dumitru Gorelco, Head of Biodiversity Policy Directorate of MoEnv as second focal point, contact phone 022 204 511, e-mail: dumitru.gorelco@mediu.gov.md;
2.	Ministry of Environment	Ala Rotaru, Senior Consultant in the Biodiversity Policy Directorate of MoEnv, as primary focal point, contact phone: 022 204 537, e-mail: ala.rotaru@madrm.gov.md; ala.rotaru@yahoo.com;
3.	Agency „Moldsilva"	Petru Rotaru, Head of Forest Fund, Protected Areas and Forest Regeneration Department, e-mail: petru.rotaru58@gmail.com;
4.	Agency „Moldsilva"	Dr. Victoria Covali, Deputy Head of Forest Fund, Protected Areas and Forest Regeneration Directorate, e-mail: covali.victoria@moldsilva.gov.md;
5.	Silvocinegetică Strășeni Enterprise	Sergiu Chihai, chief forestry engineer, contact details: 069500306, e-mail: straseni@moldsilva.gov.md; chihai.maria@yahoo.com;
6.	Codrii Natural/Scientific reserve	Sc Dr biologist Jardan Natalia, vice-director, e-mail: jardan.natalia@gmail.com;
7.	Telenesti Forestry Enterprise	Macari Arcadie, engineer forestry-chef, phone: 079940801; email: arcadie.macari@gmail.com;
8.	Institute for Forest Research and Management (FRMI)	Dr. Valeriu Caisin, deputy scientific director; Contact details: phone: 060102396; email: valeriu.caisin68@gmail.com;
9.	Environment Agency	Raisa Leon, Head of Environmental Policy Implementation Directorate, e-mail: r_leon@am.gov.md; phone: 022 820 788;
10.	Environment Protection Inspectorate	Cristina Gheorghiță, Senior Inspector of the Management, Water Resources and Atmospheric Air Directorate, e-mail: apa@ipm.gov.md; phone: 022 22 69 22;
11.	Environment Protection Inspectorate	Valentina Moisei, Senior Inspector of the Forest Fund Control, Protected Natural Areas and Green Spaces Directorate, phone: 022 24 23 26, moisei@ipm.gov.md;
12.	National Botanical Garden (Institute) „Al. Ciubotaru"	dr. șt. biol. Miron Aliona, deputy director for scientific activity; Contact details: phone.: 079643166; email: aliona_miron@yahoo.com;
13.	Ștefan Vodă District Council	Olesea Bădilă, Head of European Integration and Investment Service within Stefan Voda District Council, contact details:

Nr. d/o	Institution	Delegates personal in SWG
		phone: 0242 22081, 060309667, email: economie.sv@gmail.com;
14.	Ciuciuleni City Hall, Hancesti district	Gheorghe Grigoraș, primar; date de contact: phone: 0600-14076; 0269-33236, 33221; email: apl.ciuciuleni@yahoo.com; grigoras2608@gmail.com;
15.	Ciuciuleni City Hall, Hancesti district	Ion Belei, cadastral engineer; Contact details: phone: 0269-33236, 332238; email: beleiion@mail.ru;
16.	AO Silva Mileniu III	Andrei Cerescu, president; Contact details: phone: 069036806; e-mail: cerescu.andrei@yahoo.com; silvamileniu3@gmail.com;
17.	SE Biotica	Petru Vinari, Communication responsible Specialist, Mob. 068693818, e-mail: vinari@list.ru

TECHNOLOGY ACTION PLANS and PROJECT IDEAS REPORT(3)/TAP

REPORT III. TAP FORESTRY SECTOR

Executive Summary

Technology Action Plans (TAP) for the forestry sector have been developed for technologies that were selected during the first phase of the TNA project and detailed in the Adaptation Technology Needs Assessment Report. The technological selection and prioritization processes were carried out by the national team of experts and the sectoral working group (SWG), which included representatives of governmental organizations/institutions, academics, local public authorities and the associative sector. As part of the next phase, an extensive analysis of barriers and the enabling framework for the development of technologies and their subsequent dissemination was carried out.

Climate change greatly affects forest ecosystems and associated biological diversity in the Republic of Moldova. Changes in climate patterns, including temperature rise, changes in precipitation, etc., pose a threat to the state of native forest ecosystems, causing a wide range of adverse effects, causing risks and vulnerabilities. The development and maintenance of compositionally diversified forests adapted to climate change is a significant challenge in the Republic of Moldova, especially in the South, and will require urgent research measures in the field of species selection, adaptive provenances and genotypic studies of native species.

The scarcity of forest resources, the current state and productivity of forest ecosystems is a major limiting factor. The productivity of forest ecosystems can be improved by applying appropriate forest management practices, suggesting that forests could store more carbon. Current results show that the most promising management practices in terms of increasing carbon stocks are afforestation and reforestation/rehabilitation/reconstruction activities.

The review of national policy priorities, legislation and regulatory framework shows that adaptation to climate change is not yet a national priority, as the country faces numerous other challenges. In addition, adaptation policies are considered to be secondary to mitigation. At the same time, effective adaptation policies and strategies are also essential for the long-term development of forestry to ensure the availability of resources and ecosystem services essential for economic development and societal well-being. At the same time, the national policy framework in force on technological innovations and climate change sets objectives and measures to address climate change, in the light of international documents ratified or adopted by the Republic of Moldova.

For the national forestry sector, within the previous phases of the TNA process, 3 technologies considered with the greatest impact on the adaptation potential of the national forestry sector and the technology transfer and diffusion capacity were selected. In this context, TAPs have been developed for the following technologies:

- Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change.
- The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions.
- Considerations on climate change impacts, forest species and appropriate forest ecosystem management strategies.

The actions, activities, time periods defined for implementation, as well as key risks in the implementation of TAP are described in the Generalization Table in this Summary, but also in the corresponding chapters dedicated to each technology. All actions selected for TAP on each technology are necessary and feasible for developing an environment that allows achieving the specified target for each technology. At the same time, actions that were recommended as project ideas were selected under each TAP and are considered to bring important effects for the further development and adoption of the technology. Thus, the specified project ideas trigger a "significant change" in the development of related technology and support it to grow on a large scale.

The technology "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change" provides for the application of ecological restoration practices on a total area of 25.0 thousand ha for degraded and inappropriate arboretums or about 21% of the current ecological restoration needs (substitutions, restorations) of degraded/inadequate arboretums managed by Agency "Moldsilva". As a pilot project for this technology, it is proposed to implement actions related to capacity development/consolidation, compiled with a piloting component of the action aimed at directly carrying out ecological restoration works of inadequate and vulnerable arboretums, which would include up to 5% of the volume established in the technology (about 1250 ha). The creation of new sectoral capacities will focus on the establishment of 3 regional mechanized centers for carrying out ecological restoration works (North, Center, South). Those centers may be established as subdivisions within existing forestry entities with experience in forest improvement.

The technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in the new climatic conditions" provides for the adaptation of the subsector of production of forest reproductive material to the evolution of climate change through activities to strengthen and modernize the process throughout the production chain: Identification, legalization and care/maintenance of seed source arboretums (including forest genetic resources); harvesting, processing and certification of forest seed; industrial breeding and valorization of forest reproductive material, etc. The technology includes the establishment and commissioning of some basic elements of the subsector for the production of forest reproductive material: The creation of 3 regional centers for industrial breeding of forest reproductive material (RCIBFRM/NCFGS) usable in the new climatic conditions. As basic tasks/activities of RCIBFRM/NCFGS, it is foreseen the management of the seed base (arboretums, seed sources and FGR, etc.), the production of about 65-70 million seedlings annually (including about 20-30% with protected roots) or about 80-90% of the sectoral needs in case of implementation of extensive afforestation/reforestation/reconstruction/rehabilitation programmes.

The technology "Climate change impact considerations, forest species and adequate forest ecosystem management strategies" provides for the creation of a modern infrastructure for forest research and development, initiation/implementation of substantiation programs on the adaptive capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature-based solutions (NBS), as well as developing new solutions/approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change; promoting sustainable forest management practices under climate change conditions.

Ambition	Actions	Necessary activities to implement	Period	Risks
I. Technology "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change"				
Ecological restoration by substitution/ restor	1. Creation of new sectoral capacities to carry out ecological restoration works	1.1. Elaboration of project documentation for the establishment of 3 entities specialized in ecological restoration of forests	2023-2024	- Shortage on the local market of operators/institutions specialized in forest design, production and/or delivery of specialized equipment for silvotechnical works. - Deviating the policy framework from key priorities in the activity of the forestry sector. - Increasing the budget deficit and the impossibility of financial support for the forestry sector. - Limited capacities of qualified personnel (design, silvotechnical operations, etc.). - Poor experience in communicating with society and public authorities. - Limited capacities to produce reproductive forest material for forest regeneration/ecological restoration works. - Natural disasters affecting the condition of new arboretums created as a result of reconstruction/rehabilitation activities (droughts, floods, etc.). - Limited capacities to ensure the integrity of rehabilitated arboretums (fires, grazing animals, illegal logging, etc.).
		1.2. Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers/RCEFR), endowment with special equipment and equipment for the assigned functions	2023-2025	
		1.3. Recruitment and upskilling of staff for ecological restoration centers	2023-2024	
	2. Update of the normative/ legislative framework regarding the technical and financial assurance of forest management	2.1. Revision of the Law on public finances and budgetary-fiscal responsibility to ensure sustainable management of forest resources in public ownership (state; ATU)	2023	
		2.2. Revision of the Forest Code on technical criteria and economic stimulation of activity to improve the condition and productivity of forests	2023	
		2.3. Development of technical aspects regarding forest management financing and economic stimulation of forest improvement activity through secondary legislation (GD; regulations, etc.)	2023-2024	
		2.4. Review of forestry technical regulations in terms of ensuring timely interventions in the condition and development of arboretums, including the	2023-2025	

Ambition	Actions	Necessary activities to implement	Period	Risks
ation of inadequate arboretums vulnerable to clima		care/maintenance of seed source arboretums		
	3. Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions	3.1. Development and implementation of the operational program for continuous improvement of forestry personnel on key areas	2023-2030	
		3.2. Review and improvement of the regulatory framework on labour remuneration in the forestry sector	2023-2024	
		3.3. Development and implementation of a sectoral programme/action plan on promoting new technologies and innovations	2023-2027	
	4. Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption	4.1. Development and implementation of a communication plan of the forestry sector with society and public authorities	2023-2024	
		4.2. Review of the internal regulatory framework for liquidation of conflicts of interest/functional overlaps in the process of technological activity and amplification of corruption prevention activities in the forestry sector	2023-2027	
	5. Design of works and interventions for the ecological restoration of inadequate arboretums	5.1. Evaluation of available arboretums and technical materials with priority of arboretums to be completed with ecological restoration works (25 thousand ha)	2023-2024	
		5.2. Elaboration of technical projects for ecological restoration of arboretums (estimated 85 projects; 25 thousand ha)	2023-2024	
		5.3. Technical endorsement and public consultation of ecological restoration projects	2023-2026	

Ambition	Actions	Necessary activities to implement	Period	Risks
technical area of 25 thousand ha (21% of current)	6. Implementation of ecological restoration works of inadequate and vulnerable arboretums	6.1. Carrying out the primary phase of ecological restoration works of inadequate and vulnerable arboretums based on technical projects (extraction of pre-existing stand; deforestation; tillage, etc.)	2024-2030	
		6.2. Carrying out phase II of ecological restoration works of inadequate and vulnerable arboretums (planting/care/maintenance of forest crops, etc.)	2024-2030	
	7. Monitoring the implementation of technology and works	7.1. Technical supervision of the implementation process of ecological restoration projects of inadequate arboretums vulnerable to climate change	2024-2030	
		7.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	2023-2030	
		7.3. Review and amplify the monitoring activity on the implementation process by the central forestry authority of forest policy documents and regulatory framework (governmental/parliamentary hearings; annual implementation reports, etc.)	2023-2030	

Ambitioned)	Actions	Necessary activities to implement	Period	Risks
II. Technology "Use of modern biotechnologies of propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions"				
Strengthening the institutional framework	1. Creation of new sectoral capacities for industrial growth of forest reproductive material	1.1. Elaboration of project documentation for the establishment of 3 regional centers for industrial breeding of forest reproductive material, including NCFGS	2023	- Deficit on the local market of forest infrastructure design operators/institutions, delivery of specialized forest nursery technique. - Limited capacities of qualified forestry personnel. - Opposition of forestry entities owning demarcated sectors. - Deviating the policy framework from key priorities in the activity of the forestry sector. - Increasing the budget deficit and the impossibility of financial support for the forestry sector. - Limited capacities to develop the performant regulatory and technical framework. - Limited area of arboretums suitable for seed harvesting. - High periodicity of fruiting years in the main tree species (especially oak stands). - Low interest in business development in the field of production of forest reproductive material. - Low profitability and increased costs of works to maintain fruiting capacities of seed source arboretums. - Natural disasters affecting the condition of arboretums, seed sources and forest nurseries (droughts, floods, etc.).
		1.2. Establishment of 3 regional centers for industrial breeding of forest reproductive material, including NCFGS, endowment with special equipment and equipment for assigned functions	2023-2026	
		1.3. Delimitation and direct management of regional centres for industrial rearing of forest reproductive material (including NCFGS), seed source arboretums and those established as FRG;	2023-2024	
		1.4. Recruitment and upskilling of personnel for industrial breeding centres for forest reproductive material	2023-2024	
	2. Updating the normative/legislative framework to ensure timely and constant production of forest reproductive material	2.1. Supplementing the Water Law (no. 272/2011) with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources	2023-2024	
		2.2. Supplementing the Forestry Code (no. 887/1996) with provisions that would target particularities regarding the functionality of forest nurseries	2023-2024	

Ambition	Actions	Necessary activities to implement	Period	Risks
rk in the field of reproductive forest material production		2.3. Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production	2024-2025	
		2.4. Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material	2024-2025	
		2.5. Update and completion of the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks	2024-2025	
		2.6. Review of technical regulations related to the care/maintenance of seed source arboretums, especially in terms of ensuring constant fruiting	2024-2025	
	3. Strengthening the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions	3.1. Carrying out works to identify new arboretums sources of seeds to ensure needs and create reserves (about 3-5 thousand ha))	2024-2026	
		3.2. Update and implementation of procedures and processes for certification of forest seeds, including for marketing on the international market	2024-2030	
		3.3. Establishment and maintenance of the State Register of Basic Materials	2023-2030	
		3.4. Establishment in maintaining the State Register of Producers of Forest Reproductive Material	2023-2030	

Ambition	Actions	Necessary activities to implement	Period	Risks
uction by establishing NCFGS and 2RCl BFRM; produkti	4. Production of forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction and extension works	4.1. Carrying out works of care/maintenance of arboretums sources of seeds (irrigation, fertilization, etc.);	2025-2030	
		4.2. Industrial harvesting and processing of forest seeds in sufficient quantities (350-400 tons) for the process of forest regeneration/reconstruction and expansion	2025-2030	
		4.3. Industrial growth of seedlings for the process of regeneration/reconstruction and expansion of forests (65-70 million saplings/year, including about 20-30% with protected roots)	2025-2030	
	5. Monitoring the implementation of technology and works	5.1. Technical supervision of the process of growing forest reproductive material (entire production chain: Seeds, seedlings, certification, etc.)	2023-2030	
		5.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	2023-2030	

Ambition	Actions	Necessary activities to implement	Period	Risks
of about 65-70 million seedlings annually (incl ud				

Ambitioning about 20-30% with protected roots);	Actions	Necessary activities to implement	Period	Risks
III. Technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"				
Identif	1. Updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice	1.1. Supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as promoting innovation in forestry	2023-2024	- Deviating the policy framework from key priorities in the activity of the forestry sector. - Increasing the budget deficit and the impossibility of financial support for the forestry sector.

Ambitionoficlimatechange-relatedinteractions,	Actions	Necessary activities to implement	Period	Risks
		1.2.Revision of the normative document regarding the methodology of forest budget formation, including the establishment of a minimum quota of 7-8% for research and development activity	2023-2024	- Limited capacities to develop the performant regulatory and technical framework. - Poor cooperation between R&D institutions. - Limited capacities of competent and highly qualified personnel. - Insufficient collaboration of the forestry sector with research and development institutions. - Low degree of implementation of scientific research results in national forestry practice. - Shortage of operators on the local market specialized in the production and/or delivery of specialized forestry equipment. - Shortage of highly qualified personnel in the field of forest research. - Poor experience in communicating with society and public authorities.
		1.3. Initiation and implementation of a sectoral plan for updating/revising the main technical regulations related to the forestry regime based on the results/recommendations of national research and development institutions	2024-2025	
		1.4. Revision of the regulatory framework on labour remuneration in the forestry sector in order to increase the salary level of highly qualified personnel participating in research and development activities	2023-2024	
	2. Strengthening the capacities of the forestry R&D sector according to the new climatic conditions	2.1. Development and implementation of a sectoral plan on the development of forest research and development infrastructure	2024-2026	
		2.2. Development and implementation of a national program on technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.)	2023-2027	
		2.3. Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and	2023-2028	

Ambition	Actions	Necessary activities to implement	Period	Risks
forest species and appropriate forest ecosystem man		development centers (EFI; IUFRO; EUFORGEN, etc.);		
	3. Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change	3.1. Elaboration and implementation of a consolidated medium-term and strategic sectoral research operational program that would target priority directions and forest issues (migration and/or species succession; forest regeneration; adaptation to climate change, etc.)	2025-2030	
		3.2. Elaboration of a new program for sustainable development of the forestry sector that will incorporate the recommendations of scientific research in forestry	2029-2030	
		3.3. Establishing an effective public information system on the state of forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems (Forest Platform)	2025-2030	
	4. Monitoring the implementation of technology and works	4.1. Technical supervision of the research/design process	2023-2030	
		4.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	2023-2030	

Ambition	Actions	Necessary activities to implement	Period	Risks
agement strategies: Capacities to adaptnative fore				

Ambition	Actions	Necessary activities to implement	Period	Risks
stecosystemstoclimatechange,ecosystembasedapp				

Ambition	Actions	Necessary activities to implement	Period	Risks
roach (EbA) and nature-based solutions (NBS)				

Chapter 1 Action Plan for forest-based adaptation technologies to climate change

1.1 Overview of the forestry sector

The Republic of Moldova is one of the most exposed regions in Europe to drought and aridisation, with a low degree of afforestation – only 11.4% of the territory. The forestry sector is an important economic area of the Republic of Moldova, and climate change greatly affects forest ecosystems and associated biological diversity. Because the Republic of Moldova is located in a region with a high degree of vulnerability and frequently faces heat waves, forest fires, droughts, etc., which are a stressful factor for the health of forest ecosystems.

Forests fulfil multiple protective functions, two of which are directly attributed to climatic aspects. The first is the climatic function, which is manifested by attenuating the thermal, water and wind excessiveness of the climate, as well as by favoring and regulating precipitation throughout the forest compared to the uncovered land. Also included here is the toxic function, which consists of the capacity to generate oxygen through photosynthesis, a process that involves the absorption of carbon dioxide from the atmosphere.

Changes in climate patterns, including temperature rise, changes in precipitation, etc., pose a threat to the state of forest ecosystems in the Republic of Moldova, causing a wide range of adverse effects, causing risks and vulnerabilities, including:

- Changes in species behavior as a result of stress induced by tolerance limits and their ability to adapt;
- Changing the distribution and structure of habitats, as a result of changes in species composition;
- The rise of exotic (introduced) species in current natural habitats and increasing their potential to become invasive (Acer negundo; Ailanthus altissima, etc.);
- Changing the distribution of wetland ecosystems, with their possible limitation and eventual disappearance;
- Changes in natural ecosystems and their species caused by heating and fires, etc.;
- Increasing the vulnerability of forest ecosystems and increasing the number of forest fires;
- Change/worsening of the phytosanitary status of forests;
- Changing species composition in forests;
- Changing types and incidence of forest pests and diseases;
- High mortality rate of forest seeds;
- The disappearance of certain species of flora and fauna.

Climate change certainly leads to increased biotic damage, tree species becoming more susceptible to pest attacks (oak stands, ash, willow, acacia, elm, etc.). The development and maintenance of compositionally diverse and climate-adapted forests is a significant challenge and will require urgent research into species selection, adaptive provenances and genotypic studies of native species.

Various emission scenarios (MM/Climate Change Office, etc.) for the period up to the end of the twenty-first century forecast variations in precipitation predicting a general and gradual downward trend in annual precipitation against the background of rising temperatures and sequential increase in

potential evaporation, varying from one geographical area to another. Trends in changing thermal regime will continue and are likely to correlate with variations in emissions and other climatic phenomena, and forests will be directly or indirectly affected by climate change.

According to calculations made through GHG inventories, it is found that in the Republic of Moldova forest lands have an important share in greenhouse gas sequestration, holding about 62% (2.29 million tons CO^2) of the total volume of removals made by local sources (3.59 million tons CO^2), which largely corresponds to the international trend. A limiting factor in this context is the current state and productivity of forestry ecosystems. The productivity of forest ecosystems can be improved by applying appropriate forest management practices, suggesting that forests could store more carbon. Current results show that the most promising management practices in terms of increasing carbon stocks are afforestation and reforestation/rehabilitation/reconstruction activities. At the same time, forest management should be changed more than has been done so far, if the aim of influencing carbon sequestration is to become paramount. The main measures should be oriented towards the expansion of forest areas, and for existing forests, towards their nature-oriented management: Reduction and/or stabilization of timber harvests, natural regeneration, conservation of fundamental natural arboretums, etc.

The Republic of Moldova has set itself such tasks by adopting a series of policy documents containing integrated measures to address the new conditions created by climate change for the forestry sector. Thus, the national policy framework in force with reference to technological innovations and climate change includes a set of documents that refer, in whole or in part, to forestry, establish objectives and measures in terms of addressing climate change, in the light of international documents ratified or adopted by the Republic of Moldova. For documents with major impact on the capacity of the forestry sector to adapt to climate change, a certain analysis of regulations and the main content in current provisions is carried out (Table 1.1).

Table 1.1: Analysis of regulations and main content in regulatory acts and policy documents related to the forestry sector

Normative acts and policy documents	Main stipulations
Forestry Code, nr. 887/1996	The code establishes the purpose of regulating the sustainable management of the forest fund through rational use, regeneration, guarding and protection of forests, maintaining, preserving and improving forest biological diversity, ensuring with forest resources the current and future needs of society based on their multifunctionality.
Law of the plant kingdom, nr. 239/2007	The law establishes measures to ensure conservation and protection of plant kingdom objects by establishing rules and norms of conservation, protection and regulation of their use.
Law on improvement through afforestation of degraded lands, nr. 1041/2000	The law establishes measures of improvement through afforestation works of degraded lands, regardless of the type of property, which can be carried out in order to protect the soil, restore the hydrological balance and improve environmental conditions. A major result is also the increase in areas covered with forests or other categories of forest vegetation.
Law on areas and strips of protection of rivers and water basins, nr. 440/1995	The law regulates the creation of water protection zones and riparian strips for the protection of rivers and water basins, the regime of their use and protection activity, including the creation and sustainable management of forest plantations.
Law on production, marketing and use of forest reproductive material, nr. 44/2022	The law establishes the legal, economic and organizational bases of production, marketing and use of forest reproductive material on the territory of the Republic of Moldova, as well as quality conditions for the production and/or marketing of forest reproductive material. The document refers to forestry enterprises, natural and legal persons who manifest their intention to produce, market and use forest material for

Normative acts and policy documents	Main stipulations
	forestry purposes. At the same time, the attributions of the specialized central authorities are established, as well as the conditions and requirements for registration of producers of forest material, certification of material, requirements for its marketing, import and export, but also control of producers, suppliers and beneficiaries of forest reproductive material.
GD nr. 618/2007 on the approval of the List of indicators for each criterion of sustainable forest management	According to the list, the criteria for sustainable forest management are as follows: a) maintaining, conserving and improving biological diversity in forests (total 9 indicators, including the indicator on the ratio between stands of native species and introduced species, etc.); b) maintaining forest health and vitality (total 4 indicators, including indicator on the area of forests affected by severe defoliation (main pests: *Lymantria disappear; Tortrix viridana; Operophtera brumata; Erannis defoliaria; Stereonychus fraxini*, etc.); indicator on annual areas of forests and other forest vegetation land affected by fires, etc.); c) maintaining and enhancing forest protection functions (total 2 indicators); d) maintaining and strengthening the productive capacity of forest resources, their contribution to global carbon cycles (total 3 indicators, including the indicator on total carbon stock and its evolution in various stands, etc.); e) maintaining and stimulating the productive functions of forests (total 5 indicators, including the indicator on the change in the share of forest area in the total area of the country/degree of afforestation, etc.); f) maintaining other socio-economic functions and conditions of forests (total 6 indicators).
Sustainable Development Strategy of the Forestry Sector for 2001-2020, HP nr. 350/2001	The document mentions the role of forests as an invaluable source of various benefits through its products and contribution to the development of society, as well as major importance in maintaining ecological balance. The strategy favors the extension of areas covered with forest vegetation by afforestation of degraded lands, affected by landslides, afforestation of riparian strips for the protection of rivers and water basins, creation of green islands of trees and shrubs, corridors of interconnection between forested massifs, etc. (at least 130 thousand ha). As the main impact of the implementation of the document, it is foreseen to increase the forested areas up to 15% of the territory, reduce greenhouse gas emissions, reduce the degree of soil degradation; reducing and stopping landslides, etc. Implementation costs – 345.9 million lei (GD 739/2003).
Environmental Strategy for 2014-2023, GD nr. 301/2014	The strategy specifies that forest resources are strategically important natural resources. Forests play a particular role in maintaining ecological balance, combating desertification and land and soil degradation, preserving biodiversity, protecting landscape, water and river basins, food and energy security, mitigating the impact of climate change, and last but not least, preventing and reducing the risk of natural disasters. Thus, it is necessary, through Specific Objective 6.4: Extension of forest areas up to 15% of the country's territory, of natural areas protected by the state up to 8% of the territory and ensuring efficient and sustainable management of natural ecosystems. At the same time, it is foreseen to improve the quality of at least 50% of surface waters by implementing the river basin management system; restoration of about 150 thousand ha of degraded wetlands, with their inclusion in the economic circuit of the country. The forestry sector (riparian strips; water source protection strips, etc.) must also contribute to this process. The implementation costs are estimated at 83 million lei.
Strategy on biological diversity of the Republic of Moldova for 2015-2020, GD nr. 274/2015	The document contains in specific objective C. Implementation of measures to stop threats to biodiversity, Specific objective 1. Implement measures to halt soil degradation and mitigate the effects of climate change. In Section 3 Direct threats to biological diversity, 1. Climate change, it is stipulated that: "Climate change is a global phenomenon that endangers natural, social and economic systems through their sensitivity and vulnerability to climatic factors." For the purpose of assessing the problem of adaptation of biological resources to climate change. The strategy included actions to elaborate the study on the relationship between ecosystems, biodiversity and the aspect of climate change in the Republic of Moldova and technologies to ensure the adaptability of forest ecosystems to climate change. The implementation costs are estimated at 379.2 million lei for afforestation of riparian strips for protection of rivers

Normative acts and policy documents	Main stipulations
	and water basins; 376.2 million lei for the rehabilitation of forest curtains for the protection of agricultural fields; 338.0 million lei for the creation of forest plantations on degraded lands, promoting native species.
The Strategy of the Republic of Moldova for adaptation to climate change until 2020 and the Action Plan for its implementation, GD nr. 1009/2014	The strategy provides for afforestation of 20 thousand ha of land and creation of green islands, creation/restoration of 3000 ha of forest belts and creation of energy plantations on an area of 5 thousand ha by 2020. The implementation costs are estimated at 500 million lei for land afforestation; 66 million lei for the restoration/creation of forest curtains; 380 million lei for the creation of energy plantations.
The Low Emission Development Strategy of the Republic of Moldova until 2030 and the Action Plan for its implementation, GD nr. 1470/2016	The strategy stipulates the task of 3.8 thousand ha forested annually; 5.9% of the total area (860 000 ha) of degraded land improved by afforestation; 3.6% of the total area of degraded land planted with forest vegetation; 12 000 ha of forest protection curtains planted, 10 thousand ha of energy forestry crops planted. The implementation costs are estimated at 2597 million lei from the state budget, 1621.4 million lei from external assistance.

In the previous phases of the TNA process, the Sectoral Working Group (SWG), through evaluation and voting procedures, selected 3 technologies with the greatest impact on the adaptation potential of the national forestry sector and the capacity for technology transfer and diffusion:

- Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change.
- The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions.
- Considerations on climate change impacts, forest species and appropriate forest ecosystem management strategies.

In this context, it is mentioned that for the forestry sector, priority has been given to technologies aimed at restoring the ecoprotective and bioproductive potential of existing forests, especially degraded and inadequate ones by applying special measures – ecological restoration. It is also established as essential adaptation to the evolution of climate change of the subsector aimed at producing forest reproductive material through activities to strengthen and modernize the process throughout the production chain: Identification, legalization and care/maintenance of seed source arboretums (including seed source arboretums, FRG, etc.); harvesting, processing and certification of forest seed; industrial breeding and valorization of forest reproductive material, etc. The implementation of this technology/measure is a particularly important precondition for restoring the ecoprotective and bioproductive potential of existing forests through reconstruction/regeneration, but also for measures to expand the forest area at the expense of new lands. Both the first two technologies and the entire process of adaptation of the forestry sector to climate change must be supported by an appropriate technical-scientific argumentation. In this context, in order to support and consolidate the results of the first two technologies, it is foreseen to initiate cumulative fundamental research programs with applied components on the adaptive capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature-based solutions (NBS).

These prioritized technologies are relatively known in the Republic of Moldova, but are not implemented for certain technical and financial reasons, except for ecological reconstruction, which is applied in a proportion of 10-15% of the needs and with priority in protected areas. In the previous period, certain measures/technologies were undertaken within the forestry sector aimed at adapting

forest ecosystems to climate change. Due to the available technical and financial resources, but also due to differing visions, the efforts of institutions within the forestry sector (Moldsilva; forestry entities; LPA, etc.) are focused primarily on maintaining a fragile balance, rather than on development and paradigm shift.

In general, digital and innovative technologies are understaffed in the forestry sector. The predominance of labor in the activities of cultivation and use/exploitation of forests is an element that eloquently characterizes the current technological situation in the forestry sector. The forestry sector is to make substantial efforts in the field of computerization and mechanization of some activities, by using existing means or by creating new specific means. At the same time, the Republic of Moldova does not have a National Forest Inventory (NBFI), and the process of collecting data on forests does not correspond exactly to international requirements. Accurate and up-to-date information on the volume, distribution, composition and general condition of forests (both public and private forests) is extremely important for formulating development and monitoring policies, providing assistance and support for sustainable management, as well as complying with national and international reporting commitments.

1.2 Action Plan for the technology "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change"

1.2.1 Introduction

The technology "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change" is selected as the main activity aimed at strengthening the ecoprotective and bioproductive potential of existing natural and/or artificial forests. Because about 1/3 of the arboretums within the forest fund are made up of artificially introduced species, which do not fit into the natural ecosystems of the Republic of Moldova. At the same time, according to estimates, at present about 40% or 120 thousand ha of forests managed by Agency "Moldsilva" have certain degradation elements that affect their capacities to adapt to climate change and require measures of reconstruction/rehabilitation/consolidation.

The rehabilitated forests will constitute arboretums made up of flexible and long-lasting tree and shrub species, resilient/resistant to adverse factors (disease and pest attacks; weather and climate change, etc.). Also, the technology provides for the conversion from the grove regime to the Codru regime, ensuring regeneration from seed, creating stable arboretums capable of adapting to climate change, etc.

Green restoration is a very complex operation and is qualified as an indispensable component of the forest-based sector's adaptation to climate change. The main effects/benefits of the implementation of those operations being:

a) Environmental benefits:
   - Conversion from the grove regime to the Codru regime, ensuring regeneration from seed, creating long-lasting arboretums capable of adapting to climate change.

- Taking a decisive step in the conservation of biological diversity, forest vegetation providing refuge and habitats for various species of plants and wild animals endangered by anthropogenic impact.
- Diminishing soil degradation processes through erosion, landslides, etc.
- Qualitative improvement of aquatic resources, forest vegetation contributing to efficient groundwater supply, reduction of solid flow and concentration of pollutants.
- Reducing pollution of the atmosphere by capturing carbon dioxide and various pollutants that endanger human health and the vitality of biological ecosystems, ensuring the increase of carbon capture capacities by the targeted arboretums by 40-50%, making the most of the available stationary potential.

b) Socio-economic benefits:
   - Increasing the potential of products and services of rehabilitated forests (wood, medicinal plants, berries, etc.).
   - Increasing revenues in the state budget, local budgets and for the population, especially in rural areas (estimated about EUR 2.0 million annually: Marketing of wood mass (about 70%) harvested in the process of sustainable management of rehabilitated forests, services and non-wood products (about 30%: Berries, medicinal plants, hunting, beekeeping, recreation, carbon sequestration, etc.).
   - Creation of new jobs, estimated about 6250 people (afforestation/reforestation works; forest exploitation; wood processing and marketing; collection and marketing of non-wood products of the forest, handicrafts, etc.).

c) Capacity building, technology transfer and diffusion:
   - Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management, innovative technical solutions for ecological restoration of degraded and inadequate arboretums, forest management in a sustainable manner and in accordance with new climatic conditions.
   - Achieving a wide range of transfer and dissemination of existing and new technologies in the forestry sector in the Republic of Moldova (digital technologies (including GIS/GPS); innovative technical solutions for substitution of inappropriate species and arboretums; carbon monitoring; planting seedlings with protected roots, etc.).

Technology does not affect gender equality. Women are widely involved in the implementation process in most stages and activities: Harvesting forest seeds; growing seedlings in forestry nurseries; planting seedlings; care and maintenance of forestry crops; harvesting non-wood products (fruits, berries, medicinal plants), etc. Also, the wood production harvested as a secondary result of the works contributes to improving living conditions and domestic comfort in neighboring localities. The degree of direct involvement in technology is estimated at 60% men and 40% women.

1.2.2 Ambition for TAP

For the forest-based sector, objectives and actions aimed at adapting to climate change include scientifically justified adaptation measures with clear mitigation co-benefits and approaches to sustainable development, maintenance and adequate monitoring of forest condition, with intensification of afforestation/reforestation process through the use of climate-resilient tree and shrub species. At the same time, for the current prioritized technology, as preliminary objectives and targets (phase I), the ecological reconstruction of inadequate and vulnerable arboretums for adaptation to

climate change is provided – substitution/restoration of degraded, totally derived arboretums, inappropriate to stationary conditions, poorly productive, etc.; testing and adjustment of ecological forest restoration technologies/approaches; reviewing technical regulations dedicated to ecological restoration; exchange of experience at national and international level, etc.

The technology provides for the application of ecological restoration practices on a total area of 25.0 thousand ha for degraded and inappropriate arboretums or about 21% of the current ecological restoration needs (substitutions, restorations) of degraded/inadequate arboretums managed by the Agency "Moldsilva". The value of the investment in this technology will be estimated EUR 50.0 million for an implementation period of 8 years.

For the next stages, the ecological restoration works of inadequate and vulnerable arboretums in order to adapt to climate change must cover at least 95.0 thousand ha of forests managed by the Agency "Moldsilva". Also, during the next stages, it is considered appropriate to include under ecological restoration works the inadequate and vulnerable arboretums under the management of the administrative-territorial units (ATU) of level I (mayoralties), the estimated reserve is about 15-20 thousand ha.

As specific objectives pursued within the implementation of technology, the following are established:

- Creating new sectoral capacities to carry out ecological restoration works.
- Updating the normative/legislative framework regarding the technical and financial assurance of forest management.
- Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions.
- Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption.
- Implementation of works and interventions for ecological restoration of inadequate and vulnerable arboretums based on technically substantiated decisions.

1.2.3 Actions and activities selected for inclusion in TAP

1.2.3.1 Summary of barriers and measures to overcome barriers

During the barrier assessment exercise for the technology "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change", 17 barriers and/or needs were identified and described. As a fundamental cause of the problem was identified the presence of excessive areas of inadequate arboretums vulnerable to climate change in forests managed by Agency "Moldsilva" (about 40% or 120 thousand ha), and their rehabilitation representing complicated, laborious and expensive technical solutions, consequently, LOW's interest in technology. The main barriers to be addressed in the process of assessing the transfer of current technology relate to different areas related directly or indirectly and are quite complex. An essential part of these barriers is a consequence of the natural conditions (soils, resorts, hydrology, etc.), in which an important part of new forests have been artificially created over the last 50-70 years. Others relate to limited institutional and personnel capacities in forestry, lack of public and private investment, etc. Financial barriers are also due to the perception of the forestry sector at the level of political decision-making (Government, Parliament) in

terms of its overall contribution to GDP, which is low and varies within the limits of 0.2-0.3%. Finally, these barriers or needs seriously affect the activity of the national forestry sector, essentially diminishing sectoral intervention capacities for the purpose of ecological reconstruction of unsuitable arboretums. The main categories of barriers to the transfer of this technology and their characterization aspects are set out in Table 1.2.

Table 1.2: Key barriers to technology transfer "Ecological restoration of inadequate and vulnerable arboretums for adaptation to climate change"

Nr. d/o	Key barriers	Detailed aspects of barriers
1.	Funding gap for activities to maintain, improve/rehabilitate the condition of existing forests	The funds allocated annually in the state budget for forest management constitute only about 2-3% of the budget of the state forestry sector, the rest have their own revenues from commercial activity. For activities to improve/restore the condition of existing forests, the principle of 'residual financing' applies. The LPA and private forestry sectors are outside state support.
2.	Weak technical capacities and facilities in the field of forest regeneration and reconstruction	The forestry sector is provided with technology and equipment for technological processes in a proportion of about 20-30%. Most works/operations are performed by primary labor and/or mechanization.
3.	Low implementation of new technologies in forest regeneration and reconstruction	Most of the existing technical facilities in the forestry sector are morally and physically obsolete, with a period of use of over 20 years. The forestry sector lacks an operational programme to promote new technologies and innovations.
4.	Reduced capacity of degraded and unsuitable stands to regenerate and adapt to climate change	Due to functional parameters (phytosanitary status; regeneration mode; productivity; consistency, etc.), degraded and improper stands bear fruit much less often than normal stands. Abnormal drying processes due to climatic factors mostly take place in degraded and improper stands.
5.	Shortage of personnel and expertise in the field of regeneration and ecological reconstruction of inadequate and vulnerable stands	Forest design institutions, but also forest management institutions (territorial forestry entities) are facing the shortage of qualified personnel specialized in forest regeneration/reconstruction. The spectrum of forestry experts specialized in forecasts and modelling related to the evolution of forest status under climate change conditions is very limited.
6.	Low degree of updating and implementation of forest policy documents and regulatory framework, including climate developments	Most forest policy documents adopted over the last two decades have an implementation rate of 50-70%, without ensuring a decisive qualitative and quantitative leap. An important part of the provisions of the forest regulatory framework remain (regeneration of forests from seed; forest planning of all forests, regardless of departmental affiliation and ownership, etc.) at the level of "good intention", without practical implementation. Technical regulations also require profound updates to cover the full spectrum of measures to adapt forests depending on climate risks.

Financial barriers, although relatively significant for the technology in question, can also be overcome by capitalizing on internal reserves by covering about 30-40% of the costs of the works from the revenues obtained as a result of carrying out the initial phase of the reconstruction works – extraction/exploitation of the pre-existing stand. In total, 19 activities were identified as measures aimed at overcoming barriers (except for insignificant ones) and ensuring the transfer of technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change". Most of them relate to the following categories:

- Review and completion of the existing regulatory framework (Forestry Code; Law on public finances and budgetary-fiscal responsibility, etc.) and development of technical aspects through secondary legislation (increasing the public financial contribution to forest management; increasing the level of remuneration of forest staff; directions for sustainable

forest development; choosing and applying forestry treatments; forest regeneration and expansion, etc.).

- Development and implementation of new sectoral programs/plans for the development of technical and institutional capacities (improvement of communication frameworks and capacities; combating corruption and conflicts of interest in technological processes; development of forest design capacities; cooperation with university and technical vocational education institutions; promotion of research, innovation and new technologies; creation of capacities to carry out ecological restoration, etc.).

1.2.3.2 Activities identified for the implementation of selected actions

As a result of detailed analyses carried out at the previous stages on aspects related to the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change", a complex of actions aimed at implementing this technology was developed. Thus, in order to overcome the 17 barriers and/or needs, 19 measures were identified to overcome the barriers (except for the insignificant ones) and ensure the transfer of the technology "Ecological restoration of inadequate and vulnerable stands for the purpose of adapting to climate change". In the current process, for the technology concerned, important measures/activities have been selected and consolidated into 7 major actions (Table 1.3). At the same time, other activities specific to actions that are considered to contribute essentially to the implementation of technology have been developed. In this context, the activities (20 activities) are established as concrete measures for the implementation of the actions/objectives of the technology, based also on the purpose of gradually overcoming the identified barriers to the transfer of that technology.

Table 1.3: Actions and activities aimed at implementing the technology "Ecological restoration of unsuitable and vulnerable stands for adaptation to climate change"

Name of share	Necessary activities to implement
1. Creation of new sectoral capacities to carry out ecological restoration works	1.1. Elaboration of project documentation for the establishment of 3 entities specialized in ecological restoration of forests (location; primary infrastructure; staff provision; technical equipment, etc.)
	1.2. Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers), endowment with special equipment and equipment for assigned functions (extraction of pre-existing stand; deforestation; tillage, care/maintenance of forest crops, etc.)
	1.3. Recruitment and upskilling of staff for ecological restoration centers
2. Update of the normative/legislative framework regarding the technical and financial assurance of forest management	2.1. Revision of the Law on public finances and budgetary-fiscal responsibility to ensure sustainable management of forest resources in public ownership (state; ATU)
	2.2. Revision of the Forest Code regarding technical criteria and economic stimulation of the activity of improving the condition and productivity of forests, as well as directions of sustainable forest development
	2.3. Development of technical aspects regarding forest management financing and economic stimulation of forest improvement activity through secondary legislation (GD; regulations, etc.)
	2.4. Review of technical regulations in the forestry field (forest planning; choice and application of forest treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of arboretums, including the care/maintenance of seed source arboretums
3. Strengthening the capacities of "Moldsilva"	3.1. Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; forest

Name of share	Necessary activities to implement
Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions	extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.)
	3.2. Review and improvement of the regulatory framework on labor remuneration in the forestry sector
	3.3. Development and implementation of a sectoral programme/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.)
4. Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption	4.1. Development and implementation of a communication plan of the forestry sector with society and public authorities
	4.2. Review of the internal regulatory framework for liquidation of conflicts of interest/functional overlaps in the process of technological activity and amplification of corruption prevention activities in the forestry sector
5. Design of works and interventions for the ecological restoration of inadequate stands	5.1. Assessment of available stands and technical materials with prioritization of stands inadequate and vulnerable to climate change necessary to be undertaken with ecological restoration works
	5.2. Elaboration of technical projects for ecological restoration of inadequate stands vulnerable to climate change (estimated 85 projects)
	5.3. Technical endorsement and public consultation of projects for the ecological restoration of unsuitable stands vulnerable to climate change
6. Implementation of ecological restoration works of inadequate and vulnerable stands	6.1. Carrying out the primary phase of ecological restoration works of inadequate and vulnerable stands based on technical projects (extraction of pre-existing stand; deforestation; tillage, etc.)
	6.2. Carrying out phase II of ecological restoration works of inadequate and vulnerable stands (planting/care/maintenance of forest crops, etc.)
7. Monitoring the implementation of technology and works	7.1. Technical supervision of the implementation process of ecological restoration projects of inadequate stands vulnerable to climate change
	7.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes
	7.3. Review and amplify the monitoring activity on the implementation process by the central forestry authority of forest policy documents and regulatory framework (governmental/parliamentary hearings; annual implementation reports, etc.)

The technology implementation process starts with activities aimed at creating and strengthening new sectoral capacities to carry out ecological restoration works (design; infrastructure creation; technical equipment; staff recruitment and training, etc.). In parallel with the activities of creating and strengthening capacities in the field of ecological reconstruction, activities aimed at updating the normative/legislative framework on financial assurance of forest management (Law on public finances and budgetary-fiscal responsibility; Forestry Code, etc.), which will require the massive involvement of experts in the budgetary-fiscal, forestry and legal fields.

Another important aspect necessary to be solved at the initial stage of technology implementation is the revision of the technical regulations related to the implementation of the forestry regime in terms of ensuring timely interventions in the condition and development of stands (choosing and applying forestry treatments; carrying out care and management works; regeneration and expansion of forests, etc.), which will contribute to the essential diminution of the area of potentially degraded stands and inadequate, maintaining the stability and adaptation of forest ecosystems to climate change, etc. The implementation of ecological restoration works of inadequate and vulnerable stands will be carried out based on extensive technical design activities, and the entire process of technology implementation will be ensured with monitoring and evaluation activities, with the elaboration of appropriate reports and informative notes. Further details on the actions and activities identified for the implementation

of the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change" are set out in paragraph 1.2.7 (Overview table of TAP for ecological restoration of unsuitable and vulnerable stands for adaptation to climate change) to this Report.

1.2.4 Stakeholders and timeline for TAP implementation

The implementation of the technology will be carried out by Agency "Moldsilva" (including territorial entities) with the participation of structures within MoEnv (DFM; DPASC; DPDB; IEP, etc.), companies and private individuals. The technical and scientific aspects will be ensured by the specialized institutions: FRMI, NBG, etc. For certain actions and activities, the implementation will be carried out with the participation of the competent structures within the Ministry of Finance (budgetary-fiscal responsibilities for ensuring sustainable management of forest resources in public property), MECR (staff training and improvement; promotion of new technologies and innovations; communication of the forestry sector with society and public authorities, etc.), MoEnv (budgetary-fiscal responsibilities for ensuring sustainable management of forest resources). publicly owned forest resources; improving the regulatory framework on labor remuneration in the forestry sector, etc.), MMPS (improving the regulatory framework on labor remuneration in the forestry sector), NAC (liquidation of conflicts of interest/functional overlaps in the process of technological activity and amplification of corruption prevention activities in the forestry sector), private sector (SME – harvesting and processing of wood/non-wood products; planting and caring for forestry crops; harvesting of non-wood products of the forest; transport and logistics services, etc.) and civil society (NGO – expertise, communication, training, etc.). The total implementation period of the technology will be 8 years (Table 1.4).

Table 1.4: Stakeholder analysis by implementation activities for the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change"

Actions/components	Activities required to implement	Institutions/structures involved	Period
1. Creation of new sectoral capacities to carry out ecological restoration works	1.1. Elaboration of project documentation for the establishment of 3 entities specialized in ecological restoration of forests (location; primary infrastructure; staff provision; technical equipment, etc.)	ME, Moldsilva, design institutions, FRMI, NBG	2023
	1.2. Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers), endowment with special equipment and equipment for assigned functions (extraction of pre-existing stand; deforestation; tillage, planting/care/maintenance of forestry crops, etc.)	ME, MF, ME, Moldsilva, FRMI, NBG	2023-2025
	1.3. Recruitment and upskilling of staff for ecological restoration centers	ME, Moldsilva, FRMI, LPA	2023-2024
2. Update of the normative/legislative framework regarding the technical and financial assurance of forest management	2.1. Revision of the Law on public finances and budgetary-fiscal responsibility to ensure sustainable management of forest resources in public ownership (state; ATU)	ME (DFM, DPASC, DPDB), MF, ME, Moldsilva, LPA, CALM, FRMI	2023
	2.2. Revision of the Forest Code regarding technical criteria and economic stimulation of the activity of improving the condition and productivity of forests, as well as directions of sustainable forest development	ME (DFM, DPASC, DPDB), MF, ME, Moldsilva, LPA, CALM, FRMI	2023
	2.3. Development of technical aspects regarding forest management financing and economic stimulation of	ME (DFM, DPASC, DPDB), MF, ME,	2023-2024

Actions/components	Activities required to implement	Institutions/structures involved	Period
	forest improvement activity through secondary legislation (GD; regulations)	Moldsilva, LPA, CALM, FRMI	
	2.4. Review of technical regulations in the forestry field (forest planning; choice and application of forest treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of stands, including the care/maintenance of seed source stands	ME (DPASC, DPDB), MECR, Moldsilva, FRMI, NBG	2023-2025
3. Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions	3.1. Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; extension /regeneration/econstruction of forests; forest planning; migration/species succession; climate modelling, etc.)	ME (DFM, DPASC, DPDB), MECR, Moldsilva, NBG, FRMI, NGO	2023-2030
	3.2. Review and improvement of the regulatory framework on labor remuneration in the forestry sector	MoEnv, MMPS, ME, MECR, Moldsilva, NBG, FRMI	2023-2024
	3.3. Development and implementation of a sectoral programme/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.)	ME, MECR, Moldsilva, NBG, FRMI	2023-2030
4. Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption	4.1. Development and implementation of a communication plan of the forestry sector with society and public authorities	ME, Moldsilva, LPA, CALM, FRMI, NBG; NGO	2023-2030
	4.2. Review of the internal regulatory framework for liquidation of conflicts of interest/functional overlaps in the process of technological activity and amplification of corruption prevention activities in the forestry sector	ME, Moldsilva, NAC	2023-2026
5. Design of works and interventions for the ecological restoration of inadequate stands	5.1. Assessment of available stands and technical materials with prioritization of stands inadequate and vulnerable to climate change necessary to be undertaken with ecological restoration works	ME, Moldsilva, FRMI, NBG	2023-2024
	5.2. Elaboration of technical projects for ecological restoration of inadequate stands vulnerable to climate change (estimated 15 projects)	ME, Moldsilva, FRMI, NBG	2023-2024
	5.3. Technical endorsement and public consultation of projects for the ecological restoration of unsuitable stands vulnerable to climate change	ME, Moldsilva, FRMI, NBG	2023-2026
6. Implementation of ecological restoration works of inadequate and vulnerable stands	6.1. Carrying out the primary phase of ecological restoration works of inadequate and vulnerable stands based on technical projects (extraction of pre-existing stand; deforestation; tillage, etc.)	ME, Moldsilva, FRMI, NBG; SME	2024-2030
	6.2. Carrying out phase II of ecological restoration works of inadequate and vulnerable stands (planting/care/maintenance of forest crops, etc.)	ME, Moldsilva, FRMI, NBG; SME	2024-2030
7. Monitoring the implementation of technology and works	7.1. Technical supervision of the implementation process of ecological restoration projects of inadequate stands vulnerable to climate change	ME, Moldsilva, FRMI, NBG; NGO	2024-2030
	7.2. Monitoring and evaluation of the project implementation process, elaboration of reports and informative notes	ME, Moldsilva, FRMI, NBG; NGO	2023-2030

Actions/components	Activities required to implement	Institutions/structures involved	Period
	7.3. Review and amplify the monitoring activity on the implementation process by the central forestry authority of forest policy documents and regulatory framework (governmental/parliamentary hearings; annual implementation reports, etc.)	ME, Govern, State Chancellery, Parliament, Moldsilva	2023-2030

For direct implementation, the mechanisms established by the legislation in the field will be used (Forest Code; Rules for the release of standing timber in forests (GD 740/2003); Technical rules for ecological restoration of forests, etc.). Technology activities include exchange of experience between national institutions involved in the process, but also with similar institutions in neighboring countries (Romania, Ukraine, etc.). The technology will facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within LPAs and privately (harvesting and processing wood/non-wood products; planting and caring for forestry crops; harvesting non-wood forest products; transport and logistics services, etc.).

1.2.5 Estimate of resources needed for actions and activities

The estimated value of the financial resources needed for actions aimed at implementing the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change" is 57195.0 thousand Euro or an annual average of about 7150 thousand Euro (Table 1.5). The estimated cost per operational unit (ha) will be 2288 Euro/ha. At the same time, it is mentioned that about 30-40% of the investment can be insured/recovered from the income obtained by forestry entities from the sale of wood harvested at the initial stage of ecological reconstruction works.

Due to the current state in the forestry sector (shortage of highly qualified personnel; shortage of modern equipment and equipment, etc.), the technology implementation process must start with extensive capacity building activities (institutional; personnel; technical equipment; creation/rehabilitation of forest infrastructure, etc.) to facilitate the implementation of ecological restoration works (actions 1-4). Thus, for technology-related capacity building activities, financial means in the amount of 6740 thousand Euro or 11.8% of the total investment value for the technology in question are required.

Table 1.5: Resources needed for actions aimed at implementing the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change"

Name of share	Implementation period	Action budget, thousand Euro	Percentage, %
1. Creation of new sectoral capacities to carry out ecological restoration works	Year 1-Year 3	2835,0	5,0
2. Update of the normative/legislative framework regarding the technical and financial assurance of sustainable forest management	Year 1-Year 3	65,0	0,1
3. Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions	Year 1-Year 8	3610,0	6,3
4. Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption	Year 1-Year 5	230,0	0,4
5. Design of works and interventions for the ecological restoration of inadequate stands	Year 1-Year 4	215,0	0,4

Name of share	Implementation period	Action budget, thousand Euro	Percentage, %
6. Implementation of ecological restoration works of inadequate and vulnerable stands	Year 2-Year 8	50000,0	87,4
7. Monitoring the implementation of technology and works	Year 1-Year 8	240,0	0,4
TOTAL		57195,0	100,0

To ensure success, investments in capacity development/building must be made/capitalized on as a priority during the first 3 years. In this context, new sectoral capacities will be created to carry out ecological restoration works through the establishment of 3 regional centers (design; infrastructure creation; technical equipment; staff recruitment and training, etc.). These centers can be established as subdivisions within existing forestry entities with experience in forest improvement (North – Balti/Soroca SORO; Center – SE Telenesti/SE Chisinau/SE Nisporeni-Silva; South – ÎS Iargara/ ÎS Comrat/ ÎSC Taraclia). This activity is the most expensive and difficult at the initial stage of implementation, the estimated value of the investment is 2645.0 thousand Euro or about 40% of the financial means necessary for capacity development/consolidation within technology (Table 1.6).

Table 1.6: Primary technical endowment for reconstruction/rehabilitation of degraded and inadequate forests

Name of equipment/technique	Number of units	Estimated unit cost, thousand euros	Total estimated costs, thousands of euros
Self-propelled mower (Raptor 300 equivalent)	1	315,0	315,0
Self-propelled mower (Raptor 400 equivalent)	2	400,0	800,0
Mower cutter (M450 equivalent)	3	45,0	135,0
Mower cutter (M650 equivalent)	4	70,0	280,0
Tractor aggregation milling cutter (160-180 CP)	3	80,0	240,0
Tractor aggregation milling cutter (200-350 CP)	4	185,0	740,0
Sapling planters	9	15,0	135,0
TOTAL			2645,0

The capacity building of the Agency "Moldsilva" and its territorial structures for the application of an efficient forest management in a sustainable manner and in accordance with the new climatic conditions will also be ensured through activities aimed at improving forestry personnel in key areas (research/design; extension/regeneration/reconstruction of forests; forest planning; migration/species succession; climate modeling, etc.), improving the regulatory framework on remuneration of work for forestry personnel, as well as promotion of new technologies and innovations in the forestry sector. The capacities of the Agency "Moldsilva" and its subordinated structures should also be strengthened on the communication and anti-corruption dimension (liquidation of conflicts of interest/functional overlaps in the process of technological activity; amplification of corruption prevention activities, etc.).

Another important issue to be addressed at the initial stage is to ensure synergism with the reproductive forest material production subsector (seeds, seedlings, etc.). The success of the implementation of the technology "Ecological restoration of inadequate and vulnerable stands for the purpose of adapting to climate change" depends largely on the quantity, quality and assortment of reproductive forest material. It follows from this desideratum that both technologies must be started in parallel, carefully following the implementation schedules of key activities.

1.2.6 Management planning

1.2.6.1 Risk and emergency assessment

The process of planning technology deployment activities also includes the assessment of possible risks and emergency situations for which certain measures to reduce consequences/influences are stipulated. In this context, risks that have a major influence on the condition and integrity of rehabilitated stands (fires, floods, droughts, grazing, illegal logging, etc.), provision with highly qualified personnel, availability of advanced technique/equipment, provision of technical regulations, etc. are subject to priority assessment. The main risks associated with the implementation of this technology are minimal and medium. At the same time, the experience of the country and the institutions involved offers the certainty of successfully overcoming them. In Table 1.7, the analysis of identified/potential risks for the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change" is carried out.

Table 1.7: Risks associated with the implementation of the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change"

Risks	Categories	Anticipation/mitigation actions
I. Financial and social risks		
1.1. Funding gap for activities to maintain, improve/rehabilitate the condition of existing forests	Medium	In the process of implementing the technology, the normative/legislative framework on technical and financial assurance of forest management will be updated, including the establishment of minimum annual financing rates (Law on public finances and budgetary-fiscal responsibility; Forest Code, etc.).
1.2. Internal deficit of financial means and non-compliance with obligations assumed by the co-financier	Minimum	The harvesting/exploitation of pre-existing wood mass (about 40 m3/ha) at the initial stage of the works is an indispensable element in the process of technology implementation. Agency "Moldsilva" has experience in implementing CDM projects "Soil conservation in Moldova" and "Development of communal forestry sector in Moldova" (28.8 thousand ha of newly planted forests) in the process of which it mobilized about 47 million US dollars.
1.3. Opposition of local population (including pastoralists/animal keepers) due to limitation of access and uses in rehabilitated forests	Medium	Agency "Moldsilva" and subordinated structures (forestry entities, FRMI, etc.) will implement a comprehensive communication plan aimed at raising awareness of the need for reconstruction/rehabilitation of inadequate and vulnerable stands. Providing alternative sectors for access and traditional uses by the local population (mushrooms, berries; recreation, grass harvesting, etc.).
1.4. High level of rural poverty and growing forest/energy resource needs	Medium	The local population will have the opportunity to increase their income by engaging in logging works, creating and maintaining forestry crops, harvesting forest seeds, etc. The wood mass exploited during the implementation of the reconstruction/rehabilitation works will be capitalized primarily in the neighboring localities.
II. Institutional, technological and regulatory risks		
2.1. Shortage of forest infrastructure design operators/institutions on the local market	Medium	Certain forest design compartments are covered by FRMI, which as part of the technology will be subject to the capacity building procedure. In the region (Hungary; Czech Republic; Poland; Romania, etc.) there are sufficient operators providing services in the field of forest infrastructure design (nurseries, logging, etc.).
2.2. Limited capacities of qualified personnel for the design of ecological	Minimum	The institutions involved in the process (Agency "Moldsilva", FRMI, etc.) have a certain experience and a minimum number of qualified personnel to ensure the quality and timeliness of the design works.

Risks	Categories	Anticipation/mitigation actions
restoration works of inadequate and vulnerable stands		In the process of technology implementation, an extensive capacity building program will be carried out in this compartment (implementation of the operational program for continuous improvement of forestry personnel on key areas; improvement of the regulatory framework on labor remuneration in the forestry sector, etc.).
2.3. Limited institutional and qualified personnel capacities for ecological reconstruction/rehabilitation works of inadequate and vulnerable stands	Minimum	The institutions involved in the process (Agency "Moldsilva", FRMI, territorial forestry entities, etc.) have certain technical capacities and qualified personnel to ensure the quality and timeliness of ecological reconstruction/rehabilitation works of inadequate and vulnerable stands. In the process of implementing the technology, an extensive capacity building program will be carried out at this department (establishment of entities specialized in ecological reconstruction of forests (3 ecological restoration centers), endowment with special equipment and equipment, etc.).
2.4. Limited production capacities of forest reproductive material for forest regeneration/ecological restoration works	Medium	Agency "Moldsilva" and subordinated forestry entities have technical capacities (forest nurseries) for the production of over 50 million saplings/year. By implementing the technology "Use of modern biotechnologies for propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" it is foreseen to strengthen capacities by setting up 3 regional centers for industrial growth of seedlings, with a total capacity of about 65 million seedlings/year.
2.5. Limited capacities to ensure the integrity of rehabilitated stands (fires, grazing animals, illegal logging, etc.)	Medium	Agency "Moldsilva" and territorial forestry entities have strategies and technical approaches to prevent/mitigate the effects of risks related to the integrity of rehabilitated forests/young forestry crops (guarding; creation of fire protection systems; control/background reviews; communication programs, etc.). Agency "Moldsilva" and territorial forestry entities will sign interaction plans with similar structures of GIES in the context of ensuring timely interventions in case of forest fires and other weathering.
III. Climate and ecological risks		
3.1. Natural disasters affecting the condition of new stands created as a result of reconstruction/rehabilitation activities (droughts, floods, etc.)	Medium	Agency "Moldsilva" and forestry entities have strategies and technical approaches to prevent/diminish the effects of climate risks (watering forest crops in the first years; creating flood protection waves and channels; creating fire protection systems, etc.);
3.2. Affecting biodiversity and habitats in the process of carrying out technological operations of reconstruction/rehabilitation	Minimum	Stands for reconstruction/rehabilitation have a high degree of degradation, including in terms of biodiversity, and works affecting the soil cover/herbaceous blanket (soil preparation, maintenance of forestry crops, etc.) have a short period (4-7 years). Biodiversity will increase by using in the process of reconstruction/rehabilitation works an assortment of over 85 species of trees and shrubs. This will provide greater structural diversity and an increase in the diversity of habitats used by fauna.

1.2.6.2 Next steps

The main requirements for the subsequent provision of TAP is the assessment of available stands and technical materials with the prioritization of stands inadequate and vulnerable to climate change necessary to be undertaken with ecological restoration works. This activity must be cumulated with the process of creating new sectoral capacities to carry out ecological restoration works of unsuitable stands (RCEFR). This prioritization, but also the new technical capabilities are the basic foundation for the successful implementation of the technology.

1.2.7 TAP overview table for technology "Ecological restoration of unsuitable and vulnerable stands for adaptation to climate change"

Sector:	Forestry sector
Sub-sector:	Rehabilitation of degraded and inadequate stands
Technology:	*Ecological restoration of inadequate and vulnerable stands for adaptation to climate change*
Technology ambition	Substitution/restoration of degraded, totally derived, branded stands, inappropriate to stationary conditions, poorly productive, having as main target the total area of about 120,000 ha, of which for the first stage is planned the reconstruction of 25,000 ha (21% of current needs); testing and adjusting technologies/approaches for ecological restoration of forests; reviewing/updating technical regulations dedicated to ecological reconstruction; exchange of experience at national and international level, etc.; term 8 years;
Benefits	Resilience/adaptation/environment: (i) Conversion from grove to forest regime of rehabilitated stands, ensuring regeneration from seed, creating long-lasting stands capable of adapting to climate change; (ii) Conservation of forest biological diversity; (iii) Application of efficient forest management, innovative technical solutions for ecological restoration of degraded and inadequate stands, forest management in a sustainable manner and in accordance with new climatic conditions; Capacity building, technology transfer and diffusion: (iv) Achieving a wide spectrum of transfer and diffusion of existing and new technologies in the forestry sector in the Republic of Moldova (digital technologies (including GIS/GPS); innovative technical solutions for substitution of inappropriate species and stands; carbon monitoring; planting seedlings with protected roots, etc.); Economic and social: (v) Increasing the potential of products and services of rehabilitated forests (wood, medicinal plants, berries, etc.); (vi) Increasing revenues in the state budget, local budgets and for population, especially in rural areas (estimated about EUR 80/ha/year or an income of about EUR 2.0 million annually); (vii) Creation of new jobs (about 6250 people) in rural areas related to a wide range of activities; Mitigation: (vi) Increase carbon sequestration capacities by approximately 198 kt CO2 annually, making full use of available stationary potential;

Actions	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Estimated budget, thousand Euro
1. Creation of new sectoral capacities to carry out ecological restoration works	1.1. Elaboration of project documentation (location; primary infrastructure; provision of personnel; technical equipment, etc.) for the establishment of 3 entities specialized in ecological restoration of forests	SB; NEF; SI	Agency „Moldsilva"; Projection institution	Year 1	Shortage of forest design operators/institutions on the local market;	Projects for the establishment of 3 entities specialized in ecological restoration of forests developed and approved according to the legal procedure.	Projects for the establishment of entities specialized in ecological restoration of forests.	150,0
	1.2. Establishment of entities specialized in ecological restoration of forests (3 centers for ecological restoration of forests/RCEFR), endowment with special equipment and equipment for the assigned	SB; NEF; SI	Agency „Moldsilva"; Projection institution	Year 1-Year3	Shortage of operators specialized in the production and/or delivery of specialized equipment for silvotechnical works;	Ecological restoration centers of forests established and functional for the assigned tasks.	3 centers for ecological restoration of established and functional forests.	2650,0

Actions	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Estimated budget, thousand Euro
	functions (extraction of pre-existing stand; deforestation; tillage, care/maintenance of forestry crops, etc.)							
	1.3. Recruitment and training of staff for ecological restoration centers	NEF; SI	Agency „Moldsilva"; entities specialized in ecological restoration	Year 1-Year 2	Limited capacities of qualified forestry personnel.	RCEFR personnel recruited and trained according to approved staffing states.	Number of RCEFR staff recruited.	35,0
2. Update of the normative/legislative framework regarding the technical and financial assurance of forest management	2.1. Revision of the Law on public finances and budgetary-fiscal responsibility to ensure sustainable management of forest resources in public ownership (state; ATU)	SB	Agency „Moldsilva"; MoEnv; MF	Year 1	Deviating the policy framework from key priorities in the activity of the forestry sector. Increasing the budget deficit and the impossibility of financial support for the forestry sector.	Law on public finances and budgetary-fiscal responsibility completed with provisions on sustainable management of forest resources in public ownership approved and implemented.	Amendments made/approved in the Law on public finances and budgetary-fiscal responsibility.	5,0
	2.2. Revision of the Forest Code regarding technical criteria and economic stimulation of the activity of improving the condition and productivity of forests, as well as directions of sustainable forest development	SB; SI	Agency „Moldsilva"; MoEnv	Year 1	Deviating the policy framework from key priorities in the activity of the forestry sector.	The Forestry Code completed with technical criteria regarding the economic stimulation of the activity of improving the condition and productivity of forests, the directions of sustainable forest development.	Amendments made/approved in the Forestry Code.	10,0
	2.3. Development of technical aspects regarding forest management financing and economic stimulation of forest improvement activity through secondary legislation (GD; regulations, etc.)	SB; SI	Agency „Moldsilva"; MoEnv; MF	Year 1-Year 2	Deviating the policy framework from key priorities in the activity of the forestry sector. Limited capacities to develop the performing technical framework.	Regulations on technical and financial assurance of forest management approved according to the legal procedure (HG; decisions ME, Moldsilva). The activity of technical and financial assurance of forest	GD and adopted ME decisions on the development of the secondary framework for technical and financial assurance of	10,0

Actions	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Estimated budget, thousand Euro
						management is carried out through a viable and robust mechanism.	forest management.	
	2.4. Review of technical regulations in the forestry field (forest planning; choice and application of forest treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of stands, including the care/maintenance of seed source stands	SB; SI	Agency „Moldsilva"; FRMI; NBG	Year 1-Year 3	Limited capacities to develop the performing technical framework.	Main forest-related technical regulations updated/revised in terms of climate change and approved and implemented according to the legal procedure.	Technical regulations related to forestry updated/revised and approved in terms of climate change.	40,0
3. Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions	3.1. Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.)	SB; NEF; SI	Agency „Moldsilva"; MoEnv; MECR; ONG	Year 1-Year 8	Limited capacities of qualified personnel for developing and implementing the training program.	Increasing the competences and skills of forestry staff in key areas related to forest management.	The number of forestry personnel improved in key areas;	2100,0
	Activity 3.2. Review and improvement of the regulatory framework on labor remuneration in the forestry sector	SB; NEF	Agency „Moldsilva"; MoEnv; MMPS	Year 1-Year 2	Sectoral and budgetary deficit of financial means.	The regulatory framework on remuneration of work in the forestry sector revised and implemented according to the legal procedure. Increase of the average salary in the forestry sector.	The number of forestry personnel remunerated according to the new tariffs. The relative value of the average salary	10,0

Actions	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Estimated budget, thousand Euro
						Increasing interest in employment in the forestry sector.	on the forestry sector compared to the average indices on the national economy.	
	Activity 3.3. Development and implementation of a sectoral programme/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.)	SB; NEF; SI	Agency „Moldsilva"; ME; MECR;	Year 1-Year 5	Sectoral and budgetary deficit of financial means. Limited capacities of qualified personnel to use new technologies in sectoral activity.	Sectoral programme/action plan on promotion of new technologies and innovations developed and implemented. Increasing the share of sectoral core activities carried out using new technologies.	Value of sectoral investments in new technologies and innovations.	1500,0
4. Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption	Activity 4.1. Development and implementation of a communication plan of the forestry sector with society and public authorities	SB; NEF; SI	Agency „Moldsilva"; ME; MECR; NGO	Year 1-Year 2	Poor experience in communicating with society and public authorities.	Forest sector communication plan developed and implemented. Improving the image of the forestry sector in society.	Organized communication events. Number of participants in organized communication events.	200,0
	4.2. Review of the internal regulatory framework for liquidation of conflicts of interest/functional overlaps in the process of technological activity and amplification of corruption prevention activities in the forestry sector	SB; SI	Agency „Moldsilva"; NAC; ME	Year 1-Year 5	Poor experience in analysing and identifying conflicts of interest in forestry. Opposition of forestry personnel interested in the current situation.	Mitigating and/or liquidating situations and cases of conflicts of interest/functional overlaps in the forestry sector. Reducing corruption cases in the forestry sector.	Number of structural operating regulations, revised job descriptions in terms of liquidation of conflicts of interest and corruption in the forestry sector.	30,0

Actions	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Estimated budget, thousand Euro
5. Design of works and interventions for the ecological restoration of inadequate stands	5.1. Evaluation of available stands and technical materials with priority setting of inappropriate stands and vulnerable to climate change necessary to go through with ecological restoration works (25 thousand ha)	SB; NEF; SI	Agency „Moldsilva"; FRMI; NBG	Year 1-Year 2	Limited capacities of qualified personnel for designing ecological restoration works of inadequate and vulnerable stands.	About 25 thousand ha of inadequate stands vulnerable to climate change are assessed and prioritized.	Area of inappropriate stands vulnerable to climate change assessed and prioritized for interventions.	25,0
	5.2. Elaboration of technical projects for ecological restoration of inadequate stands vulnerable to climate change (estimated 85 projects; 25 thousand ha)	SB; NEF; SI	Agency „Moldsilva"; FRMI; NBG	Year 1-Year 2	Limited capacities of qualified personnel for designing ecological restoration works of inadequate and vulnerable stands.	An estimated 85 technical projects are developed for the ecological reconstruction of 25 thousand ha of inadequate stands vulnerable to climate change.	Number of technical projects developed for the ecological restoration of stands that are inadequate and vulnerable to climate change.	170,0
	5.3. Technical endorsement and public consultation of projects for the ecological restoration of unsuitable stands vulnerable to climate change	SB; NEF; SI	Agency „Moldsilva"; FRMI; NBG	Year 1-Year 4	Limited institutional and qualified personnel capacities for ecological reconstruction/rehabilitation works of inadequate and vulnerable stands.	Projects for the ecological restoration of unsuitable stands vulnerable to climate change are approved and implemented (estimated 85 projects).	Number of projects for the ecological restoration of stands approved and implemented. Area of unsuitable and climate-vulnerable stands covered by technical projects.	20,0

Actions	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Estimated budget, thousand Euro
6. Implementation of ecological restoration works of inadequate and vulnerable stands	6.1. Carrying out the primary phase of ecological restoration works of inadequate and vulnerable stands based on technical projects (extraction of pre-existing stand; deforestation; tillage, etc.)	SB; NEF; SI	Agency „Moldsilva"; FRMI; NBG; SME	Year 2-Year 8	Limited institutional and qualified personnel capacities for ecological reconstruction/rehabilitation works of inadequate and vulnerable stands. Limited capacities to produce reproductive forest material for forest regeneration/ecological restoration works.	Carrying out the primary phase of ecological restoration works of inadequate and vulnerable stands on the area of 25.0 thousand ha.	The area of unsuitable stands vulnerable to climate change covered by the primary phase of ecological restoration works.	30000,0
	6.2. Carrying out phase II of ecological restoration works of inadequate and vulnerable stands (planting/care/maintenance of forest crops, etc.)		Agency „Moldsilva"; FRMI; NBG; SME	Year 2-Year 8	Limited institutional and qualified personnel capacities for ecological reconstruction/rehabilitation works of inadequate and vulnerable stands. Limited capacities to produce reproductive forest material for forest regeneration/ecological restoration works;	Carrying out phase II of the ecological restoration works of inadequate and vulnerable stands on the area of 25.0 thousand ha.	The area of unsuitable stands vulnerable to climate change covered by phase II of ecological restoration works.	20000,0
7. Monitoring the implementation of technology and works	7.1. Technical supervision of the implementation process of ecological restoration projects of inadequate stands vulnerable to climate change	SB; NEF; SI	Agency „Moldsilva"; FRMI; NBG; NGO	Year 2-Year 8	Limited institutional and qualified personnel capacities for supervising/verifying ecological reconstruction/rehabilitation works of inadequate and vulnerable stands.	Ensuring the quality of the implementation process of ecological restoration projects of inadequate stands vulnerable to climate change.	Events of technical supervision of the implementation process of projects for ecological restoration of unsuitable stands and vulnerable to	35,0

Actions	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Estimated budget, thousand Euro
							climate change carried out according to the established plan.	
	7.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	SB; NEF; SI	Agency „Moldsilva"; ME; IEP; NGO	Year 1-Year 8	Natural disasters affecting the condition of new stands created as a result of reconstruction/rehabilitation activities (droughts, floods, etc.). Limited capacities to ensure the integrity of rehabilitated stands (fires, grazing animals, illegal logging, etc.).	The process of implementing the ecological reconstruction technology/works is carried out in accordance with the technical provisions and the time plan.	Events for monitoring and evaluating the implementation process carried out according to the established plan.	175,0
	7.3. Review and amplify the monitoring activity on the implementation process by the central forestry authority of forest policy documents and regulatory framework (governmental/parliamentary hearings; annual implementation reports, etc.)	SB; NEF; SI	ME;	Year 1-Year 8	Low interest of the Government and Parliament in forestry issues. Deviating the policy framework from key priorities in the activity of the forestry sector.	Governmental/parliamentary hearings, annual implementation reports are systematic and reflect key issues. The activity of the forestry sector is on the agenda of the policy framework with involvement in solving key issues.	Governmental/parliamentary events/hearings on forestry issues carried out according to the established plan.	30,0
TOTAL								57195,0

1.3 Action plan for the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions"

1.3.1 Introduction

The technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in the new climatic conditions" provides for the adaptation of the subsector of production of forest reproductive material to the evolution of climate change through activities to strengthen and modernize the process throughout the production chain: Identification, legalization and care/maintenance of seed source stands (including forest genetic resources); harvesting, processing and certification of forest seed; industrial breeding and valorization of forest reproductive material, etc. Because, according to the data of various studies and national reports, it is found that forest nurseries are currently growing forest reproductive material, without relying on the requirements of EU standards and data of international treaties on adaptation to climate change. At the same time, the current requirements to increase forest productivity and the development of the forest economy in terms of adaptation to climate change make it necessary to ensure the production of high-quality propagating material.

The technology corresponds, in particular, to sectoral priorities on intensifying the process of afforestation/reforestation of land, ensuring forest resilience to climate change, increasing the ecoprotective and bioproductive potential of existing and/or natural forests, conservation of biological diversity of forests, etc. In this context, the production of forest material in the required assortment, qualitatively and in the necessary quantities, which will contribute to increasing the success of forestry crops and adapting regeneration and afforestation works to climate change. Improve the management and conservation process of seed source stands as well as forest genetic resources, in particular in terms of adaptation to climate change.

The process of implementing the prioritized technology will include the use of biotechnologies for the production of seedlings (multiplication, rooting, in vitro growth, etc.), including with protected roots (about 50-60% of production capacity). Also, for the regeneration, ecological reconstruction and afforestation works in the Republic of Moldova will be ensured the assortment of species of trees and shrubs growing in local forests (over 85 species). This assortment must be supplemented with tree and shrub species from the area bordering the Republic of Moldova (Romania, Ukraine, Bulgaria, Greece, Hungary, etc.), including in terms of tolerance limits to medium and maximum temperatures. This process will include about 20-30 species of trees and shrubs, including the barberry (*Quercus frainetto Ten*.), the sky (*Quercus cerris L*.), etc. This compartment will be completed with the revision of the normative basis aimed at the management and conservation of seed source stands, as well as forest genetic resources, including in terms of adaptation to climate change.

The technology includes the establishment and commissioning of some basic elements of the subsector for the production of forest reproductive material: The creation of 2 regional centers for industrial breeding of forest reproductive material (RCIBFRM) usable in the new climatic conditions (northern and southern zones). The activity of this department provides for the appropriate technical

equipment, building the production infrastructure, developing primary operational activities, staff training, marketing, etc.

Another important compartment of this technology is the creation and technical endowment of the National Center for Forest Genetics and Seminology/NCFGS (area of activity – Center Area). As basic tasks/activities of NCFGS are provided: Management of the seed base (stands, seed sources and FGR on about 3-4 thousand ha); certification of regeneration material; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro breeding; primary operational activity; provision of seed processing equipment, nursery and laboratory equipment for quality assessment, etc.).

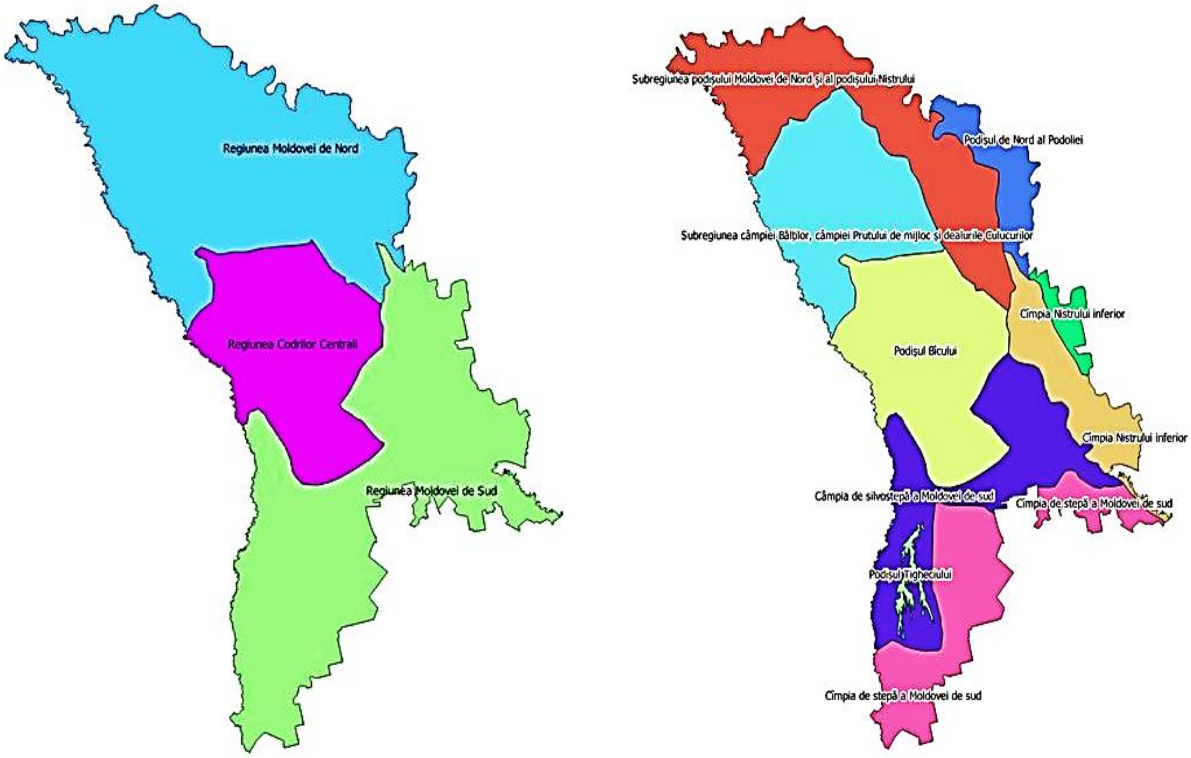


Figure 1.1. Map of regions and subregions of origin (Caisin V., Florence Gh., 2020)

The geographical location of the centers of industrial rearing of forest reproductive material will be made taking into account the delimitation of the regions and subregions of origin (Fig. 1.1). Thus, compliance with the process of production, movement, marketing/export of local forest material will be ensured. The main and direct benefits of implementing the technology in question are:

a) Environmental benefits:
   - Increasing the quantity and quality of forest seed material harvested from identified sources, with beneficial consequences on the quality of saplings and future forestry crops.
   - Production of forest material in the required assortment, quality and in the necessary quantities, which will contribute to increasing the success of forestry crops and adapting regeneration and afforestation works to climate change.
   - Improving the management and conservation process of seed source stands as well as forest genetic resources, especially in terms of CCA.

b) Socio-economic benefits:

- Creation of new jobs in rural areas (about 525 people), related to a wide range of activities: Primary harvesting and processing of forest seeds; development of forest nurseries with industrial capacities; research and biotechnology, etc.
- Increase revenues in the state budget, local budgets and for population, especially in rural areas, generating on average about 65-70 million lei annually (when reaching the maximum production capacity).

c) Capacity building, technology transfer and diffusion:
   - Contributes to strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply innovative technical solutions for growing forest reproductive material both for regeneration works within the existing forest fund (including ecological restoration of degraded and inadequate stands) and for afforestation works on new lands (forest extension).
   - Implementation of innovative components foreseen within the measure: Biotechnologies; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and in vitro breeding; automated irrigation systems; technical solutions for the care of seed source stands and those designated as forest genetic resources; digital technologies (GIS/GPS) for land and works records, etc.
   - Review the regulatory basis for the management and conservation of forest genetic resources, including adaptation to climate change.

Technology does not affect gender equality. Women are widely involved in the implementation process at most stages and activities: Harvesting seeds of trees and shrubs; growing seedlings in forestry nurseries; growing and harvesting non-wood products (fruits, berries, medicinal plants), etc. The degree of direct involvement in technology is estimated at 55% men and 45% women.

1.3.2 Ambition for TAP

The technology is focused on contributing to achieving the priorities of the forestry sector regarding the intensification of the afforestation/reforestation process of land and ensuring the resilience of forests to climate change by producing forest material in the required assortment, quality and in the necessary quantities. This will contribute directly to increasing the success of forest crops and adapting regeneration, reconstruction and afforestation works to climate change. It will also contribute to improving the management and conservation process of seed source stands as well as forest genetic resources, in particular in terms of adaptation to climate change, ensuring steady forest seed production.

In quantitative aspect, the technology covers seed source stands and those designated as forest genetic resources with a total area of about 5-7 thousand ha, as well as existing forest nurseries (about 900 ha; over 30 forest nurseries) within the "Moldsilva" Agency and its territorial structures (24 entities), located throughout the country. At the same time, for the current prioritized technology, as preliminary objectives and targets, the use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions is foreseen – strengthening the institutional framework in the field by setting up and commissioning the National Center for Forest Genetics and Seminology (NCFGS) and 2 regional centers for industrial growth of the material forest breeding (RCIBFRM); use of biotechnologies for the production of propagating material (multiplication, rooting, in vitro growth, etc.), including with protected roots; management

of forest seed base (stands, seed sources and FGR) with harvesting, industrial processing and seed conditioning of trees and shrubs; certification of regeneration material; conducting forest genetic research and in vitro breeding; reviewing the regulatory basis for the management and conservation of forest genetic resources, including adaptation to climate change. The capacities of the newly created industrial centers will ensure the production of about 65-70 million seedlings annually (including about 20-30% with protected roots) or about 80-90% of the sectoral needs in case of implementation of extensive afforestation/reforestation/reconstruction/rehabilitation programs. That quantity shall include an assortment of species corresponding to the Eco pedological conditions of the land envisaged to be afforested or forests intended for regeneration/reconstruction/rehabilitation.

For the next stages (after 2030), the production potential of seed and planting material will have to be increased by about 40-50%, both for internal needs (increasing volumes for regeneration/reconstruction, afforestation works, etc.) and for the regional/international market, including medium and large seedlings usable for green spaces/areas, forest curtains/alignments for the protection of agricultural fields, infrastructure, etc.

1.3.3 Actions and activities selected for inclusion in TAP

1.3.3.1 Summary of barriers and measures to overcome barriers

The barrier assessment process for the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" identified and described 18 barriers and/or needs, of which 11 with a major impact. As a fundamental cause of the problem, the lack of forest reproductive material (seedlings) in sufficient quantities and of appropriate quality has been identified. The main barriers to the transfer of this technology and their characterization aspects are set out in Table 1.8.

Table 1.8: Key barriers to technology transfer "Use of modern biotechnologies for propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions"

Nr. d/o	Key barriers	Detailed aspects of barriers
1.	Low profitability and increased costs of works to maintain fruiting capacities of seed source stands	Due to the current condition, as well as pedoclimatic conditions, seed source stands require additional investments through care/maintenance works (irrigation, fertilization, protection, etc.). The labor shortage and the laborious nature of the works to maintain the fruiting capacities of the source stands increase the costs of the care/maintenance works. The low natural productivity of seed source stands increases the cost of harvested reproductive material.
2.	Insufficient investment in identification and management of stands, seed sources and forest genetic resources	The activity of identifying forest stands, seed sources and genetic resources has no direct and immediate economic effect, being ignored by holders and/or investors. Also, investing in the management of seed stands and forest genetic resources is not a priority, as the use of reproductive material from identified sources in the forest regeneration/reconstruction process is not yet a clear obligation.
3.	High taxes, which suffocate forestry entities and diminish investment capacities in high-performance equipment and equipment for forest nursery activities	The share of taxes and fees in the total amount of expenditures and consumption of the forestry sector varies between 22-27%, having a fluctuating character. Due to the major degree of complexity, the forest nursery activity is laborious and expensive, the primary investments required in this compartment constitute about 20% of the annual budget of the forestry sector.

Nr. d/o	Key barriers	Detailed aspects of barriers
4.	Acute deficit of forest seeds in terms of quantity, quality and assortment	The shortage of forest seeds is acutely felt, especially in years with poor fruiting at the oak stands. The forestry sector lacks seed deposits for multiannual storage and covering needs in years with poor fruiting. Due to a combination of biotic and abiotic factors (origin from shoots; pedoclimatic conditions; management deficiencies, etc.), oak stands (especially fluffy oak) have a fruiting periodicity of 8-15 years. This situation is aggravated by ignoring the identification works, as well as the care/maintenance of seed source stands (irrigation, fertilization, protection, etc.).
5.	Laborious harvesting and processing/processing of forest seeds	Most of the existing technical facilities in the forestry sector are morally and physically obsolete, with a period of use of over 20 years. Shortage of skilled and unskilled (seasonal) labor due to the minimum wage amount (the lowest of all sectors of the national economy) for workers in the forestry sector.
6.	Insufficient monitoring of the origin and quality of reproductive material for the production of seedlings in forest nurseries	Lack of a mechanism to stimulate the production and valorization of forest reproductive material with authentication of identity and quality. The law on production, marketing and use of forest reproductive material was adopted only in March 2022.
7.	Shortage of personnel and expertise in forest nursery and seed stand management	Forest design institutions, but also those of forest management (territorial forestry entities) are facing the shortage of qualified personnel specialized in forest nursery and management of seed source stands. The spectrum of experts specialized in the design of modern forest nurseries (industrial breeding centers) and/or the industrial production of forest seeds is very limited or even absent in the Republic of Moldova. This situation is aggravated by the fact that starting with 2018 the process of improving forestry staff has been practically abandoned.
8.	The degree of low implementation of forest policy documents and regulatory framework	Most forest policy documents adopted over the last two decades have an implementation rate of 40-60%, without ensuring a decisive qualitative and quantitative leap. An important part of the provisions of the forest regulatory framework remains (regeneration of forests from seed; forest planning of all forests, regardless of departmental affiliation and ownership, etc.) at the level of "good intention", without implementation in practice.
9.	Ambiguous legislative provisions regarding the provision of water resources to forest nurseries	The Forestry Code does not include provisions that would address particularities regarding the functionality of forest nurseries. The legislation regulating water use, including for irrigation purposes (Water Law, no. 272 of 23.12.2011) does not contain concrete criteria/parameters for forest nurseries.
10.	Poor monitoring of forest nursery production activities and processes	Part of the seedlings are grown in nurseries and planted within forestry crops without checking the quality of seed material (15-20%). The share of forest seeds harvested from identified sources accounts for up to 15%.
11.	The regulatory basis related to the breeding and marketing of forest reproductive material is poorly developed and/or updated	The law on production, marketing and use of forest reproductive material was adopted only in March 2022. Technical regulations related to the rearing and marketing of forest reproductive material require profound creation and/or updating, including in terms of overcoming climate risks.

The analysis of the data in Table 1.8 shows that the main barriers addressed in the process of assessing data technology transfer relate to different directly or indirectly related domains and are quite complex. An essential part of these barriers refers to limited institutional and personnel capacities in forestry, public and private investment gaps, high taxes, which suffocate forestry enterprises and diminish investment capacities in high-performance technique/equipment for forest management activities, etc. The process is also influenced by insufficient supervision of the production process and quality of forest reproductive material in forest nurseries, without establishing its origin or

provenance, without authenticating its identity, quality and resilience to climate change, etc. Finally, these barriers or needs seriously affect the activity of the national forestry sector, essentially diminishing the sectoral intervention capacities in order to ensure the process of regeneration/reconstruction/expansion of forests with high quality reproductive forest material, in the necessary volume and assortment.

1.3.3.2 Activities identified for the implementation of selected actions

As a result of detailed analyses carried out at the previous stages, as well as at the current stage on aspects related to the technology "Use of modern biotechnologies for propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions", a complex of measures aimed at the successful implementation of this technology was developed. Thus, in order to overcome the 18 barriers and/or needs, 27 measures were identified aimed at overcoming barriers (except for insignificant ones) and ensuring the transfer of technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions". In the current process, for the technology concerned, important measures/activities have been selected and consolidated into 5 actions (Table 1.9). At the same time, additional action-specific activities have been developed, which are considered to make an essential contribution to the implementation of the technology. In this context, specific activities (20 activities) are established as concrete measures for the implementation of the actions/objectives of the technology, based also on the purpose of gradually overcoming the barriers and risks identified in the way of transferring the respective technology.

Table 1.9: Actions and activities aimed at implementing the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions"

Name of action	Required activities to implement
1. Creation of	1.1. Elaboration of project documentation for the establishment of 3 centers specialized in industrial breeding of forest reproductive material (location; primary infrastructure; personnel supply; technical equipment; production capacities; area of activity and transfer of forest material, etc.)
	1.2. Establishment of centers specialized in industrial breeding of forest reproductive material (2 regional centers: North and South areas; NCFGS: Center Area), endowment with special technique and equipment for assigned functions (care of seed source stands; forest seed processing; forest seed storage; nursery and laboratory equipment for assessing the quality of seeds/seedlings; tillage; irrigation systems; care/maintenance of seedlings, etc.)
	1.3. Delimitation and direct management of centers specialized in industrial rearing of forest reproductive material, seed source stands and those established as FRG
	1.4. Recruitment and upskilling of personnel for industrial breeding centers for forest reproductive material

Name of action	Required activities to implement
new sectoral capacities for industrial growth ho	

Name of action	Required activities to implement
forest reproductive material	
2. Updating the	2.1. Supplementing the Water Law (no. 272/2011) with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources
	2.2. Supplementing the Forestry Code (no. 887/1996) with provisions that would refer to particularities regarding the functionality of forest nurseries
	2.3. Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production
	2.4. Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material
	2.5. Update and completion of the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks
	2.6. Review of technical regulations related to the care/maintenance of seed source stands, especially in terms of ensuring constant fruiting

Name of action	Required activities to implement
ormative/legislative framework to ensure time	

Name of action	Required activities to implement
Iyand construant production offorestreproducti	

Name of action	Required activities to implement
vematerial	
3. Strengthening the capacities of t	3.1. Carrying out works to identify new stands, sources of seeds to ensure the needs and create reserves (another about 3-5 thousand ha)
	3.2. Creation within the forestry sector of a network of seed warehouses for multiannual storage and covering needs in years of poor fruiting
	3.3. Update and implementation of procedures and processes for certification of forest seeds, including for marketing on the international market
	3.4. Establishment and maintenance of the State Register of Basic Materials
	3.5. Establishment in maintaining the State Register of Producers of Forest Reproductive Material

Name of action	Required activities to implement
heAgency "Moldsilva" anditsterritorialstruc	

Name of action	Required activities to implement
turesinthefieldoffforestnurseryinaccordanc	

Name of action	Required activities to implement
ewiththenewclimaticconditions	
4. Production	4.1. Carrying out works of care/maintenance of seed source stands (irrigation, fertilization, protection, etc.)
	4.2. Industrial harvesting and processing of forest seeds in sufficient quantities (350-400 tons) for the process of forest regeneration/reconstruction and expansion
	4.3. Industrial growth of planting material for forest regeneration/reconstruction and expansion process (65-70 million seedlings annually, including about 20-30% with protected roots)

Name of action	Required activities to implement
offorestreproductivematerialinthequantiti	

Name of action	Required activities to implement
esandassortmentnecessaryforforestregenera	

Name of action	Required activities to implement
tion/reconstructionandextensionworks	
5. Mon	5.1. Technical supervision of the process of growing forest reproductive material (entire production chain: Seeds, seedlings, certification, etc.)
	5.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes

Name of action	Required activities to implement
itoringtheimplementationoftechnologyandwo	

Name of action	Required activities to implement
rks	

The technology implementation process starts with activities aimed at creating and strengthening new sectoral capacities for industrial growth of forest reproductive material (design; infrastructure creation; technical equipment; staff recruitment and training, etc.). In parallel with the activities of creating and strengthening capacities in the field of forest reproductive material breeding, activities will be carried out aimed at updating the normative/legislative and technical framework on forest nursery in accordance with the new climatic conditions (Water Law; Forest Code; technical regulations regarding the care/maintenance of seed source stands, the growth and marketing of forest reproductive material, etc.), which will require the massive involvement of experts in the budgetary-fiscal, forestry and legal fields.

At the same time, the initial stage of technology implementation aims to strengthen the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery. Activities in this direction will focus on identifying new stands sources of seeds to ensure needs and create reserves, updating and implementing procedures and processes for certification of forest seeds, establishing and maintaining state registers of basic materials and producers of forest reproductive material, etc.

The activities within the technology will culminate in the production of forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction and expansion works during the implementation period (350-400 tons/year forest seeds; 65-70 million saplings annually, etc.). The implementation of the works will be carried out based on design and/or technical supervision activities, and the entire process will be ensured with monitoring and evaluation activities, with the elaboration of appropriate reports and informative notes. Other details on the actions and activities identified for the implementation of the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" are set out in paragraph 1.3.7 (Overview table of TAP for the use of modern biotechnologies for propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions) of the this Report.

1.3.4 Stakeholders and timeline for TAP implementation

The main implementation obligations belong to the "Moldsilva" Agency, which has capacity, experience and tools to apply technology through its territorial subdivisions (forestry entities and

FRMI). MoEnv (DFM; DPASC; DPDB; IEP; Agency "Apele Moldovei" etc.), NBG (assortment of tree and shrub species; species association schemes; plant multiplication methodologies, including *in vitro*, etc.), IGPPP (plant multiplication methodologies, including *in vitro*; plant protection, etc.), companies and private individuals. For certain actions and activities, implementation will be carried out with the participation of competent structures within the Ministry of Foreign Affairs (seed and seedlings certification procedures, etc.), MF (budgetary-fiscal responsibilities), MECR (staff training and improvement, etc.), private sector (SME – care/maintenance of seed source stands (irrigation, fertilization, protection, etc.); harvesting forest seeds; care of seedlings in nurseries; transport and logistics services, etc.) and civil society (NGO – expertise, communication, training, etc.). The total implementation period of the technology will be 8 years (Table 1.10).

At the same time, on certain fields (technical equipment; staff training in designing technical solutions for the care of seed source stands and those designated as forest genetic resources; staff training on the application of technologies for growing forest reproductive material, etc.) certain capacity building actions of the Agency "Moldsilva" will be implemented (including with the consultation of specialists and specialized companies from Poland, Czech Republic, Hungary, etc.) to ensure the success of activities.

Table 1.10: Stakeholder analysis by implementation activities for the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions"

Name of action	Necessary activities to implement	Responsible institutions and focal points	Period
1. Creation of new sectoral capacities for industrial growth of forest reproductive material	1.1. Elaboration of project documentation for the establishment of 3 regional centers for industrial breeding of forest reproductive material, including NCFGS (location; primary infrastructure; provision of personnel; technical equipment; production capacities; area of activity and transfer of forest material, etc.)	Agency „Moldsilva"; Design institution; FRMI NBG; MAFI	2023
	1.2. Establishment of 3 regional centers for industrial growth of forest reproductive material (North, Center, South), including NCFGS, endowment with special technique and equipment for assigned functions (care of seed source stands; processing and storage of forest seeds; nursery and laboratory equipment for assessing the quality of seeds/seedlings; tillage; irrigation systems; care/maintenance of seedlings, etc.)	Agency „Moldsilva"; Design institution; FRMI; NBG; MAFI	2023-2026
	1.3. Delimitation and direct management of regional centers for industrial rearing of forest reproductive material (including NCFGS), seed source stands and those established as FRG;	Agency „Moldsilva"; FRMI; NBG; ES	2023-2024
	1.4. Recruitment and training of personnel for industrial breeding centers for forest reproductive material	Agency „Moldsilva"; RCIBFRM; NCFGS; FRMI; MECR; ONG	2023-2024
2. Updating the normative/legislative framework to ensure timely and constant production of forest reproductive material	2.1. Supplementing the Water Law (no. 272/2011) with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources	Agency „Moldsilva"; MoEnv; Agency „Apele Moldovei"; MAFI; ONG	2023-2024
	2.2. Supplementing the Forestry Code (no. 887/1996) with provisions that would target particularities regarding the functionality of forest nurseries	Agency „Moldsilva"; MoEnv; ONG	2023-2024

Name of action	Necessary activities to implement	Responsible institutions and focal points	Period
	2.3. Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production	Agency „Moldsilva”; MoEnv; MF; ONG	2024-2025
	2.4. Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material	Agency „Moldsilva”; MoEnv; FRMI; ONG	2024-2025
	2.5. Update and completion of the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks	Agency „Moldsilva”; MoEnv; FRMI	2024-2025
	2.6. Review of technical regulations related to the care/maintenance of seed source stands, especially in terms of ensuring constant fruiting	Agency „Moldsilva”; MoEnv; FRMI; NBG	2024-2025
3. Strengthening the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions	3.1. Carrying out works to identify new stands sources of seeds to ensure needs and create reserves (about 3-5 thousand ha)	Agency „Moldsilva”; NCFGS; RCIBFRM; FRMI; NBG	2024-2026
	3.2. Update and implementation of procedures and processes for certification of forest seeds, including for marketing on the international market	Agency „Moldsilva”; NCFGS; FRMI; NBG	2024-2030
	3.3. Establishment and maintenance of the State Register of Basic Materials	Agency „Moldsilva”; NCFGS; FRMI; NBG	2023-2030
	3.4. Establishment in maintaining the State Register of Producers of Forest Reproductive Material	Agency „Moldsilva”; NCFGS; FRMI	2023-2030
4. Production of forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction and extension works	4.1. Carrying out works of care/maintenance of seed source stands (irrigation, fertilization, protection, etc.);	Agency „Moldsilva”; NCFGS; FRMI; NBG; SME	2025-2030
	4.2. Industrial harvesting and processing of forest seeds in sufficient quantities (350-400 tons) for the process of forest regeneration/reconstruction and expansion	Agency „Moldsilva”; NCFGS; RCIBFRM; SME	2025-2030
	4.3. Industrial growth of planting material for forest regeneration/reconstruction and expansion process (65-70 million seedlings annually, including about 20-30% with protected roots)	Agency „Moldsilva”; NCFGS; RCIBFRM; SME	2025-2030
5. Monitoring the implementation of technology and works	5.1. Technical supervision of the process of growing forest reproductive material (entire production chain: Seeds, seedlings, certification, etc.)	Agency „Moldsilva”; FRMI; NBG; MAFI; ONG	2023-2030
	5.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	Agency „Moldsilva”; MoEnv; IEP; MAFI; ONG	2023-2030

For direct implementation, the mechanisms established by the legislation in the field will be used (Forest Code; Law on production, marketing and use of forest reproductive material in the Republic

of Moldova; guidelines and recommendations for the care and maintenance of seed source stands; guidelines and recommendations on the organization of the work of forest nurseries, etc.). Technology activities include exchange of experience between national institutions involved in the process, but also with similar institutions in neighboring countries (Romania, Ukraine, etc.). Indirectly, the technology will facilitate involvement in the development of small and medium-sized forestry enterprises (SMEs) within LPAs and privately (participation in forest seed harvesting; care of seed source stands; care of seedlings in nurseries; transport and logistics services, etc.).

1.3.5 Estimate of resources needed for actions and activities

The estimated budget required for actions aimed at implementing the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" is 30276.3 thousand Euro or an annual average of about 3785 thousand Euro (Table 1.11). At the same time, it is mentioned that an important part of the investment (about 40-50%) can be provided from the income obtained by forestry entities/NCFGS/RCIBFRM from the marketing of forest seeds and saplings produced, starting with the 3rd year of technology implementation.

Table 1.11: Resources needed for actions aimed at implementing the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions"

Name of action	Period	Budget action, thousand Euro	Percent, %
1. Creation of new sectoral capacities for industrial growth of forest reproductive material	Year 1-Year 3	7990,0	26,4
2. Updating the normative/legislative framework to ensure timely and constant production of forest reproductive material	Year 1-Year 3	110,0	0,4
3. Strengthening the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions	Year 1-Year 8	190,0	0,6
4. Production of forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction and extension works	Year 3-Year 8	21802,6	72,0
5. Monitoring the implementation of technology and works	Year 1-Year 8	183,8	0,6
TOTAL		30276,3	100,0

Due to the current state in the forestry sector (shortage of highly qualified personnel; shortage of modern equipment and equipment, etc.), the technology implementation process must start with extensive capacity building activities (institutional, personnel, technical equipment; creation/rehabilitation of forest infrastructure, etc.) to facilitate the process of producing reproductive forest material in industrial quantities according to new techniques and approaches, adapted to climate change (actions 1-3). Thus, for technology-related capacity building activities, financial means in the amount of EUR 8290 thousand or 27.4% of the total investment value for the technology in question are required.

To ensure success, investments in capacity development/building must be made/capitalized on as a priority during the first 3-4 years. It is also necessary to cooperate closely with higher education institutions that train specialists in the field to deepen in the curriculum the aspects related to the growth of forest reproductive material, including according to new technologies and in conditions of climate change. In this context, new sectoral capacities for industrial growth of forest reproductive

material will be created through 3 regional centers (design; infrastructure creation; technical equipment; staff recruitment and training, etc.). These centers may be established as subdivisions within existing forestry entities with experience in forest nursery, including in terms of compliance of regions/subregions of origin (North – SE Balti/ SE Soroca/ SE Soldanesti; Center – SE Nisporeni-Silva/SE Telenesti/SE Chisinau; South – SE Tighina/ SE Comrat/ ÎSC Taraclia/ ÎS Silva-Sud Cahul). This activity is quite expensive and difficult at the initial stage of implementation, the estimated value of the investment is 7990 thousand Euro or about 26% of the financial means necessary for the development/consolidation of capacities within the technology.

Another important issue needed to be addressed at the initial stage is to ensure synergism with regeneration activities (including ecological restoration of inadequate stands vulnerable to climate change) and expansion of forests. The success of the technology "The use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions" depends largely on the process of preparation and implementation of national programs that will capitalize/request the quantity, quality and assortment of reproductive forest material produced by newly created capacities, based on an industrial and adaptive approach to climate change. From this desideratum it follows that both technologies must be started practically in parallel, carefully following the implementation schedules of key activities, terms of reaching maximum production capacities, etc.

1.3.6 Management planning

1.3.6.1 Risk and emergency assessment

The process of identifying and planning the implementation activities of the given technology also includes the assessment of possible risks and emergency situations for which certain measures/strategies to reduce the consequences/influences are stipulated. The activity in the forestry sector is dominated by a number of natural risks that can decisively influence the final or intermediate result. Due to the large expanses, the mostly open character of forest objects and infrastructure, risks caused by the anthropogenic factor also have important influences. In this context, priority assessment is given to risks that have a major influence on the state and integrity of the process of production of reproductive forest material throughout the production chain (fires, floods, droughts, grazing animals, illegal logging, etc.), provision of highly qualified personnel, availability of advanced technique/equipment, provision of technical regulations, etc.

The main risks associated with the implementation of this technology are minimal and medium. At the same time, the experience of the country and the institutions involved offers the certainty of overcoming them. Table 1.12 also reviews the identified/potential risks for the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions".

Table 1.12: Risks associated with the implementation of the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in the new climatic conditions"

Risks	Categories	Anticipation/ mitigation actions
I. Financial and social risks		

Risks	Categories	Anticipation/ mitigation actions
1.1. Funding gap for activities of maintenance, improvement/rehabilitation of the condition of seed source stands	Medium	In the process of implementing the technology, the update of the normative framework on the methodology of forest budget formation will be carried out so that the forest seed production activity is carried out through a viable and robust financial mechanism (GD; decisions MM, Moldsilva).
1.2. Internal deficit of financial means and non-compliance with obligations assumed by the co-financier	Minimum	The marketing of forest seeds and saplings produced within the technology implementation framework will cover an important part of the investment (about 40-50%).
1.3. Opposition of the local population (including pastoralists/animal keepers) due to limited access and uses in seed source stands	Medium	Agency "Moldsilva" and subordinated structures (forestry entities, FRMI, etc.) will implement a comprehensive communication plan aimed at raising awareness of the need to limit traditional uses in stands seed sources. Providing alternative sectors for access and traditional uses by the local population (mushrooms, berries; recreation, grass harvesting, etc.).
1.4. High level of rural poverty and growing forest/energy resource needs	Medium	The local population will have the opportunity to increase their income by engaging in the care of seed source stands, harvesting forest seeds, growing/caring for seedlings, etc.
1.5. Low interest in business development in the field of production of forest reproductive material	Medium	The initiation and implementation of state programs on forest regeneration/reconstruction and extension on a cumulative area of about 125 thousand ha for the next 10 years will require the annual production of over 100 million saplings, creating premises for the development of new businesses in this field.
II. Institutional, technological and regulatory risks		
2.1. Shortage of forest infrastructure design operators/institutions on the local market	Medium	Certain forest design areas are covered by the FRMI, which as part of the technology will be subject to the capacity-building procedure. In the region (Hungary; Czech Republic; Poland; Romania, etc.) there are sufficient operators providing services in the field of forest infrastructure design (nurseries, logging, etc.).
2.2. Limited capacities of qualified personnel for the field of forest nursery and seedling	Minimum	The institutions involved in the process (Agency "Moldsilva", FRMI, etc.) have a certain experience and a minimum number of qualified personnel to ensure the quality and timeliness of the works. In the process of technology implementation, an extensive capacity building program will be carried out in this department (staff training; improvement of the normative/legislative/regulatory framework, etc.).
2.3. Limited capacities to ensure the integrity of seed stands and forest nurseries (fires, livestock grazing, illegal logging, etc.)	Medium	Agency "Moldsilva" and territorial forestry entities have strategies and technical approaches for preventing/mitigating the effects of risks related to the integrity of forests and forest nurseries (guarding; creation of fire protection systems; control/background reviews; communication programs, etc.). Agency "Moldsilva" and territorial forestry entities will sign interaction plans with similar structures of GIES in the context of ensuring timely interventions in case of forest fires and other weathering.
III. Climate and ecological risks		
3.1. Natural disasters affecting the condition of new stands created as a result of reconstruction/rehabilitation activities (droughts, floods, hurricanes, etc.)	Medium	Agency "Moldsilva" and forestry entities have strategies and technical approaches to prevent/diminish the effects of climate risks (irrigation systems; creation of flood protection waves and channels; creation of anti-erosion systems, etc.).
3.2. Damage to biodiversity and habitats	Minimum	Biodiversity will increase by producing forest reproductive material in an assortment of over 85 species of trees and shrubs. This will provide greater structural diversity and an increase in the diversity of habitats used by fauna.

1.3.6.2 Next steps

The main requirements for the subsequent provision of TAP is the assessment and delimitation of forest seed source stands. This activity should be cumulated with the process of creating new sectoral capacities for the production of reproductive forest material in the necessary assortment, based on an industrial and adaptive approach to climate change (NCFGS/RCIBFRM). This prioritization, but also the new technical capabilities, are the basic foundation for the successful implementation of the technology.

1.3.7 TAP overview table for technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions"

Sector:	**Forestry sector**
Sub-sector:	Breeding forest reproductive material
Technology:	*The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions*
Technology ambition	Strengthening the institutional framework in the field of reproductive forest material production by establishing NCFGS and 2 RCIBFRM; use of biotechnologies for the production of propagating material (multiplication, rooting, in vitro growth, etc.), including with protected roots; management of forest seed base (stands, seed sources and FGR) with harvesting, industrial processing and seed conditioning of trees and shrubs; certification of regeneration material; conducting forest genetic research and in vitro breeding; reviewing the regulatory basis for the management and conservation of forest genetic resources, including adaptation to climate change; production capacities of newly created centers – about 65-70 million seedlings annually (including about 20-30% with protected roots) or about 80-90% of sectoral needs in case of implementation of extensive afforestation/reforestation/reconstruction/rehabilitation programs; term 8 years.
Benefits	Resilience/adaptation/environment: (i) Increasing the quantity and quality of forest seed material harvested from identified sources, with beneficial consequences on the quality of saplings and future forestry crops; (ii) Production of forest material in the required assortment, quality and quantities required, which will contribute to increasing the success of forest crops and adapting regeneration and afforestation works to climate change; Capacity building, technology transfer and diffusion: (iii) Improving the management and conservation process of seed source stands as well as forest genetic resources, in particular in terms of adaptation to climate change; (iv) Application of innovative technical solutions for growing forest reproductive material both for regeneration works within the existing forest fund and for afforestation works on new land: Biotechnologies; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and in *vitro* propagation; automated irrigation systems; technical solutions for the care of seed source stands and those designated as forest genetic resources, etc.; (vi) Review of the regulatory basis for the management and conservation of forest genetic resources, including climate change adaptation; Economic/social: (vii) Creation of new jobs in rural areas (about 525 people), related to a wide range of activities; (viii) Increasing revenues in the state budget, local budgets and for population, especially in rural areas, generating on average about 65-70 million lei annually (when reaching maximum production capacity).

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget actions, thousand Euro
1. Creation of new sectoral capacities for industrial growth of forest reproductive material	1.1. Elaboration of project documentation for the establishment of 3 regional centers for industrial breeding of forest reproductive material, including the National Center for Genetics and Forest Seminology (Center area) (location; primary infrastructure;	BS; NEF; SI	Agency „Moldsilva"; Design institution	Year 1	Shortage of forest infrastructure design operators/institutions on the local market.	Projects for the establishment of 3 entities specialized in ecological restoration of forests developed and approved according to the legal procedure.	Projects for the establishment of entities specialized in ecological restoration of forests.	100,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget actions, thousand Euro
	provision of personnel; technical equipment; production capacities; area of activity and transfer of forest material, etc.)							
	1.2. Establishment of 3 regional centers for industrial growth of forest reproductive material (North, Center, South), including NCFGS, endowment with special technique and equipment for assigned functions (care of seed source stands; processing and storage of forest seeds; nursery and laboratory equipment for assessing the quality of seeds/seedlings; tillage; irrigation systems; care/maintenance of seedlings, etc.)	BS; NEF; SI	Agency „Moldsilva"; Design institution; SME	Year 1-Year 4	Shortage of operators specialized in the production and/or delivery of forest nurseries technology.	Regional centers for industrial breeding of forest reproductive material established and functional for the tasks assigned.	Number of established and operational regional centers for industrial rearing of forest reproductive material.	7800,0
	1.3. Delimitation and direct management of regional centers for industrial rearing of forest reproductive material (including NCFGS), seed source stands and those established as FRG;	NEF; SI	Agency „Moldsilva"; FRMI; NBG; ES	Year 1-Year 2	Limited capacities of qualified forestry personnel; opposition of forestry entities owning demarcated sectors.	The seed source stands are delimited to each RCIBFRM according to the areas of activity and regions of provenance.	Area of seed source stands assigned to each RCIBFRM.	70,0
	1.4. Recruitment and training of personnel for industrial breeding centers for forest reproductive material	NEF; SI	Agency „Moldsilva"; NCFGS; FRMI	Year 1-Year 2	Limited capacities of qualified forestry personnel.	RCIBFRM/NCFGS personnel recruited and trained according to approved staff.	Number of RCIBFRM/NCFGS staff recruited and trained.	20,0
2. Updating the normative/legislative framework to ensure timely and constant production of forest reproductive material	2.1. Supplementing the Water Law (no. 272/2011) with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources	BS; SI	Agency „Moldsilva"; MoEnv; Agency „Apele Moldovei"; ONG	Year 1-Year 2	Deviating the policy framework from key priorities in the activity of the forestry sector.	Water Law (no. 272/2011) supplemented with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources.	Amendments to the Water Law (no. 272/2011).	10,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget actions, thousand Euro
	2.2. Supplementing the Forestry Code (no. 887/1996) with provisions that would target particularities regarding the functionality of forest nurseries	BS; SI	Agency „Moldsilva"; MoEnv; ONG	Year 1-Year 2	Deviating the policy framework from key priorities in the activity of the forestry sector.	The Forestry Code (no. 887/1996) completed with provisions that would refer to particularities regarding the functionality of forest nurseries according to the legal procedure.	Amendments to the Forestry Code (no. 887/1996).	10,0
	2.3. Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production	NEF; SI	Agency „Moldsilva"; MoEnv; MF; ONG	Year 2-Year 3	Deviating the policy framework from key priorities in the activity of the forestry sector; Increasing the budget deficit and the impossibility of financial support for the forestry sector.	Regulation on the methodology of forest budget formation approved according to the legal procedure (GD; decisions MoEnv, Moldsilva); The forest seed production activity is carried out through a viable and robust financial mechanism.	GD, decisions of MoEnv and Moldsilva adopted on the methodology of forest budget formation.	10,0
	2.4. Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material	NEF; SI	Agency „Moldsilva"; MoEnv; FRMI; ONG	Year 2-Year 3	Limited capacities to develop the performant regulatory and technical framework.	The secondary regulatory framework on the production, marketing and use of forest reproductive material is developed, approved and fully implemented.	GD, decisions of MoEnv and Moldsilva adopted on the secondary normative framework on the production, marketing and use of forest reproductive material.	25,0
	2.5. Update and completion of the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks	NEF; SI	Agency „Moldsilva"; MoEnv; FRMI	Year 2-Year 3	Limited capacities to develop the performant regulatory and technical framework.	The set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks, is updated/supplemented,	GD, decisions of MoEnv and Moldsilva adopted on technical regulations on breeding and marketing of forest	30,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget actions, thousand Euro
						approved and put into action according to the legal procedure.	reproductive material.	
	2.6. Review of technical regulations related to the care/maintenance of seed source stands, especially in terms of ensuring constant fruiting	NEF; SI	Agency „Moldsilva"; MoEnv; FRMI; NBG	Year 2-Year 3	Limited capacities to develop the performant regulatory and technical framework.	Technical regulations related to the care/maintenance of seed source stands are reviewed, approved and put into action according to the legal procedure.	HG, decisions of MoEnv and Moldsilva adopted on technical regulations related to the care/maintenance of seed source stands.	25,0
3. Strengthening the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions	3.1. Carrying out works to identify new stands sources of seeds to ensure needs and create reserves (about 3-5 thousand ha)	NEF; SI	Agency „Moldsilva"; NCFGS; FRMI; NBG	Year 2-4	Limited area of stands suitable for seed harvesting; Limited capacities of competent personnel in the field of forest seeding.	Stands of new seed sources identified and delimited to ensure needs and create reserves (about 3-5 thousand ha).	Moldsilva decisions adopted on delimitation and legislating of stands new seed sources.	50,0
	3.2. Update and implementation of procedures and processes for certification of forest seeds, including for marketing on the international market	NEF; SI	Agency „Moldsilva"; NCFGS; FRMI; NBG	Year 2-Year 8	Limited capacities of competent personnel in the field of forest seeding.	The entire volume of harvested forest seeds is certified according to national and international standards.	Dynamics of the volume of certified forest seeds; Share of certified forest seeds in the total volume harvested/produced.	105,0
	3.3. Establishment and maintenance of the State Register of Basic Materials (stands, seed sources)	BS; NEF; SI	Agency „Moldsilva"; NCFGS; FRMI; NBG	Year 1-Year 8	Limited capacities of competent personnel in the field of forest seeding; limited area of stands suitable for seed harvesting.	The State Register of Basic Materials is established and maintained according to the legal procedure.	Evolution of the number and area of stands included in the State Register of Basic Materials.	20,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget actions, thousand Euro
	3.4. Establishment in maintaining the State Register of Producers of Forest Reproductive Material	BS; NEF; SI	Agency „Moldsilva"; NCFGS; FRMI	Year 1-Year 8	Low interest in business development in the field of production of forest reproductive material.	The State Register of Producers of Forest Reproductive Material is established and maintained according to legal procedure.	The evolution of the number of legal entities included in the State Register of producers of forest reproductive material; cumulative production capacity of producers included in the State Register of Producers of Forest Reproductive Material.	15,0
4. Production of forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction and extension works	4.1. Carrying out works of care/maintenance of fruiting capacities of key stands (estimated 2500 ha), seed sources (irrigation, fertilization, protection measures, etc.);	NEF; SI	Agency „Moldsilva"; NCFGS; FRMI; NBG; SME	Year 3-Year 8	Low profitability and increased costs of works to maintain fruiting capacities of seed source stands.	The seed source stands are fully covered with care/maintenance works (irrigation, fertilization, protection, etc.).	Dynamics of areas with stands, seed sources cared for/maintained according to technical procedures.	5250,0
	4.2. Industrial harvesting and processing of forest seeds in sufficient quantities (350-400 tons) for the process of forest regeneration/reconstruction and expansion	BS; NEF; SI	Agency „Moldsilva"; NCFGS; SME	Year 3-Year 8	Limited area of stands suitable for seed harvesting; High periodicity of fruiting years in the main tree species (especially oak stands).	Industrial harvesting and processing of sufficient quantities of forest seeds (350-400 tons) for the process of forest regeneration/reconstruction and expansion.	Dynamics of harvests/production of forest seeds for the process of regeneration/reconstruction and expansion of forests.	2736,8

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget actions, thousand Euro
	4.3. Industrial growth (technological production operations) of planting material for the process of regeneration/reconstruction and expansion of forests (65-70 million saplings annually, including about 20-30% with protected roots)	BS; NEF; SI	Agency „Moldsilva"; NCFGS; SME	Year 3-Year 8	Limited capacities of competent personnel in the field of forest nursery; deficit of forest seeds in terms of quantity, quality and assortment.	The process of forest regeneration/reconstruction and expansion is fully ensured with industrially grown seedlings (65-70 million seedlings annually, including about 20-30% with protected roots).	Dynamics of the volume of planting material grown industrially (including with protected roots) for the process of forest regeneration/reconstruction and expansion.	13815,8
5. Monitoring the implementation of technology and works	5.1. Technical supervision of the process of growing forest reproductive material (entire production chain: Seeds, seedlings, certification, etc.)	BS; NEF; SI	Agency „Moldsilva"; FRMI; NBG; MAFI; ONG	Year 1-Year 8	Limited capacities of highly qualified personnel in the field of forest nursery.	The process of production of forest reproductive material (the entire production chain: Seeds, seedlings, certification, etc.) is carried out according to established legal and technical procedures; quality assurance of the technology implementation process, including adaptation to climate change.	Number of technical supervision events of the technology implementation process.	30,6
	5.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	BS; NEF; SI	Agency „Moldsilva"; MoEnv; IEP; MAFI; ONG	Year 1-Year 8	Limited capacities of highly qualified personnel in the field of forest nursery; natural disasters affecting the condition of stands, seed sources and forest nurseries (droughts, floods, etc.).	The process of production of forest reproductive material (the entire production chain: Seeds, seedlings, certification, etc.) is carried out according to established legal and technical procedures; the process of implementing the technology proceeds in accordance with the technical provisions and the time plan.	Number of events to monitor and evaluate the technology implementation process.	153,1

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget actions, thousand Euro
TOTAL								30276,3

1.4 Technology Action Plan "Climate Change Impact Considerations, Forest Species and Appropriate Forest Ecosystem Management Strategies"

1.4.1 Introduction

The technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" provides for the creation of a modern infrastructure for forest research and development, initiation and implementation of substantiation programs on the adaptive capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature based solutions (NBS). These programmes will focus mainly on:

- Establishing climate thresholds corresponding to the spatial distribution limits of forest types and/or forest species, with the development of bioclimatic models to predict future distributions of steady-state forests, in a range of plausible climate change scenarios.
- Collection and analysis of historical information about the migration of species and forests over certain distances to estimate how long it might take for the boundary of existing forests to migrate a certain distance.
- Calibration of biogeochemical models for forecasting changes in the productivity of stands and carbon stocks in the main forest types, with and without the effects of increased CO^2 concentrations.
- Assessment of adaptive capacity, including inherent adaptive capacity of forest species and ecosystems, as well as socio-economic factors determining the ability to implement planned adaptation measures.

The technology corresponds, in particular, to sectoral priorities for the development and implementation of scientifically justified adaptation measures with clear mitigation co-benefits and sustainable development approaches, the promotion of new sustainable forest management practices, the use of climate-resistant tree and shrub species in forestry practices. In this context, it is foreseen the development and promotion of new strategies/approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change, as well as the implementation of sustainable forest management principles. These documents and approaches will be based on a cycle of fundamental research cumulated with applied components on the adaptive capacities of native forest ecosystems to climate change (resilience of species and stands; revision of approaches in the process of applying forest treatments and works, forest regeneration works, etc.).

Technology is a priority for the forestry sector, and among the main innovative aspects foreseen within the technology are mentioned aspects regarding the evolution/forecasting of the spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; resilience of forest species and ecosystems to the effects of climate change, etc.

The main and direct benefits of implementing the technology in question are:

a) <u>Environmental benefits:</u>
   - Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change, based on fundamental and applied local research.

- Elaboration of new technical regulations to ensure concrete steps in achieving the resilience of forest ecosystems to the effects of climate change.
- Improving the management and conservation process of stands, especially in terms of adaptation to climate change.
- Testing/piloting new technologies and approaches to creating climate-smart forests.

b) Socio-economic benefits:
   - Creation of new jobs (directly about 135 people), related to a wide range of activities: Conducting forestry scientific research and investigations; creation and maintenance of research infrastructure, experimental sectors/lots; transport and logistics services, etc.
   - The implementation in practice of new approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change developed within the technology will anticipate public and private expenditures for compartments related to forest regeneration/expansion, application of forest treatments/works worth about EUR 2.5-3.5 million annually.

c) Capacity building, technology transfer and diffusion:
   - Contributes to strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply innovative technical solutions for forest ecosystem management in new climatic conditions.
   - Implementation of innovative components provided within the measure: Application/use of informational/digital technologies in the process of conducting investigations and processing results; evolution/forecast of spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; resilience of forest species and ecosystems to the impacts of climate change; monitoring carbon stocks; recording, monitoring and forecasting the processes of succession of forest species, etc.
   - Development of new approaches and technical regulations to ensure resilience of forest ecosystems to climate change impacts.

Technology does not affect gender equality. Women are extensively involved in the implementation process in most stages and activities: Conducting field and office research; practical testing of new forest management approaches and technologies, etc., respecting occupational safety measures. The degree of direct involvement in technology is estimated at 45% men and 55% women.

1.4.2 Ambition for TAP

The country's climate priorities consist of implementing climate change adaptation measures, by incorporating the climate component into medium and long-term strategic planning, encouraging adaptation actions to mitigate climate risks in investment decision-making and business planning, in order to increase the resilience of national economy sectors, land use and ecosystems, and to accelerate the country's transition to low carbon and resilient development. Through the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" for the forest-based sector, objectives and actions aimed at adapting to climate change include scientifically justified adaptation measures with clear mitigation co-benefits and approaches to sustainable development, maintenance and adequate monitoring of forest condition, with intensified forest afforestation/reforestation using climate-resistant tree and shrub species. It also provides for the promotion of new practices of sustainable forest management to halt the reduction of forest areas, halt

the degradation of forest biodiversity by promoting natural forest types; reducing fragmentation of forest massifs; combating illegal logging and related trade by implementing timber traceability and forest certification methods. At the same time, for the current technology prioritized on the forestry sector, as preliminary objectives and targets, the following are foreseen:

- Identification of interactions related to climate change, forest species and appropriate forest ecosystem management strategies – initiation and implementation of cumulative fundamental research programs with applied components on the adaptive capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature-based solutions (NBS); elaboration of new solutions/approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change (updated operational list of tree and shrub species for regeneration/afforestation; new spatial distribution limits of forest types and/or forest species; technical guidance on forest regeneration/expansion under new climatic conditions; technical guidance on the application of forest treatments according to the new climatic conditions, etc.); promoting sustainable forest management practices under climate change conditions; exchange of experience with similar institutions in neighboring countries and international forest centers.

1.4.3 Actions and activities selected for inclusion in TAP

1.4.3.1 Summary of barriers and measures to overcome barriers

The main barriers to be addressed in the technology transfer assessment process "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" refer to the limited administrative-institutional and personnel capacities of the forestry sector in this chapter, the deficit of public and private investments, insufficient development of forest R&D infrastructure, etc. These barriers seriously affect the capacity of the national forestry sector to ensure sustainable management activities of forest ecosystems, generational change in forests through regeneration, ecological restoration and afforestation operations, qualitative planting material, in the assortment of tree and shrub species corresponding to stationary conditions, etc.

It is also mentioned that the topic of current scientific research does not cover the entire spectrum of problems and risks faced by the national forestry sector at the moment or are forecast for the future. This cumulation of barriers and/or needs seriously affects the capacity of the forestry sector to ensure a qualitative and efficient management of forest ecosystems, generates uncertainties regarding the future of the national forest heritage. As a fundamental cause of the problem, insufficient technical-scientific assurance of the process of adaptation to climate change of forest ecosystems is identified. In total, for this technology, 18 barriers/needs are identified, of which 10 with major impact. The main categories of barriers to the transfer of this technology and their characterization aspects are set out in Table 1.13.

Table 1.13: Key barriers identified to technology transfer 'Climate change impact considerations, forest species and appropriate forest ecosystem management strategies'

Nr. d/o	Key barriers	Detailed aspects of barriers
1.	Deficit in financial resources for forest research and development activity	The financial means allocated annually in the state budget for forest management constitute only about 2-3% of the budget of the state forestry sector, the rest have their own revenues from commercial activity. The financial means allocated annually in the

Nr. d/o	Key barriers	Detailed aspects of barriers
		forestry budget for research and development activity represent on average only about 2.5%, to a need of 7-8%.
2.	Insufficient technical endowment of forest research and development institutions	Most of the technical facilities existing in forest research and development institutions are morally and physically obsolete, with a period of use of over 25 years. Poor application of forest R&D institutions to international projects with technical endowment components.
3.	Insufficient development of forest R&D infrastructure	Insufficiency of thematic experimental networks (sample areas, experimental lots, forestry-didactic/experimental bases, etc.) with forest profile.
4.	Shortage of forestry personnel in the field of research and development	R&D institutions are facing a shortage of highly qualified personnel. The spectrum of experts specialized in forest management and modelling on the evolution of forests under climate change conditions is very limited.
5.	Lack of a sustainable programme in the forestry sector to upskill and upskill staff	Starting with 2018, the process of improving forestry staff was abandoned. Lack of an operational program for continuous improvement of forestry personnel, including seasons at international research and development centers.
6.	Low degree of implementation of scientific research results in national forestry practice	The low quality and timeliness of the results and recommendations of scientific research in forestry. Limited access of forestry practitioners to information, reports and recommendations of scientific research in forestry. Most forest and environmental policy documents (strategies, programmes, action plans, etc.) adopted over the last two decades are mostly outdated, expired and have an average implementation rate of 40-60%.
7.	Insufficient legislative regulation of the process of promoting research and innovations in forestry practice	The current version of the Forestry Code does not include provisions that would concern concrete aspects regarding the provision of scientific research in forestry, certain general aspects are mentioned in Articles 12 and 41, and aspects related to innovation are missing.
8.	The topic of scientific research does not cover the entire spectrum of problems faced by the national forestry sector	Lack of initiative of institutions within the forestry sector in promoting forestry issues in national research programs. Inefficient application of the institutional approval mechanism by the forestry sector for research programs developed and implemented by NARD.
9.	Insufficient collaboration of the forestry sector with R&D institutions	Deficit of institutionalized experimental objects on basic problems of national forestry within the forest fund. Lack of memoranda/agreements for collaboration, exchange of experience and data between research and development institutions and forestry entities.
10.	The normative basis related to forest management is poorly updated by current research activities	Technical regulations related to the forestry regime require profound creation and/or updating, including in terms of overcoming climate risks. The results of current forest research activities have a general, less recommendatory and regal character.

1.4.3.2 Activities identified for the implementation of selected actions

The detailed analysis of aspects related to the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" carried out at the previous stages of the project generated the development of a complex of measures aimed at facilitating the implementation process of that technology. In order to overcome the 18 barriers and/or needs, 19 measures were identified to ensure technology transfer "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies". In the current process, for the technology concerned, important measures/activities have been selected and consolidated into 4 actions (Table 1.14). At the same time, additional action-specific activities have been developed, which are considered to make an essential contribution to the implementation of the technology. In this context, specific activities (12 activities) are established as concrete measures for the

implementation of technology actions/objectives, based also on the purpose of gradually overcoming the barriers and risks identified in the way of technology transfer.

Table 1.14: Actions and activities aimed at implementing the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

Name of action	Necessary activities to implement
1. Updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice	1.1. Supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as promoting innovation in forestry
	1.2. Revision of the normative document regarding the methodology of forest budget formation, including the establishment of a minimum quota of 7-8% for research and development activity
	1.3. Initiating and implementing a sectoral plan for updating/revising the main technical regulations related to the forestry regime (forest planning; choosing and applying forestry treatments; forest regeneration and extension, etc.) based on the results/recommendations of national research and development institutions
	1.4. Revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the salary level of highly qualified personnel participating in research and development activities
2. Strengthening the capacities of the forestry R&D sector according to the new climatic conditions	2.1. Development and implementation of a sectoral plan on the development of forest research and development infrastructure
	2.2. Development and implementation of a national program on technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.)
	2.3. Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.);
3. Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change	3.1. Elaboration and implementation of a consolidated sectoral research operational program on medium and strategic term that would target priority directions and forest issues (4 compartments: Migration and/or species succession; forest regeneration; adaptation to climate change, etc.)
	3.2. Elaboration of a new program for sustainable development of the forestry sector that will incorporate the recommendations of scientific research in forestry
	3.3. Establishing an effective public information system on the state of forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems
4. Monitoring the implementation of technology and works	4.1. Technical supervision of the research/design process
	4.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes

The technology implementation process starts with activities aimed at updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice. In this context, the Forestry Code will be completed with provisions aimed at concrete aspects regarding the organization of scientific research in forestry, as well as the promotion of innovation in forestry. Also in this compartment, it is foreseen to update the methodology for forming the forestry budget by establishing a quota of at least 7-8% for the sectoral research and development activity. These two actions will ensure, including from a financial point of view, the permanence and opportunity of the activity of research and development institutions, including for the purpose of developing new approaches/recommendations/regulations for the sustainable management process of forest ecosystems. Another important aspect necessary to solve at the initial stage of technology implementation is the updating/revision of the main technical regulations related to the forestry regime (forest planning; choice and application of forestry treatments; forest regeneration and extension, etc.)

based on the latest results/recommendations of national research/development institutions. This will give new impetus to indigenous research, demonstrating the opportunity and usefulness for indigenous forestry practice.

For the forest R&D sector, extensive capacity building activities are foreseen for the activity in the new socio-economic and climatic conditions. The main issues addressed are the development of research and development infrastructure, technical equipment and training of highly qualified staff (master, doctorate, etc.). Solving these problems, correlated with the adequate financial support, will create a solid and sustainable foundation for the development and prolific activity of the forest research and development sector.

The implementation of a consolidated sectoral research operational programme that would target priority directions and forest issues (4 compartments: Migration and/or species succession; forest regeneration; adaptation to climate change, etc.) will generate the development of new approaches to establishing climate thresholds corresponding to the spatial distribution limits of forest types and/or forest species, forecasting changes in stand productivity and carbon stocks, inherent adaptive capacity of forest species and ecosystems in the Republic of Moldova, etc. The access of researchers and practitioners to information on the state of forests, as well as the exchange of information and knowledge on climate issues and sustainable management of forest ecosystems will be achieved through a functional and sustainable public information system (Forest Platform). Further details of the actions and activities identified for the implementation of the technology "Climate Change Impact Considerations, Forest Species and Appropriate Forest Ecosystem Management Strategies" are set out in paragraph 1.4.7 (TAP overview table for technology "Climate Change Impact Considerations, Forest Species and Appropriate Forest Ecosystem Management Strategies") of this Report.

1.4.4 Stakeholders and timeline for TAP implementation

The main implementation obligations belong to dedicated research institutions (NBG, IEG, IGPPP, etc.), universities, which have capacity, experience and tools to apply technology. MECR (staff training/improvement; conducting research, etc.), MM, Agency "Moldsilva" (especially FRMI), companies and private individuals will participate in the implementation process. The process will include the launch and implementation of a cycle of national research programmes focusing mainly on aspects related to the evolution/forecasting of the spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; adaptive capacities of forest species and ecosystems; socio-economic factors determining the capacity to implement sectoral adaptation measures, etc. It also provides for the involvement of the private sector (SME – participation in the development of forest research and development infrastructure, technical endowment of forest research and development institutions; transport and logistics services, etc.) and civil society (NGO – expertise, communication, training, etc.). The coverage area of the technology will be forests owned by Agency "Moldsilva" and its territorial structures (337.6 thousand ha), located throughout the country. The total implementation period of the technology will be 8 years (Table 1.15).

Table 1.15: Stakeholder analysis by implementation activities for the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

Name of action	Necessary activities to implement	Institutions/structures involved	Period
1. Updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice	1.1. Supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as promoting innovation in forestry	Agency „Moldsilva"; MoEnv; MECR; ONG	2023-2024
	1.2.Revision of the normative document regarding the methodology of forest budget formation, including the establishment of a minimum quota of 7-8% for research and development activity	Agency „Moldsilva"; MoEnv; MF; MECR; ONG	2023-2024
	1.3. Initiating and implementing a sectoral plan for updating/revising the main technical regulations related to the forestry regime (forest planning; choosing and applying forestry treatments; forest regeneration and extension, etc.) based on the results/recommendations of national research and development institutions	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; IEG; IGPPP	2024-2025
	1.4. Revision of the regulatory framework on labor remuneration in the forestry sector in order to increase the salary level of highly qualified personnel participating in research and development activities	Agency „Moldsilva"; MECR; ME; MMPS	2023-2024
2. Strengthening the capacities of the forestry R&D sector according to the new climatic conditions	2.1. Development and implementation of a sectoral plan on the development of forest research and development infrastructure	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; SME	2024-2025
	2.2. Development and implementation of a national program on technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.)	Agency „Moldsilva"; MoEnv; MECR; SME	2023-2027
	2.3. Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.)	Agency „Moldsilva"; MoEnv; MECR; ONG	2023-2028
3. Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change	3.1. Elaboration and implementation of a consolidated sectoral research operational program on medium and strategic term that would target priority directions and forest issues (4 compartments: Migration and/or species succession; forest regeneration; adaptation to climate change, etc.)	Agency „Moldsilva"; MoEnv; MECR; ONG	2025-2030
	3.2. Elaboration of a new program for sustainable development of the forestry sector that will incorporate the recommendations of scientific research in forestry	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; IEG; IGPPP; ONG	2029-2030
	3.3. Establishing an effective public information system on the state of forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems (Forest Platform)	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; IEG; IGPPP; ONG	2025-2030
4. Monitoring the implementation of technology and works	4.1. Technical supervision of the research/design process	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; ONG	2023-2030

Name of action	Necessary activities to implement	Institutions/structures involved	Period
	4.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	Agency „Moldsilva”; MoEnv; MECR; FRMI; NBG; ONG	2023-2030

The activity will include consultation and adaptation of results, exchange of experience with similar institutions and structures from neighboring countries (Romania, Hungary, Poland, Czech Republic, Bulgaria, etc.) as well as with international forest centers (EFI; IUFRO; EUFORGEN, etc.). For direct implementation, the mechanisms established by the existing legislation in the field will be used (Forest Code; Code on Science and Innovation; guidelines and recommendations on conducting scientific research, etc.).

1.4.5 Estimate of resources needed for actions and activities

The estimated value of financial resources needed for actions aimed at implementing the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" is 4879 thousand Euro or an annual average of about 610 thousand Euro (Table 1.16). Due to the current state in the forestry sector (shortage of highly qualified personnel; shortage of modern equipment and equipment; financial deficit for research and development activities, etc.), the implementation process of this technology must start with capacity building activities (institutional, personnel, technical equipment; creation/rehabilitation of forest research and development infrastructure, etc.) to facilitate the implementation of basic activities (actions 1-2). Thus, for technology-related capacity building activities, financial means amounting to EUR 3025 thousand or 62.0% of the total investment value for the technology in question are required.

Table 1.16: Resources needed for actions to implement the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

Name of action	Period	Budget actions, thousand Euro	Percent, %
1. Updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice	Year 1-Year 3	75,0	1,5
2. Strengthening the capacities of the forestry R&D sector according to the new climatic conditions	Year 1-Year 6	2950,0	60,5
3. Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change	Year 3-Year 8	1670,0	34,2
4. Monitoring the implementation of technology and works	Year 1-Year 8	183,8	3,8
TOTAL		4878,8	100,0

Strengthening the normative/legislative framework to ensure the promotion of research and innovations in forestry practice is a very important action with an extremely high synergetic potential. Because the research and development activity is the foundation of the forest regime implementation process (forest management plans; afforestation/regeneration projects; technical regulations, etc.).

Another important aspect foreseen for solving is the elaboration of a new program for sustainable development of the national forestry sector, including the incorporation of recommendations/approaches to local scientific research with forestry profile. The strategy for sustainable development of the national forestry sector expired in 2020, there is already an urgent

need for a new policy document that would establish the sectoral tasks and milestones for the period 2023-2030, including in the context of the provisions of the National Development Strategy "European Moldova 2030". There is also a need to ensure synergism with the technologies "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change" and "Use of modern biotechnologies for the propagation of vegetative material in providing the forestry sector with reproductive material in new climatic conditions", which have provided for a wide range of research and development activities. From this desideratum, it follows that all three technologies must be started in approximately parallel, carefully following the implementation schedules of key activities.

1.4.6 Management planning

1.4.6.1 Risk and emergency assessment

The process of planning technology deployment activities also includes the assessment of possible risks and emergency situations for which certain measures to reduce consequences/influences are stipulated. In this context, risks that have a major influence on the activities and processes expected to be implemented within technology (fires, floods, droughts, grazing animals, illegal logging, etc.), provision with highly qualified personnel, availability of advanced technique/equipment, provision of technical regulations, etc. are subject to priority assessment.

The main risks associated with the implementation of this technology are minimal and medium. At the same time, the experience of the country, the forestry sector and the institutions involved offers the certainty of overcoming them. Table 1.17 provides an overview and analysis of the main identified/potential risks for the technology 'Climate change impact considerations, forest species and appropriate forest ecosystem management strategies'.

Table 1.17: Risks associated with the implementation of the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

Risks	Categories	Anticipation/mitigation actions
I. Financial and social risks		
1.1. Funding gap for R&D activities	Medium	In the process of implementing the technology, the normative framework on the methodology of forest budget formation will be updated so that the research and development activity (setting the minimum quota of 7-8%) to be carried out through a viable and robust financial mechanism (GD; decisions MM, Moldsilva).
1.2. Opposition of local population (including pastoralists/animal keepers) due to limiting access and uses in forests with research and development activities	Minimum	Agency "Moldsilva" and subordinated structures (forestry entities, FRMI, etc.) will implement a comprehensive communication plan aimed at raising awareness of the need for research and development activities. Providing alternative sectors for access and traditional uses by the local population (mushrooms, berries; recreation, grass harvesting, etc.).
1.3. Low level of remuneration of personnel involved in research and development activities	Medium	The regulatory framework on remuneration of work for personnel involved in research and development activities will be reviewed and implemented according to the legal procedure. The increase in the average wage in the forestry sector will stimulate the growth of employment interest in the forestry sector.
II. Institutional, technological and regulatory risks		

Risks	Categories	Anticipation/mitigation actions
2.1. Shortage of forest infrastructure design operators/institutions on the local market	Minimum	Certain forest design areas are covered by the FRMI, which as part of the technology will be subject to the capacity-building procedure. In the region (Hungary; Czech Republic; Poland; Romania, etc.) there are sufficient operators providing services in the field of forest infrastructure design (research and development, nurseries, logging, etc.).
2.2. Limited capacities of highly qualified personnel for R&D activities	Medium	The institutions involved in the process (Agency "Moldsilva", FRMI, etc.) have a certain experience and a minimum number of qualified personnel to ensure the quality and timeliness of design works. In the process of technology implementation, an extensive capacity building program will be carried out in this compartment (implementation of the operational program for training forestry personnel on key areas; improvement of the regulatory framework on labor remuneration in the forestry sector, etc.).
2.3. Limited capacities to ensure the integrity of stands and primary R&D infrastructure (fires, animal grazing, illegal logging, etc.)	Medium	Agency "Moldsilva" and territorial forestry entities have strategies and technical approaches to prevent/mitigate the effects of risks related to the integrity of forests and infrastructure (security; creation of fire protection systems; control/background reviews; communication programs, etc.). Agency "Moldsilva" and territorial forestry entities will sign interaction plans with similar structures of GIES in the context of ensuring timely interventions in case of forest fires and other weathering.
III. Climate and ecological risks		
3.1. Natural disasters affecting the state of forests and R&D infrastructure (droughts, floods, etc.)	Medium	Agency "Moldsilva" and forestry entities have strategies and technical approaches for preventing/mitigating the effects of climate risks (creation of flood protection waves and channels; creation of fire protection systems; temporary irrigation systems, etc.).
3.2. Affecting biodiversity and habitats in the process of performing technological operations within the research and development activity	Minimum	Biodiversity will increase by implementing technological operations within the research and development activity by using an assortment of over 85 species of trees and shrubs, ecosystem based approach (EbA) and nature-based solutions (NBS). This will provide greater structural diversity and an increase in the diversity of habitats used by fauna.

1.4.6.2 Next steps

The main requirements for the subsequent provision of TAP is to strengthen the normative/legislative framework to ensure the promotion of research and innovation in forestry practice. Because the research and development activity is the foundation of the forest regime implementation process (forest management plans; afforestation/regeneration projects; technical regulations, etc.). This action must be cumulated with the process of creating new sectoral capacities to carry out research and development activities. The mentioned prioritization, but also the new technical capabilities are the basic foundation for the successful implementation of the technology.

1.4.7 TAP overview table for technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies"

Sector:	**Forestry sector**
Sub-sector:	Research and technological development
Technology:	*Climate change impact considerations, forest species and appropriate forest ecosystem management strategies*
Technology ambition	Creating a modern infrastructure for forest research and development; identification of interactions related to climate change, forest species and appropriate forest ecosystem management strategies – initiation and implementation of cumulative fundamental research programs with applied components on the adaptive capacities of native forest ecosystems to climate change, ecosystem based approach (EbA) and nature-based solutions (NBS); developing new solutions/approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change; promoting sustainable forest management practices under climate change conditions; implementation term – 8 years.
Benefits	Resilience/adaptation/environment: (i) Development and implementation of new approaches and technical regulations related to the process of adaptation of native forest ecosystems to climate change, based on local fundamental and applied research; (ii) Improving the management and conservation process of stands, in particular in terms of adaptation to climate change; (iii) Implementation in practice of new approaches and technical regulations to ensure resilience of forest ecosystems to climate change impacts developed in the technology; Capacity building, technology transfer and diffusion: (iv) Implementation of innovative components for the forestry sector: Forecasting the spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; resilience of forest species and ecosystems to climate change impacts; recording, monitoring and forecasting of forest species succession processes, etc.; Economic/social: (v) Creation of new jobs (directly about 135 people); (vi) Anticipating public and private expenditures for forest regeneration/extension departments, application of forest treatments/works worth about EUR 2.5-3.5 million annually, etc.

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget activities, thousand Euro
1. Updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice	1.1. Supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as promoting innovation in forestry	BS; SI	Agency „Moldsilva"; MoEnv; MECR; ONG	Year 1-Year 2	Deviating the policy framework from key priorities in the activity of the forestry sector.	The Forestry Code (no. 887/1996) supplemented according to the legal procedure with provisions that would target particularities regarding the organization of scientific research in forestry, as well as the promotion of innovation in forestry.	Amendments made to the Forestry Code (no. 887/1996), including on the organization of research and promotion of innovation.	10,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget activities, thousand Euro
	1.2. Revision of the normative document regarding the methodology of forest budget formation, including the establishment of a minimum quota of 7-8% for research and development activity	NEF; SI	Agency „Moldsilva"; MoEnv; MF; MECR; ONG	Year 1-Year 2	Deviating the policy framework from key priorities in the activity of the forestry sector; Increasing the budget deficit and the impossibility of financial support for the forestry sector.	Regulation on the methodology of forest budget formation approved according to the legal procedure (GD; decisions MM, Moldsilva); R&D activity in the forestry sector is carried out through a viable and robust financial mechanism.	GD, decisions of MoEnv and Moldsilva adopted on the methodology of forest budget formation.	10,0
	1.3. Initiating and implementing a sectoral plan for updating/revising the main technical regulations related to the forestry regime (forest planning; choosing and applying forestry treatments; forest regeneration and extension, etc.) based on the results/recommendations of national research and development institutions	NEF; SI	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; IEG; IGPPP; ONG	Year 2-Year 3	Limited capacities to develop the performant regulatory and technical framework; poor cooperation between R&D institutions.	The set of technical regulations related to ensuring the implementation of the forestry regime, including aspects of adaptation to climatic conditions and risks is updated/supplemented, approved and put into action according to the legal procedure.	GD, decisions of MoEnv and Moldsilva adopted on technical regulations on ensuring the implementation of the forestry regime.	45,0
	1.4. Revision of the regulatory framework on labour remuneration in the forestry sector in order to increase the salary level of highly qualified personnel participating in research and development activities	BS; NEF; SI	Agency „Moldsilva"; MECR; ME; MMPS	Year 1-Year 2	Sectoral and budgetary deficit of financial means.	The regulatory framework on remuneration of work in the forestry sector revised and implemented according to the legal procedure; Increase of the average salary in the forestry sector; Increasing interest in employment in the forestry sector.	The number of forestry personnel remunerated according to the new tariffs; The relative value of the average salary on the forestry sector compared to the average indices on the national economy.	10,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget activities, thousand Euro
2. Strengthening the capacities of the forestry R&D sector according to the new climatic conditions	2.1. Development and implementation of a sectoral plan on the development of forest research and development infrastructure	NEF; SI	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; SME	Year 2-Year 4	Limited capacities of competent and highly qualified personnel; Insufficient collaboration of the forestry sector with R&D institutions.	Forest research is carried out within a new, reconfigured and properly equipped structure.	Share of forest research and development objects renovated and/or built new.	1200,0
	2.2. Development and implementation of a national program on technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.)	NEF; SI	Agency „Moldsilva"; MoEnv; MECR; SME	Year 1-Year 5	Shortage of operators on the local market specialized in the production and/or delivery of specialized forestry equipment; shortage of highly qualified personnel in the field of forest research.	Forest Research and Development Institutions (FRMI; NBG; IEG; IGPPP, etc.) are equipped with advanced equipment and techniques for research and design; The new equipment is used in the current research-design activity.	The share of new equipment in the technical insurance of forest research and development institutions; number of applications of forest research and development institutions to international projects with technical endowment components.	1500,0
	2.3. Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.)	BS; NEF; SI	Agency „Moldsilva"; MoEnv; MECR; ONG	Year 1-Year 6	Low interest of researchers in the forestry sector.	Forest Research and Development Institutions (FRMI; NBG; IEG; IGPPP, etc.) have highly qualified personnel sufficient to carry out research and design according to current forestry issues, especially the influence of climate change on the state and evolution of forest ecosystems.	Number of highly qualified personnel trained annually in forest research and development institutions.	250,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget activities, thousand Euro
3. Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change	3.1. Elaboration and implementation of a consolidated sectoral research operational program on medium and strategic term that would target priority directions and forest issues (4 compartments: Migration and/or species succession; forest regeneration; adaptation to climate change, etc.)	NEF; SI	Agency „Moldsilva"; MoEnv; MECR; ONG	Year 3-Year 8	Shortage of highly qualified personnel in the field of forest research; deviating the policy framework from key priorities in the activity of the forestry sector;	Elaboration of new approaches regarding the establishment of climatic thresholds corresponding to the spatial distribution limits of forest types and/or forest species, forecasting changes in the productivity of stands and carbon stocks, inherent adaptive capacity of forest species and ecosystems in the Republic of Moldova, etc.	Number of new or revised technical regulations on adaptation of forest ecosystems to climate change, developed and implemented.	1200,0
	3.2. Elaboration of a new program for sustainable development of the forestry sector that will incorporate the recommendations of scientific research in forestry	BS; NEF; SI	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; IEG; IGPPP; ONG	Year 7-Year 8	Deviating the policy framework from key priorities in the activity of the forestry sector; LOW degree of implementation of scientific research results in national forestry practice.	The programme for sustainable development of the forestry sector under the new climatic conditions is developed and implemented according to the legal procedure.	Decision document (HG) on the programme for sustainable development of the forestry sector in the new climatic conditions.	120,0
	3.3. Establishing an effective public information system on the state of forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems (Forest Platform)	BS; NEF; SI	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; IEG; IGPPP; ONG	Year 3-Year 8	Poor experience in communicating with society and public authorities; poor cooperation between R&D institutions.	The public information system (Forest Platform) on the state of forests, exchange of information and knowledge on climate issues and sustainable management of forest ecosystems is created and functions sustainably.	Dynamics of the number of publications/reports published within the public forest information system; dynamics of the number of users of the forest information system.	350,0

Name of action	Necessary activities to implement	Sources of funding	Responsible institutions and focal points	Period	Risks	Success criteria	Indicators for monitoring implementation	Budget activities, thousand Euro
4. Monitoring the implementation of technology and works	4.1. Technical supervision of the research/design process	BS; NEF; SI	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; ONG	Year 1-Year 8	Limited capacities of highly qualified forestry personnel.	The process of carrying out research/design is carried out according to established legal and technical procedures; quality assurance of the technology implementation process, including adaptation to climate change.	Number of technical supervision events of the technology implementation process.	30,6
	4.2. Monitoring and evaluation of the process of implementation of technology and works, elaboration of reports and informative notes	BS; NEF; SI	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; ONG	Year 1-Year 8	Limited capacities of highly qualified forestry personnel.	The process of implementing the technology proceeds in accordance with the technical provisions and the time plan.	Number of events to monitor and evaluate the technology implementation process.	153,1
TOTAL								4878,8

1.4.8 Brief summary of project ideas for adapting the forestry sector to climate change

As described in the previous chapters, the forestry sector is an important economic area of the Republic of Moldova, and climate change greatly affects forest ecosystems and associated biological diversity. Sectoral technological needs are major and urgent. The actions selected for TAP on each technology can be classified into three broad categories: Capacity development/capacity building (regulatory, institutional, personnel, etc.), investment (infrastructure creation, technical endowment, etc.) and information. All actions correspond and are interconnected in the direction of developing an environment that allows achieving the specified target for each technology. The actions recommended as project ideas for the forestry sector have been selected as key actions of the corresponding technology, which means that the implementation of the project ideas determines the formation of a situation that facilitates the adoption/implementation of that technology. Thus, the project idea triggers a "shift" in the adoption and dissemination of the appropriate prioritized technology.

It was also intended that project ideas contain a certain feasibility and commercial attractiveness, as well as a beneficial impact on the environment. Given the shortage of State financial support, project ideas should also be economically attractive to potential investors, both national and international investors. This increases the chance that technologies will be deployed and attract additional investment. At the same time, the commercial aspect is relative and secondary, as the technologies prioritized for the forestry sector are assigned to the category "Non-market goods – publicly supplied goods". These technologies are procured/fulfilled and disseminated by a public entity (Agency "Moldsilva" etc.) to a large population of users and/or beneficiaries, and major investments in these technologies tend to be decided at governmental level and depend, to a large extent, on the policies adopted in the forestry field and/or environmental protection. The main result of technologies is to ensure the amplification and sustainability of ecosystem services (protection of agricultural land, localities and infrastructure; reduction of GHG emissions; biological diversity, etc.) granted to society by publicly owned forests (state and ATU). In this context, 3 specific project ideas were recommended for the adaptation of the forestry sector to climate change:

- Creation of regional centers for reconstruction/rehabilitation of inadequate and vulnerable stands.
- Modernization of the process of providing the forestry sector with reproductive material in the new climatic conditions by establishing the National Center for Forest Genetics and Seminology.
- Strengthening the capacities of the forestry R&D sector according to the new climatic conditions.

The project "Creation of regional centers for reconstruction/rehabilitation of inadequate and vulnerable stands" aims to strengthen or even create technical and personnel capacities for timely and qualitative performance of reconstruction/rehabilitation works of inadequate and vulnerable stands. These centers are conceived as structural subdivisions within 3 territorial entities from the northern, central, southern regions, also having a certain administrative autonomy. The established regional centers will carry out primary operations aimed at substitution/restoration of inadequate and vulnerable stands (extraction/harvesting of existing stands; removal/grubbing of stumps; tillage of soil in a state suitable for planting). Next, the activity of planting, maintaining and caring for new forest crops must be taken over by the forestry entity owning the land. This approach will offer the possibility of concentrating qualified and specialized personnel in the field of reconstruction/rehabilitation of

inadequate and vulnerable stands, modern technology with high production capacity, as well as economic efficiency of the respective process.

The project "Modernization of the process of providing the forest sector with reproductive material in the new climatic conditions by setting up the National Center for Genetics and Forest Seminology" provides for the start of the process of adaptation of the subsector of production of forest reproductive material to the evolution of climate change through consolidation and modernization activities throughout the production chain. The basic tasks of NCFGS provide: Seed base management (stands, seed sources and FGR on about 3-4 thousand ha); certification of seed and reproductive material for the entire forestry sector; processing and conditioning of forest seeds; production of seedlings, including protected roots; conducting genetic research and in *vitro* breeding; primary operational activity, etc. As a supplier of seedlings, NCFGS will serve the central region of Moldova, with an annual production capacity of approximately 15-20 million seedlings annually.

The main tasks of the project "Strengthening the capacities of the forest research and development sector according to the new climatic conditions" refer to the development of research and development infrastructure within forest institutions (FRMI; NBG; IEG; IGPPP, etc.), appropriate technical endowment of the respective research and development institutions, training of highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.).

1.4.9 Specific project ideas for adaptation of the forestry sector to climate change

1.4.9.1 Aspects regarding the project idea "Creation of regional centers for reconstruction/rehabilitation of inadequate stands vulnerable to climate change"

Under the technology "Ecological restoration of inadequate and vulnerable stands for adaptation to climate change", as a pilot project with the conventional name "Creation of regional centers for reconstruction/rehabilitation of unsuitable and climate-vulnerable stands", it is proposed to actions related to capacity development/capacity building in the field of reconstruction/rehabilitation of inadequate stands vulnerable to climate change be implemented. They can be compiled with a piloting component of the action aimed at directly carrying out ecological reconstruction works of inadequate and vulnerable stands, which would include up to 5% of the volume established in the technology (about 1250 ha). The estimated value of the costs for the implementation of the project would be 7857.3 thousand Euro (Table 1.18) or 13.7% of the total investment amount required for the technology in question.

Table 1.18: Components of the pilot project idea "Creation of regional centers for reconstruction/rehabilitation of inadequate and climate-vulnerable stands"

Components	General component content
General information	The extension of forest areas in the postwar period was achieved on degraded and poorly productive lands excluded from agricultural set-aside, with heavy pedogeological conditions and with the dominance of introduced species (acacia, softwood, etc.). As a result, about one third of the stands in the national forest fund are made up of species that do not belong to the natural ecosystems of Moldova. At the same time, according to estimates, at present about 40% or 120 thousand ha of forests managed by Agency "Moldsilva" have certain degradation elements that affect their capacities to adapt to climate change and require measures of reconstruction/rehabilitation/consolidation.

Components	General component content
	Technologies for reconstruction/rehabilitation of inadequate stands vulnerable to climate change are relatively known in the Republic of Moldova, but for certain technical and financial reasons they are implemented in a proportion of 10-15% of the needs and with priority in protected areas. Due to the available technical and financial resources, but also to visions, the efforts of institutions within the forestry sector (Moldsilva; forestry entities; LPA, etc.) They are focused primarily on maintaining a fragile balance, rather than on development and paradigm shift. The project aims to create technical and personnel capacities for timely and qualitative performance of reconstruction/rehabilitation works of inadequate stands vulnerable to climate change in the forest fund managed by Agency "Moldsilva". The capacities will be developed primarily through the establishment of 3 regional centers for the reconstruction/rehabilitation of inadequate and climate-vulnerable stands (RCEFR). The established regional centers will be specialized in carrying out primary operations aimed at substitution/restoration of inadequate and vulnerable stands (extraction/harvesting of existing stands; removal/grubbing of stumps; tillage of soil in a state suitable for planting). Next, the activity of planting, maintaining and caring for new forest crops must be taken over by the forestry entity owning the land. Subsequently, as the technical processes are consolidated and practical experience is gained, the respective centers will provide similar services to other holders of forest fund or forest vegetation (ATU; APC; private). This approach will offer the possibility of concentrating qualified and specialized personnel in the field of reconstruction/rehabilitation of inadequate and vulnerable stands, modern technology with high production capacity, as well as economic efficiency of the respective process.
Objectives (What will the project achieve?)	As specific objectives pursued during the implementation of the project, the following are established: ● *Creating new sectoral capacities to carry out ecological restoration works.* ● *Updating the normative/legislative framework regarding the technical and financial assurance of sustainable forest management.* ● *Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions.* ● *Piloting works and interventions for ecological restoration of inadequate and vulnerable stands based on technically substantiated decisions.* The main results/deliverables of the project implementation will be the following: ● *Result 1: Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers), creation of infrastructure, endowment with special equipment and equipment for assigned functions (extraction of pre-existing stand; deforestation; tillage, etc.), recruitment and training of personnel, etc.* ● *Result 2: Updating the normative/legislative framework regarding the technical and financial assurance of forest management by revising: Law on public finances and budgetary-fiscal responsibility (no. 181 of 25.07.2014) to ensure sustainable management of forest resources in public property (state; ATU); Forest Code on technical criteria and economic stimulation of activity to improve the condition and productivity of forests, directions of sustainable forest development; Technical regulations in the forestry field (forest planning; selection and application of forestry treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of stands, including the care/maintenance of seed source stands; development:*

Components	General component content
	Technical aspects regarding forest management financing and economic stimulation of forest improvement activity through secondary legislation (HG; regulations). ● *Result 3: Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions (operational program for continuous improvement of forestry personnel on key areas; improvement of the regulatory framework on remuneration of work in the forestry sector; sectoral program/action plan on promotion of new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.).* ● *Result 4: Strengthening the capacities of "Moldsilva" Agency for communication and combating corruption (communication plan of the forestry sector with society and public authorities; revision of the internal regulatory framework for liquidation of conflicts of interest/functional overlaps in the process of technological activity and amplification of corruption prevention activities in the forestry sector, etc.).* ● *Result 5: Piloting ecological restoration works of inappropriate and vulnerable stands on an area of 1250 ha or about 5% of the technology target, including technology transfer and dissemination, innovative technical solutions for substitution of inappropriate species and stands, testing and improvement of mechanisms for carrying out works, etc.).*
Link with the country's development priorities	The project corresponds, in particular, to sectoral priorities on enhancing the eco-protective and bio productive potential of natural forests, preserving the biological diversity of forests, as well as ensuring forests' resilience to climate change. The rehabilitated forests will constitute stands made up of flexible and long-lasting tree and shrub species, resilient to adverse factors (disease and pest attacks; weathering and climate change, etc.). The project also provides for the conversion from the grove regime to the Codru regime, ensuring regeneration from seed, creating long-lasting stands capable of adapting to climate change.
Scope and activities	*The project implementation area is the* entire forest fund managed by Agency "Moldsilva", focusing on the most unfavourable areas. Main implementation regions: Forestry entities from the northern, central, southern regions (North – Balti/Soroca; Center – SE Telenesti/SE Chisinau/SE Nisporeni-Silva; South – ÎS Iargara/ ÎS Comrat/ ÎSC Taraclia). *Project activities:* *Result 1:* ● Elaboration of project documentation (location; primary infrastructure; provision of personnel; technical equipment, etc.) for the establishment of 3 entities specialized in ecological restoration of forests. ● Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers), endowment with special equipment and equipment for assigned functions (extraction of pre-existing stand; deforestation; tillage, etc.). ● Recruitment and training of staff for ecological restoration centers (key personnel; primary training, etc.). *Result 2:* ● Revision of the Law on public finances and budgetary-fiscal responsibility to ensure sustainable management of forest resources in public ownership (state; ATU). ● Revision of the Forest Code on technical criteria and economic stimulation of the activity of improving the condition and productivity of forests, as well as directions of sustainable development of forests.

Components	General component content
	● Development of technical aspects regarding forest management financing and economic stimulation of forest improvement activity through secondary legislation (GD; regulations). ● Review of technical regulations in the forestry field (forest planning; selection and application of forestry treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of stands, including the care/maintenance of seed source stands. *Result 3:* ● Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.). ● Review and improve the regulatory framework on labor remuneration in the forestry sector. ● Development and implementation of a sectoral program/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.). *Result 4:* ● Development and implementation of a communication plan of the forestry sector with society and public authorities. ● Review the internal regulatory framework for liquidating conflicts of interest/functional overlaps in the process of technological activity and amplifying corruption prevention activities in the forestry sector. *Result 5:* ● Evaluation of available stands and technical materials with priority determination of inadequate stands and vulnerable to climate change necessary to go through with ecological restoration works. ● Elaboration of technical projects for ecological restoration of inadequate stands vulnerable to climate change (estimated 25 projects). ● Technical endorsement and public consultation of projects for the ecological restoration of unsuitable stands vulnerable to climate change. ● Carrying out ecological restoration works of inadequate and vulnerable stands based on technical projects (1250 ha).
Implementation period, timeline	The total implementation period will be 4 years, including: Year 1: *Result 1, activities:* ● Elaboration of project documentation (location; primary infrastructure; provision of personnel; technical equipment, etc.) for the establishment of 3 entities specialized in ecological restoration of forests; degree of finality required to reach 100%. ● Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers), endowment with special equipment and equipment for assigned functions (extraction of pre-existing stand; deforestation; tillage, etc.); degree of finality required to reach 10%. ● Recruitment and training of staff for ecological restoration centers (key personnel; primary training, etc.); degree of finality required to reach 20%. *Result 2, activities:* ● Revision of the Law on public finances and budgetary-fiscal responsibility to ensure sustainable management of forest resources in public ownership (state; ATU); degree of finality required to reach 100%. ● Revision of the Forest Code on technical criteria and economic stimulation of the activity of improving the condition and productivity of forests, as well as

Components	General component content
	directions of sustainable development of forests; degree of finality required to reach 100%. ● Review of technical regulations in the forestry field (forest planning; selection and application of forestry treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of stands, including the care/maintenance of seed source stands; degree of finality required to reach 20%. *Result 3, activities:* ● Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.); degree of finality required to reach 15%. ● Review and improve the regulatory framework on labor remuneration in the forestry sector; degree of finality required to reach 100%. ● Development and implementation of a sectoral program/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.); degree of finality required to reach 15%. *Result 4, activities:* ● Development and implementation of a communication plan of the forestry sector with society and public authorities; degree of finality required to reach 15%. *Result 5, activities:* ● Evaluation of available stands and technical materials with priority determination of inadequate stands and vulnerable to climate change necessary to go through with ecological restoration works; degree of finality required to reach 35%. Year 2: *Result 1, activities:* ● Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers), endowment with special equipment and equipment for assigned functions (extraction of pre-existing stand; deforestation; tillage, etc.); degree of finality required to reach 70%. ● Recruitment and training of personnel for ecological restoration centers (technical staff; specialized personnel; primary training, etc.); degree of finality required to reach 100%. *Result 2, activities:* ● Development of technical aspects regarding forest management financing and economic stimulation of forest improvement activity through secondary legislation (HG; regulations); degree of finality required to reach 100%. ● Review of technical regulations in the forestry field (forest planning; selection and application of forestry treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of stands, including the care/maintenance of seed source stands; degree of finality required to reach 100%. *Result 3, activities:* ● Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.); degree of finality required to reach 45%. ● Development and implementation of a sectoral program/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.); degree of finality required to reach 45%. *Result 4, activities:* ● Development and implementation of a communication plan of the forestry sector with society and public authorities; degree of finality required to reach 45%.

Components	General component content
	• Review the internal regulatory framework for liquidating conflicts of interest/functional overlaps in the process of technological activity and amplifying corruption prevention activities in the forestry sector; degree of finality required to reach 25%. *Result 5, activities:* • Evaluation of available stands and technical materials with priority determination of inadequate stands and vulnerable to climate change necessary to go through with ecological restoration works; degree of finality required to reach 100%. • Elaboration of technical projects for ecological restoration of inadequate stands vulnerable to climate change (estimated 25 projects); degree of finality required to reach 30%. • Technical endorsement and public consultation of projects for the ecological restoration of unsuitable stands vulnerable to climate change; degree of finality required to reach 30%. • Carrying out ecological restoration works of inadequate and vulnerable stands based on technical projects; degree of finality required to reach 25%. Year 3: *Result 1, activities:* • Establishment of entities specialized in ecological restoration of forests (3 ecological restoration centers), endowment with special equipment and equipment for assigned functions (extraction of pre-existing stand; deforestation; tillage, etc.); degree of finality required to reach 100%. *Result 2, activities:* • Review of technical regulations in the forestry field (forest planning; selection and application of forestry treatments; forest regeneration and extension, etc.) in terms of ensuring appropriate interventions in the condition and development of stands, including the care/maintenance of seed source stands; degree of finality required to reach 100%. *Result 3, activities:* • Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.); degree of finality required to reach 75%. • Development and implementation of a sectoral program/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.); degree of finality required to reach 75%. *Result 4, activities:* • Development and implementation of a communication plan of the forestry sector with society and public authorities; degree of finality required to reach 75%. • Review the internal regulatory framework for liquidating conflicts of interest/functional overlaps in the process of technological activity and amplifying corruption prevention activities in the forestry sector; degree of finality required to reach 75%. *Result 5, activities:* • Elaboration of technical projects for ecological restoration of inadequate stands vulnerable to climate change (estimated 25 projects); degree of finality required to reach 100%. • Technical endorsement and public consultation of projects for the ecological restoration of unsuitable stands vulnerable to climate change; degree of finality required to reach 100%. • Carrying out ecological restoration works of inadequate and vulnerable stands based on technical projects; degree of finality required to reach 70%. Year 4:

Components	General component content
	Result 3, activities: ● Development and implementation of the operational program for continuous improvement of forestry personnel on key areas (research/design; forest extension/regeneration/reconstruction; forest planning; migration/species succession; climate modelling, etc.); degree of finality required to reach 100%. ● Development and implementation of a sectoral program/action plan on promoting new technologies and innovations (GIS; remote sensing; automated monitoring systems, etc.); degree of finality required to reach 100%. *Result 4, activities:* ● Development and implementation of a communication plan of the forestry sector with society and public authorities; degree of finality required to reach 100%. ● Review the internal regulatory framework for liquidating conflicts of interest/functional overlaps in the process of technological activity and amplifying corruption prevention activities in the forestry sector; degree of finality required to reach 100%. *Result 5, activities:* ● Carrying out ecological restoration works of inadequate and vulnerable stands based on technical projects; degree of finality required to reach 100%.
Budget	The estimated total cost for the implementation of the project will be 7857.3 thousand Euro, including: 1. Result 1 – 2835.0 thousand Euro or 36.1% of the project budget. 2. Result 2 – 65.0 thousand Euro or 0.8%. 3. Result 3 – 1810.0 thousand Euro or 23%. 4. Result 4 – 130.0 thousand Euro or 1.7%. 5. Result 5 – 2542.0 thousand Euro or 32.4%. 6. Project management and monitoring – 474.8 thousand Euro or 6.0%.
Sources of funding	International programs and funds for technical support and development – GCF, GEF, etc. (65% of the total budget); National Environmental Fund (20%); co-financing by Agency "Moldsilva" (15% from the sale of wood existing in rehabilitated stands). Permanent staff: Project manager; technical assistant; procurement officer; communication specialist; administrative assistant. Experts: International expert in ecological restoration; national experts in the design and supervision of ecological restoration works, forestry legislation, etc. Partnerships: Relevant NGO, NBG.
Measurement/Evaluation	Number of forest restoration centers established; Number of staff recruited and trained for RCEFR; Number of ecological restoration projects developed; Area of inadequately rehabilitated stands, ha; Amendments made/approved in the Law on Public Finance and Budgetary-Fiscal Responsibility, Forestry Code, Technical Regulations related to forestry updated/revised and approved in terms of climate change; GD and adopted MoEnv decisions on the development of the secondary framework for technical and financial assurance of forest management; The number of forestry personnel trained in key areas; Organized communication events; Number of participants in organized communication events;
Potential risks	● Shortage on the local market of operators/institutions specialized in forest design, production and/or delivery of specialized equipment for silvotechnical works. ● Increasing the budget deficit and the impossibility of financial support for the forestry sector. ● Limited capacities of qualified personnel (design, silvotechnical operations, etc.). ● Poor experience of the forestry sector in communicating with society and public authorities.

Components	General component content
	• Natural disasters affecting the condition of new stands created as a result of reconstruction/rehabilitation activities (droughts, floods, etc.). • Limited capacities to ensure the integrity of rehabilitated stands (fires, grazing animals, illegal logging, etc.).
Project beneficiaries	Agency "Moldsilva" and subordinated forestry entities; Ministry of Environment; ATU personnel and private owners of forests and other forest vegetation; universities and other educational institutions;
Responsibilities and coordination	The implementation of the project will be carried out under the coordination of the Agency "Moldsilva" (including territorial entities) with the participation of structures within the MoEnv (DFM; DPASC; DPDB; IEP, etc.), companies and private individuals. The technical and scientific aspects will be ensured by the specialized institutions: FRMI, NBG, etc. For certain actions and activities, the implementation will be carried out with the participation of the competent structures within the Ministry of Finance (budgetary-fiscal responsibilities for ensuring sustainable management of forest resources in public property), MECR (staff training and improvement; promotion of new technologies and innovations; communication of the forestry sector with society and public authorities, etc.), ME (budgetary-fiscal responsibilities for ensuring sustainable management of forest resources). publicly owned forest resources; improving the regulatory framework on labor remuneration in the forestry sector, etc.), MMPS (improving the regulatory framework on labor remuneration in the forestry sector), the private sector (SME – harvesting and processing of wood/non-wood products; planting and caring for forestry crops; harvesting non-wood forest products; transport and logistics services, etc.) and civil society (NGO – expertise, communication, training, etc.). These centers are conceived as structural subdivisions within territorial entities with experience in forest improvement subordinated to the Agency "Moldsilva" from the northern, central, southern regions (North – SE Balti/SE Soroca; Center – SE Telenesti/SE Chisinau/SE Nisporeni-Silva; South – ÎS Iargara/ ÎS Comrat/ ÎSC Taraclia), also having a certain administrative/operational autonomy. For direct implementation, the mechanisms established by the legislation in the field will be used (Forest Code; Rules for the release of standing timber in forests (GD 740/2003); Technical rules for ecological restoration of forests, etc.). The activities within the project include exchange of experience between national institutions involved in the process, but also with similar institutions from neighboring countries (Romania, Ukraine, etc.).

1.4.9.2 Aspects regarding the project idea "Modernization of the process of providing the forestry sector with reproductive material in the new climatic conditions by establishing the National Center for Forest Genetics and Seminology"

Within the technology "Use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in the new climatic conditions", as a pilot project with the conventional name "Modernization of the process of providing the forest sector with reproductive material in the new climatic conditions by setting up the National Center for Genetics and Forest Seminology", it is proposed to implement actions related to development/strengthening of new sectoral capacities for industrial growth of forest reproductive material (design; creation of infrastructure; technical equipment; recruitment and training of personnel, etc.). This will target, in particular, the basic pillar of technology – the creation of the National Center for Forest Genetics and Seminology. The action must be compiled with a piloting component aimed at producing forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction

and extension works (2 years), e.g. for the central region of the Republic of Moldova. The estimated value of the costs for the implementation of the project would be 9238.4 thousand Euro for the 5-year period (Table 1.19) or 30.5% of the total value required for the technology in question.

Table 1.19: Components of the pilot project idea "Modernization of the process of providing the forest sector with reproductive material in the new climatic conditions by establishing the National Center for Forest Genetics and Seminology"

Components	General component content
General information	According to the data of various studies and national reports, it is found that forest nurseries, created by forestry enterprises, currently grow forest reproductive material, without relying on the requirements of EU standards and data of international treaties on adaptation to climate change. At the same time, the current requirements to increase forest productivity and the development of the forest economy in terms of adaptation to climate change make it necessary to ensure the production of high-quality propagating material. Currently, the growth of seedlings is carried out in existing forest nurseries (about 900 ha; over 30 forest nurseries) within the Agency "Moldsilva" and its territorial structures (24 entities), located throughout the country. The global capacity to grow seedlings in these nurseries is about 80 million seedlings, but it has not been reached ever in the last 30 years (the maximum was reached in 2004 – 75 million seedlings). The production process in existing nurseries is highly dependent on natural climatic conditions, irrigation systems are limited or even absent in most nurseries. The project "Modernization of the process of providing the forest sector with reproductive material in the new climatic conditions by setting up the National Centre for Genetics and Forest Seminology" provides for the start of the process of adaptation of the subsector of production of forest reproductive material to the evolution of climate change through consolidation and modernization activities throughout the production chain. The basic tasks of NCFGS provide: Seed base management (stands, seed sources and FGR on about 3-4 thousand ha); certification of seed and reproductive material for the entire forestry sector; processing and conditioning of forest seeds; creation of storage warehouse for medium and long-term storage of forest seeds; production of seedlings, including protected roots; conducting genetic research and in vitro breeding; primary operational activity, etc. As a supplier of seedlings, NCFGS will serve the central region of Moldova, with an annual production capacity of approximately 15-20 million seedlings. In case of low domestic demand at the first stage, the export of forest seeds and saplings with the related certificates according to international standards is a relatively profitable business. This project provides for proper technical equipment, construction of production and storage infrastructure, creation of irrigation systems, development of primary operational activities, staff training, marketing, etc. The project implementation process will include the use of biotechnologies for the production of seedlings (multiplication, rooting, in *vitro* growth etc.), including protected roots (about 20-30% of production capacity). Also, for the regeneration, ecological reconstruction and afforestation works in the central region of the Republic of Moldova, the assortment of tree and shrub species growing in local forests will be ensured.
Objectives (What will the project achieve?)	As specific objectives pursued during the implementation of the project, the following are established: ● Creation of new sectoral capacities for industrial breeding of forest reproductive material. ● Updating the normative/legislative framework to ensure timely and constant production of forest reproductive material. ● Strengthening the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions.

Components	General component content
	• Production of forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction and extension works. The main results/deliverables of the project implementation will be the following: • *Result 1*: Establishment of NCFGS with a production capacity of 15-20 million seedlings annually (Center area), creation of infrastructure, endowment with special technique and equipment for assigned functions (care of seed source stands; processing and storage of forest seeds; evaluation of seed/sapling quality; tillage; irrigation systems; care/maintenance of seedlings, etc.), staff recruitment and training; delimitation and assignment to direct administration of the NCFGS of seed source stands and those established as FGR (central zone), etc. • *Result 2*: Updating the normative/legislative framework to ensure timely and constant production of forest reproductive material by reviewing/supplementing: Water Law (no. 272/2011) with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources; Forestry Code (no. 887/1996) with provisions that would target particularities regarding the functionality of forest nurseries; Normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production; Technical regulations on the rearing and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks; Technical regulations related to the care/maintenance of seed source stands, especially in terms of ensuring constant fruiting. • *Result 3*: Strengthening the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions by identifying stands new sources of seeds to ensure the needs and create reserves for the Center area of the Republic of Moldova (another about 1-2 thousand ha); updating and implementing forest seed certification procedures and processes, including for marketing on the international market; establishment and maintenance of the State Register of Basic Materials; establishment in maintaining the State Register of producers of forest reproductive material. • *Result 4:* Piloting the process of producing forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstruction and expansion works in the central region of the Republic of Moldova by industrial care/maintenance of seed source stands (irrigation, fertilization, protection, etc.); industrial harvesting and processing of forest seeds in sufficient quantities (150-200 tons) for the regeneration/reconstruction process, and forest expansion; industrial growth of seedlings for the process of regeneration/reconstruction and expansion of forests (15-20 million seedlings annually, including about 20-30% with protected roots), etc.
Link with the country's development priorities	The project is focused on contributing to the achievement of national and forestry priorities regarding the intensification of the afforestation/reforestation process of land and ensuring the resilience of forests to climate change, including by producing forest material in the required assortment, quality and in the necessary quantities. This will contribute directly to increasing the success of forest crops and adapting regeneration, reconstruction and afforestation works to climate change. It will also contribute to improving the management and conservation process of seed source stands as well as forest genetic resources, in particular in terms of adaptation to climate change, ensuring steady forest seed production.
Scope and activities	*The project implementation area is the* forest fund managed by Agency "Moldsilva", with emphasis on the center area. Main region of implementation: forestry entities from the central area (SE Telenesti/SE Chisinau/SE Nisporeni-Silva – for the establishment of NCFGS, industrial care/maintenance of stands sources of seeds, harvesting forest seeds; ÎSC Straseni, SE Orhei, SE Calarasi, SE Silva-Centre Ungheni – for the industrial care/maintenance of stands sources of seeds, harvesting forest seeds).

Components	General component content
	Project activities: *Result 1:* ● Elaboration of project documentation for the establishment of NCFGS (Center area) specialized in industrial breeding of forest reproductive material (location; primary infrastructure; staffing; technical equipment; production capacities; area of activity and transfer of forest material, etc.). ● Establishment of NCFGS (Center area), creation of infrastructure, endowment with special equipment and equipment for assigned functions (care of seed source stands; forest seed processing; forest seed storage; nursery and laboratory equipment for assessing the quality of seeds/seedlings; tillage; irrigation systems; care/maintenance of seedlings, etc.). ● Delimitation and assignment in direct management of the NCFGS of seed source stands and those established as FGR (central area). ● Recruitment and training of personnel for NCFGS (key personnel; primary training, etc.). *Result 2:* ● Supplementing the Water Law (no. 272/2011) with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources. ● Supplementing the Forestry Code (no. 887/1996) with provisions that would target particularities regarding the functionality of forest nurseries. ● Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production. ● Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material. ● Updating and completing the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks. ● Review of technical regulations related to the care/maintenance of seed source stands, especially in terms of ensuring constant fruiting. *Result 3:* ● Carrying out works to identify new stands sources of seeds to ensure the needs and create reserves for the Central area of the Republic of Moldova (another about 1-2 thousand ha). ● Updating and implementing procedures and processes for certification of forest seeds, including for marketing on the international market. ● Establishment and maintenance of the State Register of Basic Materials. ● Establishment in maintaining the State Register of producers of forest reproductive material. *Result 4:* ● Carrying out works of care/maintenance of seed source stands (irrigation, fertilization, protection, etc.). ● Industrial harvesting and processing of forest seeds in sufficient quantities (150-200 tons) for the process of forest regeneration/reconstruction and expansion. ● Industrial growth of seedlings for the process of regeneration/reconstruction and expansion of forests (15-20 million seedlings annually, including about 20-30% with protected roots).
Implementation period, timeline	The total implementation period of the project will be 5 years, including: Year 1: *Result 1, activities:* ● Elaboration of project documentation for the establishment of NCFGS (Center area) specialized in industrial breeding of forest reproductive material (location;

Components	General component content
	primary infrastructure; staffing; technical equipment; production capacities; area of activity and transfer of forest material, etc.); degree of finality required to reach 100%. ● Establishment of NCFGS (Center area), creation of infrastructure, endowment with special equipment and equipment for assigned functions (care of seed source stands; forest seed processing; forest seed storage; nursery and laboratory equipment for assessing the quality of seeds/seedlings; tillage; irrigation systems; care/maintenance of seedlings, etc.); degree of finality required to reach 15%. ● Delimitation and assignment in direct management of the NCFGS of seed source stands and those established as FGR (central area); degree of finality required to reach 20%. ● Recruitment and training of personnel for NCFGS (key personnel; primary training, etc.); degree of finality required to reach 20%. *Result 2, activities:* ● Supplementing the Water Law (no. 272/2011) with concrete criteria/parameters to ensure the needs of forest nurseries in aquatic resources; degree of finality required to reach 100%. ● Supplementing the Forestry Code (no. 887/1996) with provisions that would target particularities regarding the functionality of forest nurseries; degree of finality required to reach 100%. *Result 3, activities:* ● Establishment and maintenance of the State Register of Basic Materials; degree of finality required to reach 50%. ● Establishment in maintaining the State Register of producers of forest reproductive material; degree of finality required to reach 50%. Year 2: *Result 1, activities:* ● Establishment of NCFGS (Center area), creation of infrastructure, endowment with special equipment and equipment for assigned functions (care of seed source stands; forest seed processing; forest seed storage; nursery and laboratory equipment for assessing the quality of seeds/seedlings; tillage; irrigation systems; care/maintenance of seedlings, etc.); degree of finality required to reach 75%. ● Delimitation and assignment in direct management of the NCFGS of seed source stands and those established as FGR (central area); degree of finality required to reach 100%. ● Recruitment and training of personnel for NCFGS (key personnel; primary training, etc.); degree of finality required to reach 100%. *Result 2, activities:* ● Revision of the normative document aimed at the methodology of forest budget formation by establishing a procedure for internal subsidization of forest seed production; degree of finality required to reach 100%. ● Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material; degree of finality required to reach 40%. ● Updating and completing the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks; degree of finality required to reach 40%. ● Review of technical regulations related to the care/maintenance of seed source stands, especially in terms of ensuring constant fruiting; degree of finality required to reach 40%. *Result 3, activities:*

Components	General component content
	• Carrying out works to identify new stands sources of seeds to ensure the needs and create reserves for the Central area of the Republic of Moldova (another about 1-2 thousand ha); degree of finality required to reach 40%. • Updating and implementing procedures and processes for certification of forest seeds, including for marketing on the international market; degree of finality required to reach 40%. • Establishment and maintenance of the State Register of Basic Materials; degree of finality required to reach 75%. • Establishment in maintaining the State Register of producers of forest reproductive material; degree of finality required to reach 75%. Year 3: *Result 1, activities:* • Establishment of NCFGS (Center area), creation of infrastructure, endowment with special equipment and equipment for assigned functions (care of seed source stands; forest seed processing; forest seed storage; nursery and laboratory equipment for assessing the quality of seeds/seedlings; tillage; irrigation systems; care/maintenance of seedlings, etc.); degree of finality required to reach 100%. *Result 2, activities:* • Elaboration and full implementation of the provisions of the secondary normative framework on the production, marketing and use of forest reproductive material; degree of finality required to reach 100%. • Updating and completing the set of technical regulations on the breeding and marketing of forest reproductive material, including aspects of adaptation to climatic conditions and risks; degree of finality required to reach 100%. • Review of technical regulations related to the care/maintenance of seed source stands, especially in terms of ensuring constant fruiting; degree of finality required to reach 100%. *Result 3, activities:* • Carrying out works to identify new stands sources of seeds to ensure the needs and create reserves for the Central area of the Republic of Moldova (another about 1-2 thousand ha); degree of finality required to reach 75%. • Updating and implementing procedures and processes for certification of forest seeds, including for marketing on the international market; degree of finality required to reach 70%. • Establishment and maintenance of the State Register of Basic Materials; degree of finality required to reach 85%. • Establishment in maintaining the State Register of producers of forest reproductive material; degree of finality required to reach 85%. *Result 4, activities:* • Carrying out works of care/maintenance of seed source stands (irrigation, fertilization, protection, etc.); degree of finality required to reach 85%. • Industrial harvesting and processing of forest seeds in sufficient quantities (150-200 tons) for the process of forest regeneration/reconstruction and expansion; degree of finality required to reach 85%. Year 4: *Result 3, activities:* • Carrying out works to identify new stands sources of seeds to ensure the needs and create reserves for the Central area of the Republic of Moldova (another about 1-2 thousand ha); degree of finality required to reach 100%. • Updating and implementing procedures and processes for certification of forest seeds, including for marketing on the international market; degree of finality required to reach 95%.

Components	General component content
	● Establishment and maintenance of the State Register of Basic Materials; degree of finality required to reach 95%. ● Establishment in maintaining the State Register of producers of forest reproductive material; degree of finality required to reach 95%. *Result 4, activities:* ● Carrying out works of care/maintenance of seed source stands (irrigation, fertilization, protection, etc.); degree of finality required to reach 100%. ● Industrial harvesting and processing of forest seeds in sufficient quantities (150-200 tons) for the process of forest regeneration/reconstruction and expansion; degree of finality required to reach 100%. ● Industrial growth of seedlings for the process of regeneration/reconstruction and expansion of forests (15-20 million seedlings annually, including about 20-30% with protected roots); degree of finality required to reach 100%. Year 5: *Result 3, activities:* ● Updating and implementing procedures and processes for certification of forest seeds, including for marketing on the international market; degree of finality required to reach 100%. ● Establishment and maintenance of the State Register of Basic Materials; degree of finality required to reach 100%. ● Establishment in maintaining the State Register of producers of forest reproductive material; degree of finality required to reach 100%. *Result 4, activities:* ● Carrying out works of care/maintenance of seed source stands (irrigation, fertilization, protection, etc.); degree of finality required to reach 100%. ● Industrial harvesting and processing of forest seeds in sufficient quantities (150-200 tons) for the process of forest regeneration/reconstruction and expansion; degree of finality required to reach 100%. ● Industrial growth of seedlings for the process of regeneration/reconstruction and expansion of forests (15-20 million seedlings annually, including about 20-30% with protected roots); degree of finality required to reach 100%.
Budget	The estimated total cost for the implementation of the project will be 9238.4 thousand Euro, including: ● Result 1 – 3960.0 thousand Euro or 42.9% of the project budget. ● Result 2 – 110.0 thousand Euro or 1.2%. ● Result 3 – 135.0 thousand Euro or 1.5%. ● Result 4 – 4497.6 thousand Euro or 48.7%. ● Project management and monitoring – 535.8 thousand Euro or 5.8%.
Sources of funding	International programs and funds for technical support and development – GCF, GEF, etc. (70% of the total budget); National Environmental Fund (20%); co-financing by Agency "Moldsilva" (10% from the marketing of certified seedlings and seeds). Permanent staff: Project manager; technical assistant; procurement officer; communication specialist; administrative assistant. Experts: International expert in nursery and forest seminology; national experts in nurseries, forest seeding, forestry legislation, etc. Partnerships: Relevant NGO, NBG.
Measurement/Evaluation	NCFGS constituted; Number of personnel recruited and trained for NCFGS; Area of stands seed sources identified and legislated, ha; Amendments/additions made/approved in the Water Law, Forestry Code, Secondary normative framework on production, marketing and use of forest reproductive material, Technical regulations on growing and

Components	General component content
	marketing forest reproductive material, including aspects of adaptation to climatic conditions and risks, Technical regulations related to the care/maintenance of seed source stands, especially in terms of fruit insurance Constant; Establishment and maintenance of the State Register of Basic Materials, as well as the State Register of Producers of Forest Reproductive Material; The quantity of seedlings grown within NCFGS, including with protected roots, million seedlings; Organized communication events; Number of participants in organized communication events;
Potential risks	• Deficit on the local market of forest infrastructure design operators/institutions, delivery of specialized forest nursery technique. • Limited capacities of qualified forestry personnel. • Opposition of forestry entities holding sectors delimited as seed source stands. • Increasing the budget deficit and the impossibility of financial support for the forestry sector. • Limited capacities to develop the performant regulatory and technical framework. • Limited area of stands suitable for seed harvesting. • High periodicity of fruiting years in the main tree species (especially oak stands). • Low interest in business development in the field of production of forest reproductive material. • Low profitability and increased costs of works to maintain fruiting capacities of seed source stands. • Natural disasters affecting the condition of stands, seed sources and forest nurseries (droughts, floods, etc.).
Project beneficiaries	Agency "Moldsilva" and subordinated forestry entities; Ministry of Environment; ATU personnel and private owners of forests and other forest vegetation; universities and other educational institutions.
Responsibilities and coordination	The implementation of the project will be carried out under the coordination of the Agency "Moldsilva" (including territorial entities; FRMI). MoEnv (DFM; DPASC; DPDB; IEP; Agency "Apele Moldovei" etc.), NBG (assortment of tree and shrub species; species association schemes; plant multiplication methodologies, including *in vitro*, etc.), IGPPP (plant multiplication methodologies, including *in vitro*; plant protection, etc.), companies and private individuals. For certain actions and activities, implementation will be carried out with the participation of competent structures within the Ministry of Foreign Affairs (seed and seedlings certification procedures; ANSA, etc.), MF (budgetary-fiscal responsibilities), MECR (staff training and improvement, etc.), private sector (SME – care/maintenance of seed source stands (irrigation, fertilization, protection, etc.); harvesting forest seeds; care of seedlings in nurseries; transport and logistics services, etc.) and civil society (NGO – expertise, communication, training, etc.). For direct implementation, the mechanisms established by the legislation in the field will be used (Forest Code; guidelines and recommendations on the care and maintenance of seed source stands; guidelines and recommendations on the organization of forest nurseries activity, etc.). The activities within the project include exchange of experience between national institutions involved in the process, but also with the consultation of specialists and specialized companies from Poland, Czech Republic, Hungary to ensure the expected success. The project includes the establishment and commissioning of a basic element of the subsector of production of forest reproductive material: Creation and appropriate technical endowment of NCFGS (center area; management of seed base, certification of regeneration material; processing and conditioning of forest seeds; production of seedlings with protected roots; conducting genetic research and *in vitro* multiplication; primary operational activity; seed processing equipment, nursery and laboratory equipment for quality evaluation, etc.). The coverage area will be the seed source stands and those designated as forest genetic resources (about 3-4 thousand ha) in the central region, as well

Components	General component content
	as forest nurseries in the respective region, managed by the Agency "Moldsilva" and its territorial structures. NCFGS is conceived as a structural subdivision within one of the territorial entities with experience and adequate primary conditions (water sources, land suitable for nurseries, etc.) subordinated to the Agency "Moldsilva" (SE Telenesti/SE Chisinau/SE Nisporeni-Silva), having also a certain administrative/operational autonomy.

1.4.9.3 Aspects regarding the project idea "Strengthening the capacities of the forest research and development sector according to the new climatic conditions"

Under the technology "Climate change impact considerations, forest species and appropriate forest ecosystem management strategies" as a pilot project it is recommended "Strengthening the capacities of the forest R&D sector according to the new climatic conditions". This project refers to the development of research and development infrastructure within forestry institutions (FRMI; NBG; IEG; IGPPP, etc.), adequate technical endowment of the respective research and development institutions, training of low-qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.). In this context, these activities can be compiled with the component related to updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice. The estimated value of the costs for the implementation of the project would be 1915.0 thousand Euro (Table 1.20) or 39.3% of the total value of the means necessary for the technology in question. The implementation period of the pilot project is 4 years.

Table 1.20: Components of the pilot project idea "Strengthening forest R&D capacities according to new climatic conditions"

Components	General component content
General information	The limited administrative-institutional and personnel capacities of the national forestry sector in terms of research and development, the deficit of public and private investments, insufficient development of forest research and development infrastructure, etc., seriously affect the sector's capacity to ensure sustainable management activities of forest ecosystems, generational change in forests through regeneration, ecological restoration and afforestation operations, qualitative planting material, in the assortment of tree and shrub species corresponding to stationary conditions, etc. It is also mentioned that the topic of current scientific research does not cover the entire spectrum of problems and risks faced by the national forestry sector at the moment or are forecast for the future. This cumulation of problems seriously affects the capacity of the forestry sector to ensure a qualitative and efficient management of forest ecosystems, generates uncertainties regarding the future of the national forest heritage. The project "Strengthening the capacities of the forest research and development sector according to the new climatic conditions" is designed for the development/consolidation of the primary research and development infrastructure within forest institutions (FRMI; NBG; IEG; IGPPP, etc.), minimum technical equipment corresponding to the current skills and tasks of the respective research and development institutions, training of highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.). At the same time, these activities will be compiled with the component related to updating the

Components	General component content
	normative/legislative framework to ensure the promotion of research and innovations in forestry practice.
Objectives (What will the project achieve?)	As specific objectives pursued during the implementation of the project, the following are established: ● Updating the normative/legislative framework to facilitate the promotion of research and innovations in forestry practice. ● Strengthening the capacities of the forestry R&D sector according to the new climatic conditions. The main results/deliverables of the project implementation will be the following: ● Result 1: Ensure the promotion of research and innovations in national forestry practice by updating key documents in the normative/legislative framework (Forest Code; The normative document regarding the methodology of forest budget formation, by establishing a quota of at least 7-8% for research and development activity; Sectoral plan for updating/revising the main technical regulations related to the forestry regime based on the results/recommendations of national research and development institutions) etc. ● Result 2: Ensuring the capacity building of the forest research and development sector according to the new climatic conditions by developing and implementing a sectoral plan on the development of the primary forest research and development infrastructure and a national program on the primary technical endowment of forest research and development institutions. ● Result 3: Improve the assurance of the forestry sector with highly qualified staff by developing and implementing a dedicated sectoral programme.
Link with the country's development priorities	The project corresponds, in particular, to sectoral priorities regarding the development and implementation of scientifically justified adaptation measures with clear mitigation co-benefits and sustainable development approaches, promotion of new sustainable forest management practices, use of climate-resistant tree and shrub species in forestry practices. In this context, it calls for the development and promotion of new approaches and technical regulations to ensure the resilience of forest ecosystems to the effects of climate change, as well as the implementation of sustainable forest management principles. These documents and approaches will be based on a cycle of fundamental research cumulated with applied components on the adaptive capacities of native forest ecosystems to climate change (resilience of species and stands; revision of approaches in the process of applying forest treatments and works, forest regeneration works, etc.).
Scope and activities	*The project implementation area is the* forest fund managed by Agency "Moldsilva", as well as the infrastructure (offices, experimental and demonstration networks, etc.) of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.). *Project activities:* *Result 1:* ● Supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as the promotion of innovation in the forestry field. ● Revision of the normative document regarding the methodology of forest budget formation, including the establishment of a minimum quota of 7-8% for research and development activity. ● Initiating and implementing a sectoral plan for updating/revising the main technical regulations related to the forestry regime (forest planning; choosing and applying forestry treatments; forest regeneration and extension, etc.) based on the results/recommendations of national research and development institutions. *Result 2:* ● Development and implementation of a sectoral plan on the development of primary forest research and development infrastructure.

Components	General component content
	● Development and implementation of a national program on primary technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.). *Result 3:* ● Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.).
Implementation period, timeline	The total implementation period of the project will be 4 years, including: Year 1: *Result 1, activities:* ● Supplementing the Forest Code with provisions that would target concrete aspects regarding the organization of scientific research in forestry, as well as the promotion of innovation in the forestry field; degree of finality required to reach 100%. ● Revision of the normative document regarding the methodology of forest budget formation, including the establishment of a minimum quota of 7-8% for research and development activity; degree of finality required to reach 100%. *Result 2, activities:* ● Development and implementation of a national program on primary technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.); degree of finality required to reach 20%. *Result 3, activities:* ● Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.); degree of finality required to reach 20%. Year 2: *Result 1, activities:* ● Initiating and implementing a sectoral plan for updating/revising the main technical regulations related to the forestry regime (forest planning; choosing and applying forestry treatments; forest regeneration and extension, etc.) based on the results/recommendations of national research and development institutions; degree of finality required to reach 40%. *Result 2, activities:* ● Development and implementation of a sectoral plan on the development of primary forest research and development infrastructure; degree of finality required to reach 20%. ● Development and implementation of a national program on primary technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.); degree of finality required to reach 50%. *Result 3, activities:* ● Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.); degree of finality required to reach 45%. Year 3: *Result 1, activities:* ● Initiating and implementing a sectoral plan for updating/revising the main technical regulations related to the forestry regime (forest planning; choosing and applying forestry treatments; forest regeneration and extension, etc.) based on the

Components	General component content
	results/recommendations of national research and development institutions; degree of finality required to reach 100%. *Result 2, activities:* ● Development and implementation of a sectoral plan on the development of primary forest research and development infrastructure; degree of finality required to reach 75%. ● Development and implementation of a national program on primary technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.); degree of finality required to reach 75%. *Result 3, activities:* ● Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.); degree of finality required to reach 75%. Year 4: *Result 2, activities:* ● Development and implementation of a sectoral plan on the development of primary forest research and development infrastructure; degree of finality required to reach 100%. ● Development and implementation of a national program on primary technical endowment of forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.); degree of finality required to reach 100%. *Result 3, activities:* ● Development and implementation of a sectoral training program for highly qualified staff (master, doctorate, etc.), including seasons/collaborations at international research and development centers (EFI; IUFRO; EUFORGEN, etc.); degree of finality required to reach 100%.
Budget	The estimated total cost for the implementation of the project will be 1915.0 thousand Euro, including: ● Result 1 – 65.0 thousand Euro or 3.4% of the project budget. ● Result 2 – 1550.0 thousand Euro or 81.0%. ● Result 3 – 150.0 thousand Euro or 7.8%. ● Project management and monitoring – 150.0 thousand Euro or 5.8%.
Sources of funding	International programs and funds for technical support and development – GCF, GEF, etc. (65% of the total budget); National Environmental Fund (20%); co-financing by Agency "Moldsilva" (15% from commercial activity). Permanent staff: Project manager; technical assistant; procurement officer; administrative assistant. Experts: National experts in forest legislation, etc. Partnerships: relevant NGOs.
Measurement/Evaluation	Number of highly qualified personnel trained; Amendments/additions made/approved in the Forest Code, Normative document regarding the methodology of forest budget formation; Number of technical regulations related to forestry regime revised/modified; The value of investments made in the development of primary forest research and development infrastructure; The value of technical endowments made for research and development institutions with forestry profile; Organized communication events; Number of participants in organized communication events;
Potential risks	● Poor cooperation between R&D institutions. ● Insufficient collaboration of the forestry sector with research and development institutions.

Components	General component content
	• Low degree of implementation of scientific research results in national forestry practice. • Shortage of operators on the local market specialized in the production and/or delivery of specialized forestry equipment. • Shortage of highly qualified personnel in the field of forest research. • Poor experience in communicating with society and public authorities.
Project beneficiaries	Agency "Moldsilva" and subordinated forestry entities; Ministry of Environment; ATU personnel and private owners of forests and other forest vegetation; FRMI; NBG; IEG; IGPPP; universities and other educational institutions.
Responsibilities and coordination	The implementation of the project will be carried out under the coordination of the Agency "Moldsilva". The main implementation obligations belong to dedicated research institutions (FRMI, NBG, IEG, IGPPP, etc.), universities, which have capacity, experience and tools in the field of research and development. MECR will participate in the implementation process (staff training/improvement; conducting research, etc.). The process will include the creation of primary favourable conditions (infrastructure, technical equipment, qualified personnel, etc.) for the subsequent implementation of a cycle of national research programs that will focus mainly on aspects related to the evolution/forecasting of the spatial distribution of forest species and ecosystems; migration of species and forests; bioclimatic and biogeochemical modelling; adaptive capacities of forest species and ecosystems; socio-economic factors determining the capacity to implement sectoral adaptation measures, etc. It also provides for the involvement of the private sector (SME – participation in the development of forest research and development infrastructure, technical endowment of forest research and development institutions; transport and logistics services, etc.) and civil society (NGO – expertise, communication, training, etc.).

1.4.10 Roadmap for identified and selected technologies by forestry sector

1.4.10.1 Climate change profile for the forestry sector in the Republic of Moldova

Due to the still Low index of afforestation of the territory (about 11.4%), in the Republic of Moldova there is intensification of soil erosion and landslide processes, unfavorable change of hydrological regime, continuous aridisation of environmental conditions, etc. Forest products and ecosystem services are climate dependent and highly sensitive to climate change. Climate change is greatly affecting forest ecosystems and associated biological diversity. Because the Republic of Moldova is located in a region with a high degree of vulnerability, it frequently faces heat waves, forest fires, droughts, etc., which are a stressful factor for the health of forest ecosystems.

Over the past decades, Moldova's forests have suffered considerably from reduced water flow and drying up of some water basins as a result of recent droughts and/or poor management. The rapid rate of climate change could exceed the natural ability of forest ecosystems to adapt if timely action is not taken to increase their resilience. At the same time, forests are the main element in ensuring ecological balance in this geographical area, and the issue of conservation and sustainable development of existing forests, as well as the extension of forest lands through afforestation of new areas unsuitable for agricultural use, is a matter of national interest.

Forecasts on the evolution of forests in the Republic of Moldova (World Bank, 2015) indicate a gradual long-term trend in productivity reduction. It is undeniable that forests will be directly and

indirectly affected by climate change, and forest managers in vulnerable areas will need to learn how to adapt management practices to address changing environmental conditions. Such activities as ecosystem regeneration, afforestation, improved extension services and enhanced protection will need to be supported with adequate budgetary resources in the future. In this context, these measures are expected to have high yields and a high impact on poverty, due to the range of products and services that the forestry sector offers to rural communities in the Republic of Moldova. The restoration/reconstruction of degraded forests is also linked to agricultural productivity, as they provide natural hydrological regulation and protection from wind, snow, landslides, etc.

1.4.10.2 Roadmap and interconnection of climate change adaptation technologies of the forestry sector in the Republic of Moldova with the Sustainable Development Goals

The 2030 Agenda recognizes that countries need to develop and apply an integrated, human rights-based, partnership-driven approach to development planning to achieve the Sustainable Development Goals (SDGs). The identified/prioritized technologies for climate change adaptation of the forest-based sector focus on the strategic objective "*Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon* sequestration volumes". At the same time, it is mentioned that the identified/prioritized technologies/measures aimed at adapting forest ecosystems to climate change are very complex, and the results that can be obtained by implementing them directly, indirectly or tangentially are found in achieving the Sustainable Development Goals.

These technologies/measures target both environmental and climate change objectives, but also multiple aspects related to solving the socio-economic problems faced by the Republic of Moldova: Food security, poverty eradication in rural areas, provision with renewable energy resources, ensuring thermal comfort in urban and rural settlements, providing clean water resources, combating desertification, halting and repairing soil degradation, halting biodiversity loss, etc. In this context, the main results of the identified/prioritized technologies/measures consist in ensuring the amplification and sustainability of ecosystem services (protection of agricultural land, localities and infrastructure; reduction of GHG emissions; biological diversity, etc.) granted to society by forests owned by public (state and ATU) or private. Thus, the technologies/measures identified/prioritized for the forest-based sector mainly target the following SDGs:

- SDG 1. No poverty (eradicating poverty in all its forms and in any context);
- SDG 2. Zero hunger (eradicating hunger, ensuring food security, improving nutrition and promoting sustainable agriculture);
- SDG 3. Health and well-being (ensuring healthy lives and promoting well-being for all at all ages);
- SDG 6. Clean water and sanitation (ensuring availability and sustainable management of water and sanitation for all);
- SDG 7. Clean and affordable energy (ensuring access for all to affordable, secure, sustainable and modern energy);
- SDG 8. Decent work and economic growth (promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all);

- SDG 11. Sustainable cities and communities (developing cities and human settlements to be inclusive, safe, resilient and sustainable);
- SDG 13. Climate action (taking urgent action to combat climate change and its impacts);
- SDG 15. Terrestrial life (protecting, restoring and promoting sustainable use of terrestrial ecosystems, sustainably managing forests, combating desertification, halting and repairing soil degradation and halting biodiversity loss).

The technologies/measures identified for the forestry sector, depending on the impact exerted, are classified into 3 major groups. Depending on complexity, these groups target different SDG (Table 1.21). At the same time, it is mentioned that due to the complexity and major impact exerted, group I technologies practically fit all SDG identified for the forestry sector.

Table 1.21: Interconnection of technologies/measures for adaptation of the forestry sector to climate change with Sustainable Development Goals

Technology groups	SDG targeted
I. Increasing climate resilience of forests and other forest vegetation (7 technologies/measures)	SDG 1. No poverty; SDG 2. "Zero" hunger; SDG 3. Health and well-being; SDG 6. Clean water and sanitation; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 11. Sustainable cities and communities (development of cities and human settlements for; SDG 13. Climate action; SDG 15. Terrestrial life.
II. Strengthening and adapting the main elements of forest management to climate change (6 technologies/measures)	SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life.
III. Capacity building, awareness and communication (8 technologies/measures)	SDG 1. No poverty; SDG 3. Health and well-being; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life.

The main responsibilities in the process of implementing the technologies/measures identified for the adaptation of the forestry sector to climate change lie with ME, Moldsilva, MAFI, MIRD, MECR, Apele Moldovei, GIES, EA, GBI, FRMI. At the same time, on certain fields (technical equipment, staff training in forest design, etc.) authorities, specialists and specialized private companies from Romania, Poland, Czech Republic, Hungary, etc. will be consulted to ensure the success of the activities. The implementation of technologies/measures/actions for the forestry sector is foreseen for a period of 8 years between 2023 and 2030. Most technologies/measures/actions have long implementation periods (over 5 years). Next, the roadmap for the implementation of the 21 technologies/measures identified for the forestry sector (Table 1.22), as well as the actions established for the implementation of the three selected/prioritized sectoral technologies (Table 1.23) are presented.

Table 1.22: Roadmap for identified technologies/measures by forestry sector

Impact	Adaptation technologies/measures	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro	Adaptation objective
Increasing climate resilience of forests and other forest vegetation	Increasing the degree of afforestation of the territory per country by planting forest crops resilient to climate change (30 thousand ha)	01/11/2023	31/12/2030	ME; Moldsilva; LPA	Increasing the resilience of forest ecosystems to climate change; reduction of land degradation processes; strengthening GHG sequestration capacities by about 270 kt CO2 annually	High degree of land fragmentation for afforestation; funding gap; opposing the population to the process of allocating land for afforestation; limited MFR production capacities	75,0	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Afforestation of riparian strips, rivers and water basins (15 thousand ha)	01/11/2023	31/12/2030	ME; Moldsilva; Apele Moldovei	Increased humidity in riparian and humid areas; improving the condition of meadow ecosystems, maintaining and enhancing biodiversity	High degree of fragmentation of land suitable for afforestation; funding gap; opposing the population to the process of allocating land for afforestation; limited MFR production capacities	37,5	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Creation and strengthening of forest curtain systems for the protection of agricultural fields and communication routes (12 thousand ha)	01/11/2023	31/12/2030	ME; MAFI; MIRD; Moldsilva; LPA	Maintaining/increasing the productivity of adjacent agricultural land; contributing to improving food security; improving the landscape and strengthening GHG sequestration capacities	High degree of fragmentation of ownership of agricultural land; funding gap; opposition of the population to the process of allocating land for planting forest curtains	21,6	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Implementation of practical activities for the creation and rehabilitation of silvopastoral and agroforestry systems (5 thousand ha)	01/10/2023	31/12/2028	ME; MAFI; Moldsilva; LPA	Reducing land degradation processes, surface runoff, etc.; increasing thermal comfort for users/pastoralists and animals; improving the landscape and strengthening GHG sequestration capacities	Poor technical capabilities in grassland holders; funding gap; opposing the population to the process of allocating land under improvement/rehabilitation activities	3,8	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes

Impact	Adaptation technologies/measures	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro	Adaptation objective
	Extension of green areas in urban and rural localities (3.0 thousand ha)	01/11/2023	31/12/2028	ME; Moldsilva; LPA	Increasing areas with forest vegetation within localities; contribution to increasing thermal comfort; diminish storm flood runoff, decrease pressing on urban infrastructure	Deficiencies in the process of designing and implementing urban development projects; funding gap; low urban landscape design capabilities; limited MFR production capacities	10,5	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Planting and promotion of forestry crops with industrial and energy profile (3.0 thousand ha)	01/11/2023	31/12/2028	ME; ME; Moldsilva; LPA	Diminishing the use of fossil fuel; increasing the quantity of wood with a long period of use (over 20 years); contributions to the development of rural localities and the opening of new jobs	Deficiencies in the normative framework related to the creation and management of forest plantations with energy and industrial profile; funding gap; deficiency of corresponding MFR	10,5	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Ecological restoration of inadequate and vulnerable stands for adaptation to climate change (25 thousand ha)	01/11/2023	31/12/2030	ME; Moldsilva; LPA	Creating stands resistant to adverse factors (attacks of diseases and pests; climate change, etc.); increasing carbon sequestration capacities by targeted stands by 40-50%	Poor technical capacities and facilities in the field of forest regeneration and reconstruction; shortage of staff and expertise; funding gap; limited MFR production capacities	57,2	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
Strengthening and adapting the main elements of forest management to climate change	Ensuring the implementation of the forestry regime in all forests and forest vegetation, regardless of departmental affiliation and nature of property (137 thousand ha)	01/01/2024	31/12/2030	ME; MIRD; Moldsilva; LPA	Improving the management of forests and forest vegetation owned by LPAs, MIDR, companies and private individuals; establishing concrete measures to improve the condition of forests, including ensuring resilience to climate change	Limited institutional and qualified personnel capacities in forest design; funding gap; ambiguous regulatory framework	2,1	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Adapting forest regeneration rules and practices to the needs of climate change	01/05/2023	31/12/2026	ME; Moldsilva	Climate amendment of rules and technical guidelines aimed at forest regeneration; reducing	Limited institutional and qualified personnel capacities; funding gap; lack of results and publications of indigenous forestry research	0,2	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change

Impact	Adaptation technologies/measures	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro	Adaptation objective
					forest regeneration failures in forestry practice			adaptation, strengthening and increasing carbon sequestration volumes
	Regulatory regulation of carbon stock conservation practices in forests and their incorporation into forest management	01/05/2023	31/12/2026	ME; Moldsilva	Increasing forest resilience to climate change; including indicators related to adaptation to climate change and evolution of carbon stocks in the criteria for direct assessment of forest management quality; reducing carbon losses from forest ecosystems	Limited institutional and qualified personnel capacities; funding gap; lack of results and publications of indigenous forestry research	0,1	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Encouraging the development of small woodworking enterprises in rural areas to reduce the carbon footprint and increase the use of wood in long-term products	01/01/2024	31/12/2027	ME; MIRD; Moldsilva; LPA	Development of rural localities by creating small businesses and new jobs; increasing the quantity of wood products with a long period of use (over 20 years)	Limited capacities of qualified personnel; funding gap; limited access to wood, new technologies and advanced woodworking techniques	3,0	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Adapting timber harvesting practices in Moldovan forests to climate change	01/01/2024	31/12/2027	ME; Moldsilva	Reducing the damages brought to forests in the process of forest exploitation; reducing the carbon footprint in the forestry sector	Limited capacities of qualified personnel; funding gap; limited access to new technologies and high-performance forestry techniques	2,5	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Increasing the contribution of wood from sustainable forest management, as a renewable energy source, to the country's energy balance	01/01/2024	31/12/2030	ME; MIRD; ME; Moldsilva	Diminishing uncontrolled pressing on forests; facilitating access to wood for energy for all categories of the population; increasing the substitution effect by substituting fossil-based and CO2-intensive materials and energy	Limited capacities of qualified personnel; funding gap; limited access to wood, new technologies and advanced woodworking techniques	1,5	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes

Impact	Adaptation technologies/measures	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro	Adaptation objective
Capacity building, awareness and communication	The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions	01/05/2023	31/12/2027	ME; Moldsilva	Increasing the amount of MFR harvested from identified sources; ensuring the assortment of tree and shrub species necessary for regeneration and afforestation works enhancing the success of forestry crops and adapting regeneration and afforestation works to climate change	Acute deficit of forest seeds in terms of quantity, quality and assortment; shortage of personnel and expertise in the field of forest nursery and management of seed source stands; funding gap	30,3	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Climate change impact considerations, forest species and appropriate forest ecosystem management strategies	01/01/2024	31/12/2030	ME; MECR; Moldsilva	Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change; promoting forest-related innovation; establishing a minimum quota of 7-8% for the sectoral R&D activity	Limited capacities of highly qualified personnel for research and development activities; funding gap; outdated and poorly developed R&D infrastructure	4,9	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Strengthening the information system about the state and evolution of forests in the Republic of Moldova by carrying out the National Forest Inventory (499 thousand ha)	01/01/2024	31/12/2030	ME; MECR; Moldsilva	Up-to-date, credible and truthful information about the state and evolution of forest vegetation; providing data for the process of elaboration of national forest policy reports and documents, as well as national reports for international institutions/conventions	Limited capacities of qualified personnel; funding gap; limited access to new technologies and high-performance equipment	1,6	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Improving the capacity of public advisory services on forestry and climate change relations	01/05/2023	31/12/2027	ME; Moldsilva	Increasing forest management in terms of resilience to climate change impacts; implementation of practical activities in the field of forest	Limited capacities of qualified personnel; funding gap; limited access to public services	0,4	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and

Impact	Adaptation technologies/measures	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro	Adaptation objective
					management; resilience of forests to the impacts of climate change and adapted to sustainable management principles			increasing carbon sequestration volumes
	Strengthening institutional capacities of the forestry sector in forest management regarding the necessity and opportunity of implementing climate change adaptation and mitigation measures	01/05/2023	31/12/2025	ME; Moldsilva	Strengthening the capacities of forestry specialists in the field of anticipation and management of developments in the state of forests related to climate change; improving management and reducing pressing on forests and other types of forest vegetation	Limited capacities of qualified personnel; funding gap	0,3	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Public awareness about forests and climate change, contribution to the management and consumption of wood services and products at individual and community level	01/05/2023	31/12/2030	ME; MIRD; MECR; Moldsilva; LPA	Diminishing anthropogenic pressing on forests and other types of forest vegetation; enhancing the capacities of forest ecosystems to adapt to climate change	Limited communication capacities and experience of the forestry sector; limited capacities of qualified personnel; funding gap	0,2	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Strengthening the forest fire detection, monitoring and liquidation system	01/05/2023	31/12/2028	ME; MIA; Moldsilva; GIES	Increasing detection and timely intervention capacities in liquidating forest wildfires; reduction of forest areas affected by fires; preserving biodiversity in forest ecosystems	Limited capacities of qualified personnel; funding gap; limited access to new technologies and high-performance equipment; insufficient coordination and collaboration between institutions	2,2	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and increasing carbon sequestration volumes
	Strengthening the system for detecting, monitoring and liquidating outbreaks of forest diseases and pests	01/05/2023	31/12/2027	ME; MAFI; Moldsilva; LPA	Increasing detection and timely intervention capacities in liquidating outbreaks of forest diseases and pests; creation of the digital forest health subsystem; connection to	Limited capacities of qualified personnel; funding gap; limited access to new technologies and high-performance equipment; insufficient coordination and collaboration between institutions	1,2	Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, strengthening and

Impact	Adaptation technologies/measures	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro	Adaptation objective
					international and space resources in the field; improving the health status and preserving biodiversity in forest ecosystems			increasing carbon sequestration volumes

Table 1.22: Roadmap for identified technologies/measures by forestry sector (continued)

SDG	Adaptation technologies/measures	2023				2024				2025				2026				2027				2028				2029				2030			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
SDG 1. No poverty; SDG 2. "Zero" hunger; SDG 3. Health and well-being; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	1. Increasing the degree of afforestation of the territory per country by planting forest crops resilient to climate change (30 thousand ha)																																
SDG 1. No poverty; SDG 6. Clean water and sanitation; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	2. Afforestation of riparian strips, rivers and water basins (15 thousand ha)																																
SDG 1. No poverty; SDG 2. "Zero" hunger; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	3. Creation and strengthening of forest curtain systems for the protection of agricultural fields and communication routes (12 thousand ha)																																
SDG 1. No poverty; SDG 2. "Zero" hunger; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	4. Implementation of practical activities for the creation and rehabilitation of silvopastoral and agroforestry systems (5 thousand ha)																																
SDG 3. Health and well-being; SDG 11. Sustainable cities and communities; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	5. Extension of green areas in urban and rural localities (3.0 thousand ha)																																
SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action;	6. Planting and promotion of forestry crops with industrial and energy profile (3.0 thousand ha)																																
SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and	7. Ecological restoration of inadequate and vulnerable stands for adaptation to																																

SDG	Adaptation technologies/measures	2023				2024				2025				2026				2027				2028				2029				2030			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	climate change (25 thousand ha)																																
SDG 13. Climate action; SDG 15. Terrestrial life;	8. Ensuring the implementation of the forestry regime in all forests and forest vegetation, regardless of departmental affiliation and nature of property (137 thousand ha)																																
SDG 13. Climate action; SDG 15. Terrestrial life;	9. Adapting forest regeneration rules and practices to the needs of climate change																																
SDG 13. Climate action; SDG 15. Terrestrial life;	10. Regulatory regulation of carbon stock conservation practices in forests and their incorporation into forest management																																
SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action;	11. Encouraging the development of small woodworking enterprises in rural areas to reduce the carbon footprint and increase the use of wood in long-term products																																
SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action;	12. Adapting timber harvesting practices in Moldovan forests to climate change																																
SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action;	13. Increasing the contribution of wood from sustainable forest management, as a renewable energy source, to the country's energy balance																																
SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action;	14. The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with																																

SDG	Adaptation technologies/measures	2023				2024				2025				2026				2027				2028				2029				2030			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	reproductive material in new climatic conditions																														
SDG 13. Climate action; SDG 15. Terrestrial life;	15. Climate change impact considerations, forest species and appropriate forest ecosystem management strategies																														
SDG 13. Climate action; SDG 15. Terrestrial life;	16. Strengthening the information system about the state and evolution of forests in the Republic of Moldova by carrying out the National Forest Inventory (499 thousand ha)																														
SDG 13. Climate action; SDG 15. Terrestrial life;	17. Improving the capacity of public advisory services on forestry and climate change relations																														
SDG 13. Climate action; SDG 15. Terrestrial life;	18. Strengthening institutional capacities of the forestry sector in forest management regarding the necessity and opportunity of implementing climate change adaptation and mitigation measures																														
SDG 13. Climate action; SDG 15. Terrestrial life;	19. Public awareness about forests and climate change, contribution to the management and consumption of wood services and products at individual and community level																														
SDG 3. Health and well-being; SDG 13. Climate action; SDG 15. Terrestrial life;	20. Strengthening the forest fire detection, monitoring and liquidation system																														
SDG 13. Climate action; SDG 15. Terrestrial life;	21. Strengthening the system for detecting, monitoring																														

SDG	Adaptation technologies/measures	2023				2024				2025				2026				2027				2028				2029				2030			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	and liquidating outbreaks of forest diseases and pests																																

Table 1.23: Roadmap for selected/prioritized technologies/measures by forestry sector

Adaptation technologies/measures	Actions	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro
I. Ecological restoration of inadequate and vulnerable stands for adaptation to climate change (25 thousand ha)	1.1. Creation of new sectoral capacities to carry out ecological restoration works	01/05/2023	31/12/2024	Agency „Moldsilva"; Design institution	Ecological restoration centers of forests established and functional for the assigned tasks.	Shortage of forest design operators/institutions on the local market; limited capacities of qualified personnel.	2,84
	1.2. Update of the normative/ legislative framework regarding the technical and financial assurance of forest management	01/05/2023	31/12/2025	Agency „Moldsilva"; MoEnv; MF;	Normative framework on technical and financial assurance of forest management modified and implemented (Law on public finances and budgetary-fiscal responsibility; Forest Code, etc.).	Deviating the policy framework from key priorities in the activity of the forestry sector; funding gap; limited capacities to develop the performing technical framework.	0,07
	1.3. Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions	01/05/2023	31/12/2030	Agency „Moldsilva"; MoEnv; MECR; MMPS; ONG	Increasing the competences and skills of forestry staff in key areas; the revised and implemented regulatory framework on labor remuneration in the forestry sector; increasing the share of sectoral activities carried out using new technologies.	Limited capacities of qualified personnel; funding gap.	3,61
	1.4. Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption	01/05/2023	31/12/2027	Agency „Moldsilva"; NAC; MoEnv; MECR; ONG	Forest sector communication plan developed and implemented; improving the image of the forestry sector in society; reducing corruption cases in the forestry sector.	Poor experience in communicating with society and public authorities; poor experience in analyzing and identifying conflicts of interest in forestry; opposition of forestry personnel interested in the current situation.	0,23
	1.5. Design of works and interventions for the ecological restoration of inadequate stands	01/05/2023	31/12/2026	Agency „Moldsilva"; FRMI; NBG	Projects for the ecological restoration of unsuitable stands vulnerable to climate	Limited capacities of qualified personnel; funding gap.	0,22

Adaptation technologies/measures	Actions	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro
					change are developed, approved and implemented.		
	1.6. Implementation of ecological restoration works of inadequate and vulnerable stands	01/01/2024	31/12/2030	Agency „Moldsilva"; FRMI; NBG; SME	Carrying out ecological reconstruction works of inadequate and vulnerable stands on the area of 25.0 thousand ha.	Limited institutional and qualified personnel capacities; limited MFR production capacities.	50,00
	1.7. Monitoring the implementation of technology and works	01/05/2023	31/12/2030	MoEnv; IEP; Agency „Moldsilva"; FRMI; NBG; ONG	Ensuring the quality of the technology implementation process, in accordance with the technical provisions and the time plan.	Limited institutional and qualified personnel capacities; limited MFR production capacities; natural disasters affecting the condition of newly created stands.	0,24
II. The use of modern biotechnologies for the propagation of vegetative material in providing the forest sector with reproductive material in new climatic conditions	2.1. Creation of new sectoral capacities for industrial growth of forest reproductive material	01/05/2023	31/12/2026	Agency „Moldsilva"; Design institution; SME; FRMI; NBG; ES	Regional centers of industrial growth of the MFR established and functional for the assigned tasks; seed source stands are delimited to each RCIBFRM according to their areas of activity and regions of provenance.	Shortage of forest infrastructure design operators/institutions on the local market; limited capacities of qualified forestry personnel.	7,99
	2.2. Updating the normative/legislative framework to ensure the timely and constant production of the MFR	01/05/2023	31/12/2025	Agency „Moldsilva"; MoEnv; MF; Agency „Apele Moldovei"; FRMI; ONG	The regulatory framework for ensuring the production of MFR amended and implemented (Forestry Code; Water Law, etc.); the set of technical regulations on MFR growth and marketing is updated/supplemented; technical regulations related to the care/maintenance of	Deviating the policy framework from key priorities in the activity of the forestry sector; funding gap; limited capacities to develop the performing technical framework.	0,11

Adaptation technologies/measures	Actions	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro
					seed source stands are reviewed and approved.		
	2.3. Strengthening the capacities of the Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions	01/05/2023	31/12/2030	Agency „Moldsilva”; NCFGS; FRMI; NBG	Stands of new seed sources identified and delimited to ensure needs and create reserves (about 3-5 thousand ha); the entire volume of harvested forest seeds is certified according to national and international standards; state registers of basic materials and MFR manufacturers are established and maintained.	Limited area of stands suitable for seed harvesting; limited capacities of competent personnel.	0,19
	2.4. Production of forest reproductive material in the quantities and assortment necessary for forest regeneration/reconstructio n and extension works	01/01/2025	31/12/2030	Agency „Moldsilva”; NCFGS; FRMI; NBG; SME	The seed source stands are fully covered with care/maintenance works; industrial harvesting and processing of sufficient quantities of forest seeds (350-400 tons annually); the process of forest regeneration/reconstruction and expansion is fully ensured with industrially grown planting material.	Limited capacities of competent personnel; the limited area of stands suitable for seed harvesting; low profitability and increased costs of work to maintain fruiting capacities of seed source stands.	21,80

Adaptation technologies/measures	Actions	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro
	2.5. Monitoring the implementation of technology and works	01/05/2023	31/12/2030	Agency „Moldsilva"; MoEnv; IEP; MAFI; FRMI; NBG; ONG	Quality assurance of the technology implementation process; the process of producing MFR (the entire production chain: seeds, seedlings, certification, etc.) is carried out according to established legal and technical procedures.	Limited capacities of highly qualified personnel; natural disasters affecting the condition of stands, seed sources and forest nurseries.	0,18
III. Climate change impact considerations, forest species and appropriate forest ecosystem management strategies	3.1. Updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice	01/05/2023	31/12/2025	Agency „Moldsilva"; MoEnv; MECR; MF; MMPS; FRMI; NBG; IEG; IGPPP; ONG	Forestry Code completed according to the legal procedure; Regulation on the methodology of forest budget formation approved according to the legal procedure; the set of technical regulations related to ensuring the implementation of the forestry regime is updated/completed, approved and implemented.	Deviating the policy framework from key priorities in the activity of the forestry sector; funding gap; limited capacities to develop the performing technical framework.	0,08
	3.2. Strengthening the capacities of the forestry R&D sector according to the new climatic conditions	01/05/2023	31/12/2028	Agency „Moldsilva"; MoEnv; MECR; SME; ONG; FRMI; NBG; IEG; IGPPP;	Forest research is carried out within a new, reconfigured and properly equipped structure; forest research and development institutions (FRMI; NBG; IEG; IGPPP, etc.) have equipment and advanced technique, highly qualified personnel sufficient to carry out research and design according to current forestry issues.	Limited capacities of competent and highly qualified personnel; insufficient collaboration of the forestry sector with research and development institutions.	2,95

Adaptation technologies/measures	Actions	Start year	Final year	Responsible institutions	Success indicators	Risks	Estimated costs, million. Euro
	3.3. Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change	01/01/2025	31/12/2030	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; IEG; IGPPP; ONG	The programme for sustainable development of the forestry sector in the new climatic conditions is developed and implemented; the public information system (Forest Platform) on the state of forests, the exchange of information and knowledge about forest ecosystems is created and operates sustainably.	Shortage of highly qualified personnel in the field of forest research; deviating the policy framework from key priorities in the activity of the forestry sector; low degree of implementation of scientific research results in national forestry practice.	1,67
	3.4. Monitoring the implementation of technology and works	01/05/2023	31/12/2030	Agency „Moldsilva"; MoEnv; MECR; FRMI; NBG; ONG	The process of carrying out research/design is carried out according to established legal and technical procedures; ensuring the quality of the technology deployment process, including adaptation to climate change.	Limited capacities of highly qualified forestry personnel.	0,18

Table 1.23: Roadmap for selected/prioritized technologies/measures by forestry sector (continued)

Adaptation objective	SDG	Actions	Duration, days	2023				2024				2025				2026				2027				2028				2029				2030			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 1. No poverty; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	1.1. Creation of new sectoral capacities to carry out ecological restoration works	610																																

Adaptation objective	SDG	Actions	Duration, days	2023				2024				2025				2026				2027				2028				2029				2030			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action; SDG 15. Terrestrial life;	1.2. Updating the normative/legislative framework regarding the energy and financial assurance of forest management	975																														
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	1.3. Strengthening the capacities of "Moldsilva" Agency and its territorial structures to apply an efficient forest management in a sustainable manner and in accordance with the new climatic conditions	2800																														
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 8. Decent work and economic growth; SDG 15. Terrestrial life;	1.4. Strengthening the capacities of the Agency "Moldsilva" to communicate and combat corruption	1705																														
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	1.5. Design of works and interventions for the ecological restoration of inadequate stands	1340																														

Adaptation objective	SDG	Actions	Duration, days	2023				2024				2025				2026				2027				2028				2029				2030			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action; SDG 15. Terrestrial life;	1.6. Implementation of ecological restoration works of inadequate and vulnerable stands	2555																																
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action; SDG 15. Terrestrial life;	1.7. Monitoring the implementation of technology and works	2800																																
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 1. No poverty; SDG 8. Decent work and economic growth; SDG 13. Climate action;	2.1. Creation of new sectoral capacities for industrial growth of forest reproductive material																																	
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action;	2.2. Updating the normative/legislative framework to ensure timely and constant production of forest reproductive material	975																																
Enhancing the resilience of the forest-based sector by	SDG 1. No poverty; SDG 8.	2.3. Strengthening the capacities of the	2800																																

Adaptation objective	SDG	Actions	Duration, days	2023				2024				2025				2026				2027				2028				2029				2030			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	Decent work and economic growth; SDG 13. Climate action;	Agency "Moldsilva" and its territorial structures in the field of forest nursery in accordance with the new climatic conditions																																	
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 1. No poverty; SDG 7. Clean and affordable energy; SDG 8. Decent work and economic growth; SDG 13. Climate action;	2.4. Production of forest reproductive material in quantities and assortment of forest regeneration/reconstruction and extension	2190																																
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action;	2.5. Monitoring technology implementation and works	2800																																
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action; SDG 15. Terrestrial life;	3.1. Updating the normative/legislative framework to ensure the promotion of research and innovations in forestry practice	975																																

Adaptation objective	SDG	Actions	Duration, days	2023				2024				2025				2026				2027				2028				2029				2030			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action; SDG 15. Terrestrial life;	3.2. Strengthening the capacities of the forestry R&D sector according to the new climatic conditions	2070																														
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action; SDG 15. Terrestrial life;	3.3. Development and implementation of new approaches related to the process of adaptation of native forest ecosystems to climate change	2190																														
Enhancing the resilience of the forest-based sector by maintaining and improving the capacities of forest ecosystems to provide services to society through climate change adaptation, as well as by strengthening and increasing carbon sequestration volumes	SDG 13. Climate action; SDG 15. Terrestrial life;	3.4. Monitoring the implementation of technology and works	2800																														

Bibliography

1. Agency "Moldsilva" (2020), Materials of the Scientific-Practical Symposium "Ensuring sustainable forest management by implementing forestry treatments and promoting natural regeneration, afforestation". Chisinau, 61 p.
2. Agency "Moldsilva" (2016). Strategy on adaptation of the forestry sector to climate change for 2017-2025 and Action Plan for its implementation, GD project.
3. Andreev, O. Cazanteva et al. (2017). Forestry sector and ecosystem services - ENPI FLEG II in the Republic of Moldova. – Ch.: Elan Polygraph. – 240 p.
4. Andreev A., Cazanteva O., Izverscaia T., Talmaci I. (2017), Assessment of losses of ecosystem services following illicit logging in the Republic of Moldova. Forestry sector and ecosystem services – ENPI FLEG II in the Republic of Moldova; Ecological Soc. "Biotica", Regional Program ENPI FLEG II. – Chisinau: S. n., (Typography "Elan Polygraph"), 151-227.
5. Bodrug-Lungu V. (2015), Guide on gender inclusion in forestry in the context of climate change. Climate Change Office, Ministry of Environment, 16 p.
6. Apricots V., Florence Gh. (2020), Report on the implementation of the research theme: "Delimitation of regions of origin and location of forest genetic resources in the field, elaboration of the National Catalogue of Forest Genetic Resources". Report on the technical-scientific activity of the Institute of Forest Research and Management for 2020, p.8-24.
7. Cazanțeva O., Andreev A., Munteanu A., Talmaci I., Cerescu A., Margineanu G. (2016), Assessment of lost revenues from illegal forest practices. Proceeding of the Symposium. Sustainable use, protection of animal world and forest management in the context of climate change. Ch., Typography. "Elan Polygraph", p. 255-256.
8. Cerescu A., Șpitoc L., Talmaci I., Galupa D., Lozan A., Evaluation of the Moldsilva Agency institutional reform options. Case study. „Silva-Millenium III" Public Association, Embassy of Great Britain in the Republic of Moldova, Chisinau, 109 p.
9. Daradur M., Cazac V., Josu V., Leah T., Lopotenco V., Rajendra P. Pandey, Shaker R., Talmaci I., Caisin V., Isac A. (2019), National Drought Plan of the Republic of Moldova. United Nations Convention to Combat Desertification, Ministry of Agriculture, Rural Development and Environment of the Republic of Moldova, State Hydrometeorological Service, Research and Project Centre "Eco Logistica". – Chisinau: Estetini, Typography. „Bons Offices". – 116 p.
10. Institute of Forest Research and Management Chisinau (2011-2021), Annual reports on the development and spread of pests and diseases in forests managed by Agency "Moldsilva", including forecasts for the next period, available at: www.FRMI.com.md.
11. IPCC (2000), Methodological and Technological Issues in Technology Transfer. Available at: https://www.ipcc.ch/report/methodological-and-technological-issues-in-technology-transfer/.
12. Galupa D., Ciobanu A., Scobiolă M., Left-handed V., Lozan A. (2012). Illicit logging of forest vegetation in the Republic of Moldova: Analytical study 2010-2012. Report prepared within the ENPI FLFG Moldova Program.
13. Galupa D., Talmaci I. et al. (2017). Technical guide on agroforestry best practices in sustainable land management. – Chisinau: Prince Caro, - 148 p. Available at: www.FRMI.com.md.
14. Galupa D., Talmaci I. (2021), Establishment of forest protection curtains as a measure of adaptation to climate change. Practical guide for agricultural producers. – Chisinau, "Bons-Offices SRL" Printing House. – 60 p.

15. Andrew Mitchell, Arcadie Capcelea, Nina Rinnerberger [et al.] (2015), Republic of Moldova: Note on Forest Policy, – Ch.: I.E.P. Science, 2015 (Printing house). – 68 p., ISBN 978–9975–67–892–6.
16. Popescu Laurenţiu N. (2009), Theoretical and methodological aspects of the system of record-keeping, analysis and forecast indicators in forestry and forest economics. "Dimitrie Cantemir" Christian University of Bucharest, Faculty of Economic Sciences of Cluj. An. Inst. de Ist. "G. Bariţiu" from Cluj-Napoca, Series Humanistica, Tom. VII, pp. 281–306.
17. Talmaci I., Miron A., (2016), Sustainable management of forests and grasslands owned by local public authorities. Ch., Climate East Moldova, 48 p.
18. Ion Talmaci, Erii Prosii, Ala Mardari, Alexandru Varzari, Alexandru Galupa (2018), Forests of the Republic of Moldova, current state, qualitative and quantitative indicators. Forest Magazine, nr. 3/2018, SC Magic Print SRL, Onesti. pp. 7–20. ISSN 1583-7890.
19. Lilia Taranu, Dumitru Deveatii, Lidia Trescilo et al. (2018), Vulnerability Assessment and Climate Change Impacts in the Republic of Moldova: Researches, Studies, Solutions/Led.: Vasile Scorpan, Marius Ţaranu; Climate Change Office, Min. of Agriculture, Regional Development and Environment of the Rep. of Moldova, United Nations Environment Programme. – Chisinau: S.n., (Typography. "Bons Offices"). – 352 p.
20. Sara Traerup, Riyong Kim Bakkegaard (2015), Determining technologies for climate change adaptation. A hands-on guidance to multi criteria analysis (MCA) and the identification and assessment of related criteria. Climate Resilient Development programme, UNEP DTU Partnership, 32 p.
21. Transylvania University of Brasov (UTB), Faculty of Forestry and Forestry (2015), Forest Ecosystem Services Assessment (SEF) of the Republic of Moldova. Technical Report under the ENPI FLEG II Program, 89 p.
22. Official Gazette of the Republic of Moldova no. 090 of 02.08.2001, Parliament Decision approving the National Strategy and Action Plan in the field of conservation of biological diversity, no. 112-XV of 27.04.2001.
23. Official Monitor of the Republic of Moldova no. 133 of 08.11.2001, Parliament Decision no. 350 of 12.07.2001 approving the Strategy for sustainable development of the forestry sector in the Republic of Moldova.
24. Official Gazette of the Republic of Moldova no.126-131 of 27.06.2003, GD no. 739 of 17.06.2003 on the implementation of the Strategy for sustainable development of the national forestry sector.
25. Official Monitor of the Republic of Moldova no. 33 of 05.03.2010, GD no. 150 of 02-03-2010 approving the Regulation on organization and functioning of the Agency "Moldsilva", structure and staff limit of its central apparatus.
26. Official Gazette of RM no. 4-5/36 of 16.01.1997, Forestry Code, no. 887-XIII of 21.06.96.
27. Monitor of the Parliament of the Republic of Moldova 1993, no. 3, art. 58, 59, 60, Land Code, no. 828 of 25.12.91.
28. Official Gazette nr. 40/337 of 19.06.1997, Law on Natural Resources, nr. 1102-XIII of 06.02.97.
29. Official Gazette no. 10/283 of 30.10.1993, Law on environmental protection, no. 515-XII of 16.06.93.
30. Official Gazette no. 66-68/442 of 16.07.1998, Law on the fund of state protected natural areas, no. 1538-XIII of 25.02.98.
31. Official Gazette no. 43/482 of 03.08.1995, Law on protection zones and strips of rivers and water basins, no. 440-XIII of 27.04.95.
32. Official Gazette no. 141-143 of 09.11.2000, Law on improvement through afforestation of degraded lands, no. 1041-XIV of 15.06.2000.
33. Official Gazette of the Republic of Moldova no. 104-109 of 06.05.2014, GD no. 301 of 24.04.2014 on the approval of the Environmental Strategy for 2014-2023 and the Action Plan for its implementation.

34. Official Monitor of the Republic of Moldova no. 372-384 of 19.12.2014, GD no. 1009 of 10.12.2014 on the approval of the Strategy of the Republic of Moldova for adaptation to climate change until 2020 and the Action Plan for its implementation.
35. Official Monitor of the Republic of Moldova no. 131-138 of 29.05.2015, GD no. 274 of 18.05.2015 on the approval of the Strategy on biological diversity of the Republic of Moldova for 2015-2020 and of the Action Plan for its implementation.
36. Official Gazette of the Republic of Moldova no. 297-300 of 30.10.2015, GD no. 742 of 21.10.2015 for the approval of the Action Plan on the implementation of the National Strategy for Agricultural and Rural Development for 2014-2020.
37. Official Monitor of the Republic of Moldova no. 85-91 of 24.03.2017, GD no. 1470 of 30.12.2016 on the approval of the Strategy for low-emission development of the Republic of Moldova until 2030 and the Action Plan for its implementation.
38. Official Gazette of the Republic of Moldova no. 322-328 of 01.09.2017, GD no. 695 of 30.08.2017 on the organization and functioning of the Ministry of Agriculture, Regional Development and Environment.
39. Parliament of the Republic of Moldova (2022), Law on the production, marketing and use of forest reproductive material in the Republic of Moldova; available at: https://lege.md/act/cu_privire_la_producerea_comercializarea_si_utilizarea_materialu.