Ukraine

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION

PREPARING A TECHNOLOGY ACTION PLAN

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REPORT

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This publication is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UN Environment) and the UNEP DTU Partnership (UDP) in collaboration with University of Cape Town.

Foreword

Ukraine plays an active role in international climate change cooperation processes. Being a Party of United Nations Framework Convention on Climate Change and Paris Agreement our country puts significant efforts through its policies and measures to contribute to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.

In July 2020, Ukraine at a high political level has supported the European Green Deal, which aims to achieve climate neutrality on the European continent by 2050. Ukraine has stated that it is an integral part of achieving the goals of this course and that is among other things, a logical continuation of international efforts to green the country's economy. In March 2021, the Cabinet of Ministers of Ukraine approved the National Economic Strategy for the period up to 2030, which provides for the achievement of climate neutrality no later than 2060.

Remaining an active participant in the global fight against climate change, recognizing its responsibility to achieve the goals of the Paris Agreement and guided by national interests and priorities, the Government of Ukraine needs a list of sectorial transformations, policies and measures to facilitate the transition to a climate-neutral economy in the second half of this century in the most economically and socially optimal way, on the basis of justice and in the context of sustainable development and efforts to eradicate poverty, as required by Article 4 of the Paris Agreement.

Low carbon development of Ukraine's economy will be possible only due to wide dissemination of modern highly efficient technologies, in particular, for Agriculture, Waste and Water sectors. For us, the ongoing Technology Needs Assessment project in Ukraine is an excellent opportunity to accelerate environmentally friendly technology transfer that should become the basis for Ukraine to reach the ambitious GHG emission reduction targets and promote low carbon and climate-resilient development of the country.

Iryna Stavchuk

Deputy Minister for European integration

of Environmental Protection and Natural Resources of Ukraine

Executive Summary

The Technology Action Plan is the third and final report of the Technology Needs Assessment Project for adaptation to climate change developed for the Agriculture and Water sector in Ukraine. The Technology Action Plans (TAPs) were developed for the technologies that were selected during the first stage of the TNA project and presented in detail in the Technology Needs Assessment Report for Adaptation. The selection and technology prioritization processes were performed by the national expert team on the agriculture, husbandry, forestry, and water sectors, and included representatives from government, academic, public, and business organizations. At the second stage, the barrier analysis for the development of technologies and the assessment of enabling frameworks for their further dissemination were elaborated.

The development of the TNA project has coincided with increasing national interest in sectoral adaptation to climate change and desires to increase climate resilience. For the last year, the adaptation actions have been recognized as a key pillar of green sectoral growth for Ukraine. Moreover, recently, the adaptation policy has been recognized as a matter of national environmental security by its acceptance in the President Decree for the Implementation of the Decision of National Security and Defense Council of Ukraine on Environmental Security.

Since the beginning of the year, the Ministry of Environmental Protection and National Resources, supported by the UNDP under the EU4Climate initiative, has developed the Draft Strategy of Environmental Security and Climate Change Adaptation by 2030, which is expected to be accepted soon. The next step is being developed as a sectoral adaptation plan.

Regarding this, the TNA project creates the ground for the further steps and practical implementation of adaptation policy in the agriculture and water sectors.

Accordingly, the TAPs of adaptation technologies for the agriculture and water sectors are presented in the first and second chapters of this work. Each chapter consists of sectoral introductions including analysis of the legislative and political enabling environment for the further TAPs implementation; a brief description of each technology; summarized analysis of barriers for the technologies' implementation[1]; and the full description of identified measures, actions, outcomes, means of verification, indicators, and possible risks are presented as an action plan for each technology. Additionally, the reader will find the most important next steps which should be done for the implementation of TAPs as well as the developed project ideas in order to implement these selected steps/ideas represented per each sector.

Agricultural sector

The TAPs for the adaptation of technologies in agriculture are presented in the first chapter. Climate-driven changes in Ukraine mainly threaten the country's food security, economic growth, and environmental security, which directly impact the Water sector, Agriculture, Forestry and Other Land Use (AFOLU).

The agricultural sector is a crucial component of the Ukrainian economy. The country has almost 32 million hectares of arable land, and its area is equal to one-third of the EU's arable land area. The production and export of agricultural products (over 20% of the total export value) remain the main driving force of the Ukrainian economy. However, the efficiency of agricultural production in Ukraine is competitively lower than the EU's indicators.

The interconnection of climatic and non-climatic factors affects the development of the national agricultural sector particularly through several factors: a significant variety of climate, soil, and other environmental conditions, differences in farm size; lack of access to accurate climate and weather data, different levels of climate change intensity for different agroclimatic zones in Ukraine, etc. These issues

[1] The detailed analysis of barriers and enabling measures for each technology was developed under the second stage of TNA implementation and presented in the Adaptation Barrier Analysis and Enabling Framework Report.

cause the sector’s vulnerability to climate change and influence the identification and selection of responsive adaptation technologies. Besides, the production plans of farmers is often rather based on the crops' price expectation, with less consideration of other factors, such as crop resistance to climate, sustainable resource management, environmental impact, and even the availability of resources. Thus, the farmer is ready to lose in yield in anticipation of increased prices. This behavioral approach also leads to the loss of production efficiency and increases the vulnerability of the sector. On the other hand, it means farming in Ukraine has plenty of room to increase efficiency by applying the proper technologies and developing a climate change adaptation strategic view, including dedicated policies.

Reviewing national policy priorities, legislation, and regulation frameworks shows that adaptation to climate change is not yet a national priority, because the country is facing numerous other challenges. Besides, adaptation policies are considered to be secondary to mitigation. At the same time, effective adaptation policies and strategies are also critical for the long-term development of agriculture in order to ensure the availability of resources and ecosystem services essential for sustaining food production, economic development and societal well-being.

Technological action plans were developed and presented for the following technologies: Drip Irrigation Combined with Conservation Agriculture (DICA), Application of Agroforestry Practice (For Field Protection Shelterbelt), and Integrated Pest Management by Applying the Biodegradable Mulch Film (IPM BMF).

Actions, activities, time frames defined for their implementation, and key risks in TAP implementation are described in Table 1. All actions selected for TAP per each technology are categorized as institutional, investment, and informational. All actions are necessary and feasible for developing an enabling environment to reach the target specified for each technology.

Additionally, the actions which were recommended as project ideas were selected under each TAP as the technology "backbone" actions. This means that the implementation of project ideas might bring massive effects for further technology development and adoption. In other words, the specified project idea triggers a "significant change" in technology development and pushes it to grow at a large scale.

Moreover, actions' feasibility and commercial attractiveness were used as additional criteria for selecting project ideas. Considering the insufficient level of budgetary support, project ideas have been designed to be economically attractive for potential national and international investors, thus increasing the chance that technology will further attract investments and will be implemented.

As a result of the performed analysis, the creation of the Coordination Center of Climate Oriented Agriculture (CCCOA) in the south of Ukraine was selected as a TAP project idea, specifically of DICA technology. The CCCOA aims to consolidate the existing practical examples of irrigation and CA, develop networks among farmers and strengthen practical implementation through scientific knowledge and research. Furthermore, it is considered that CCCOA would be hosted by the Academy of Agrarian Science of Ukraine, which will allow absorbing the best practical knowledge for further development of the practical tools for irrigation policy implementation. Thus, the project ideas will help implement the technologies, respond to the farmers’ needs, create local infrastructure in cooperation with local communities for the sustainable and effective utilization of water and support the development of irrigation and drainage policy framework and the institutional structure of drainage. The detailed concept note of the project is described in the sub-chapter 1.2.2.

The establishment of container nurseries based on existing state agroforestry enterprises to produce ball-rooted planting stock is selected as a TAP project idea for agroforestry practice. Beyond the regulatory and institutional barriers, the technically crucial problem for the massive dissemination of agroforestry is the lack of planting materials. The production of the relevant planting materials is a time-consuming activity. Establishing nurseries with an annual production capacity of about two million seedlings will satisfy the needs of an oblast at the first stage of technology development. In case of the low domestic demand at the first stage, the export of seedlings is a high profitable business.

For the technology Integrated Pest Management through Biodegradable Mulch Films (BMF) application, the creation of production clusters based on the agro holdings to develop a circular economy, from cropping the input materials for BMF production to BMF application, was selected as a key project idea. This project idea has a huge implementation potential capable of lifting agricultural production to a higher level of efficiency, combining innovation, economy, economic, and social development through biotechnology such as biodegradable films and biopesticides.

The most immediate next steps were selected for the implementation of each TAP including the essential need to strengthen the institutional (legislative) capacity. Without strengthening the institutional potential and further enhancing adaptation policy, the subsequent development and implementation of the TAPs are impossible, or their development is fraught with serious risks.

The immediate actions for TAP implementation per technology in 2021-2022 are:

DICA

- To adopt the Draft Law on Land Consolidation
- To examine water resource accessibility for irrigation

Agroforestry

- To complete the land inventory under shelterbelt with further shelterbelt registration in the Cadastral Map

Integrated Pest Management (BMF)

- To amend the existing Law of Ukraine on Environmental Protection and to raise awareness of the fossil-based plastic film application problem at the national level.
- To develop guidelines on environmentally recommended input materials (fertilizer, pesticides, packages, covering, etc.) for agriculture production in Ukraine.

It is important to mention that the above-mentioned mandatory actions are interconnected. For example, adopting the Law on Land Consolidation has a crucial impact on developing complex climate-oriented technology such as DICA and agroforestry.

The cross-cutting issues for the development of technological action plan and technology dissemination have the internal (within the sector) and inter-sectoral characters. The improvement of regulatory framework and expansion of the state support is typical for all adaptation technologies for the agricultural sector. Besides, the implementation of all TAP might face the same implementation risks: low technical capacity, delay or change in the project's implementation, the lack of state support and budget, etc. However, the implementation of some TAP (as an example, agroforestry) might be challenged because of the specific risks of the conflict on land ownership rights.

Finally, as an important part of the current study, the TAPs were developed addressing gender issues based on equal opportunities for further implementation and development of technologies.

Water sector

The prioritized technologies of the water sector focus on water scarcity, the lack of water for agriculture, and, in some cases, water abundance. Technologies considered in this report include Climate-Smart Irrigation, Drought Risk Assessment and Mapping, and Flood Risk Assessment and Mapping. For Climate-Smart Irrigation, actions that are required to be taken include research, overcoming financial barriers (investment), establishment of economic and legislative incentives (institutional), raising awareness and knowledge sharing (informational).

A project idea for Climate-Smart Irrigation technology involves creating a special funding program to implement the technology, particularly to purchase the necessary equipment. Creating such a funding program will help overcome the main barrier – the need for long-term soft loans, which are currently not available in the domestic market.

For the successful implementation of Drought Risk Assessment and Mapping technology, it is needed to identify financial resources and create a regulatory framework for its implementation. Legislative changes are required to create a favorable climate for overcoming financial and bureaucratic obstacles in order to implement the appropriate technology and oblige stakeholders and insurance companies to use technology in order to avoid economic losses from doing business and maximizing profits.

The success of implementing Flood Risk Assessment and Mapping technology depends primarily on removing legal barriers by developing effective insurance legislation that takes into account the benefits of using technology. The pricing of flood insurance policy has to be based on the "technology"-designated flood zones in which properties are located. This means that the technology of flood risk assessment is directly linked to the risk assessment and zoning and directly used by the insurance business to evaluate and recover damages. In Ukraine, the insurance business still does not take advantage of the use of modern technologies for risk assessment

The next steps which should be implemented as immediate actions for TAP development per technology in the water sector in 2021-2022 are as follows:

- Adoption of the law of Ukraine "On water users' associations"
- Transfer of property rights for irrigation equipment and infrastructure to water users associations
- Develop effective insurance legislation that takes into account the benefits of using technology
- Reform the remuneration system in the State Emergency Service of Ukraine (SESU)
- Establish a flood monitoring and forecast center
- Establish a drought monitoring and water scarcity center

Regarding inter-sectoral cross-cutting issues, development of the agricultural and water sectors is strongly correlated. Not accidentally, technologies based on irrigation were selected as a top priority for both sectors. Drip Irrigation combined with Conservation Agriculture (DICA) in agriculture, and Climate Smart Irrigation in the water sector have cross-cutting issues.

Despite the technical differences in their implementation, both technologies depend on favorable development of irrigation policies, state financial support, modernization of the irrigation infrastructure and innovative climate-oriented and automated irrigation processes in the fields. However, at the same time, these technologies have differences among the end-users, input service providers and stakeholders. DICA is more suitable for medium-sized farms with an average land bank of up to 1,700 hectares focused on producing cash crops. The Amalgamated Village Communities significantly affect the technology's advancement as they represent major public stakeholders, and the land market regulation policies set the regulative framework. The development of Climate-Smart Irrigation is focused on the purchase/spread of modern equipment mostly by agri holdings and large farms at the initial stage of technology deployment in Ukraine. Should technologies be implemented in the proper scale, Ukraine might increase its climate change resilience and greatly benefit from the described adaptation technologies.

The incorporation of gender issues into the TAP could bring benefits. Even though the technologies are gender-neutral and are capable of bringing benefits for both men and women, it is important to have more broad involvement of women in studies (such as for particular field conditions etc.), in data analysis, as well as into training. This will increase the presence of women in STEM (science, technology, engineering, mathematics), and hopefully would contribute to decreasing the payment gap between men and women. As of 2017, this gender payment gap in Ukraine was 21.2% in economy in general and up to 37.1% in energy sector (Diachuk et al). As COVID-19 aggravated the problem of gender inequality globally, now 136 years would be needed to reach the gender parity (compared to 100 years in pre-COVID-19 era), according to World Economic Forum assessment.

Summarized Technology Action Plans for Agricultural and Water Sectors

Agriculture						
Technology	**Ambitions**	**Actions**	**Activities**		**Timeframe**	**Risks**
Drip Irrigation combined with Conservation Agriculture (DICA)	Technology scaled up on 695 thousand hectares, implemented 400 farms by 2030	Action 1. Enhanced capacity building	1.1.	The completion of the Draft Law on Land consolidation (gender disaggregated)	2021	1. The unpredictability in the implementation. 2. To challenge the results of research and assessment 3. Delay or change in the implementation of project 4. Low technical capacity 5. To increase shadow water supply 6. To increase the soil pollution 7. The lack of state budget
			1.2.	To adjust the Cabinet of Ministries Order #384 (gender disaggregated)	2022	
			1.3.	To develop the system of indicators including gender- related and baselines	2022-2023	
			1.4.	To examine the accessibility of water resource for irrigation	2021 -2024	
			1.5.	Legislation towards the consolidated approaches on irrigation system construction and water management considering the needs of vulnerable groups as well	2022 - 2024	
		Action 2. To scale up DISA technology	2.1.	The pilot implementation of technology at the farm level	2021 -2022	
			2.2.	Field Farm School	2022 -2023	
			2.3.	The pilot implementation at the oblast level	2023-2025	
			2.4.	To scale up the proposed models to the other 8 oblasts with special consideration of need of most exposed and highly vulnerable communities	2025 -2030	
		Action 3. To enhance the financial affordability.	3.1.	To increase the budget line for the state program for the partly compensation of purchase expenses on machinery and equipment	2022-2030 (annual base)	
			3.2.	To increase the budget line to support programs for irrigation		
			3.3.	To form revolving funds for the facilitation of irrigation infrastructure	2023-2029	
		Action 4. To increase the capacity of skilled Human Resource considering the gender issue	4.1.	To establish the Coordination Centre of Climate Oriented Agriculture	2022-2024	
			4.2.	To develop the online video courses on DICA	2023	

Agroforestry practice (for field protection shelterbelts)	Technology scaled up on 85 thousand hectares, by 2030	Action 1. To develop enabling institutional and regulatory environment for agroforestry	1.1.	The completion of the Draft Law on Land consolidation	2021	1. The unpredictability in the implementation 2. Challenging the results of research and assessment 3. Delay or change in the project implementation 4. Low technical capacity 5. Risk of land resource conflicts 6. The lack of investment 7. The lack of state budget
			1.2.	To complete the shelterbelt inventory at the country level.	2021 -2024	
			1.3.	To develop a system in order to identify the land plots recommended for establishing the new shelterbelts	2022-2023	
			1.4.	To set-up on-line shelterbelt monitoring	2022 -2025	
			1.5.	To establish fully authorized system to receive the Logging ticket	2022	
		Action 2. To enhance the financial affordability for agroforestry dissemination.	2.1.	Feasibility study on selected pilot plots to develop climate credits tools for agroforestry considering the gender issue	2021 -2022	
			2.2.	To create the payment-ecosystem funds considering te needs of all members of society, including vulnerable groups	2022 -2023	
			2.3.	To extend the budget line for state support program on the development of vineyards, horticulture, and hop cultivation with focus on most vulnerable farmers	2022-2030 (annual base)	
		Action 3. To improve the technical potential for the best agroforestry practice scaling up	3.1.	To create the electronic catalogue of nurseries stock	2022	
			3.2.	To develop the app on shelterbelt species selection	2022-2024	
			3.3.	To develop an online marketplace with forwarding contract of plant material purchasing	2022-2025	
			3.4.	To modernize the state nurseries	2022-2029	
Integrated pest management by applying the biodegradable mulch film (IPM BMF)	Technology scaled up on 180 thousand hectares, by 2028	Action 1. To amend regulation	1.1.	The amendment Law of Ukraine On environmental protection	2022	1. The political indifference 2. The partial default of activity implementation 3. Delay or changes in project implementation 4. Low technical
		Action 2. To enhance policy	2.1.	To develop the strategy on bio-economy/circular economy	2022 -2023	
		Action 3. To improve the financial regulation	3.1.	To develop the regulation of flexible tax system for imported deep processing corn starch equipment	2023	
			3.2.	To develop the eco-system payments schemes in order to support the farmers using the BMF and biopesticides.	2022 -2023	

		Action 4. To increase technological capacity to improve supply	4.1.	To develop the enhanced value-added chains for BMF production including from gender perspectives	2022-2024	capacity
			4.2.	To launch the experimental cluster on the basis of the principals of circular economy	2022-2026	
		Action 5. To gain the research and practice-based knowledge	5.1.	To launch an empirical research on BMF application for different ago climatic zones considering gender perspectives and needs	2022	
Water Sector						
Technology	**Ambitions**	**Actions**	**Activities**		**Timeframe**	**Risks**
Climate-Smart Irrigation	The implementation of CSI on 0.5 million ha by 2037	Action 1. Research	1.1	The assessment of water available for irrigation in the medium and long-run	2022-2023	Scheduling risk Cost risk
			1.2	The adjustment of imported equipment to local conditions (Study to develop adjustment factors for local crops and weather conditions)	2022-2023	Scheduling risk
		Action 2. Overcoming of financial barriers	2.1	The development of special funding program, aimed at the provision of long-term soft loans, including SMEs from rural areas	2026-2037	Cost risk Scheduling risk Performance risk
			2.2	The adoption of import tax exemption for imported equipment for CSI	2022-2026	Performance risk
		Action 3. Economic and Legislative Stimuli	3.1.	The adoption of the Law of Ukraine “On water Users Associations”	2021	
			3.2.	The transition of irrigation machinery and elements of CSI system from State Agency for Water Resources to Water Users Associations.	2022-2025	
			3.3.	The extension of the existing National Standard DSTU 7735:2015 to include provisions on CSI	2021	
			3.4.	The amendment of the existing State Building Standards of Ukraine. System for ensuring the reliability and safety of construction sites. General Principles of Security, Reliability and Constructive Safety of Buildings, Buildings Structures and Foundations DBN B.1.2-14-2009 to simplify the complexity of irrigation systems.	2021	
		Action 4. Awareness	4.1.	The spread of information about CSI	2022-2032	

		rising and knowledge sharing	4.2.	The enhancement of networking of CSI value chain actors, including SMEs from rural areas	2022-2032	
Drought risk assessment and mapping	The implementation of technology: first stage - 40% of the county territory, steppe zone by 2027; second stage - 33% of the country territory, forest-steppe zone by 2030; whole country by 2033.	Action 1. Research	1.1	1.1. Research on a modern scientific and methodological basis of gender-sensitive vulnerability of the water sector to droughts and perform ranking of vulnerable areas in the time sequence of water stress for the phased implementation of adaptation measures.	2021-2022	Scheduling risk Cost risk
			1.2	Performing of ranking of vulnerable areas in the time sequence of water stress for the phased implementation of adaptation measures.	2021-2022	Performance risk
		Action 2. The training of high skilled experts	2.1.	The preparation of the special education program	2022-2023	
			2.2.	The accreditation of the education program by National Agency of the Quality of Education	2023	
			2.3.	The training of specialists to acquire high skills for implementation of technology, form which at least 51% are women	2023-2025	
			2.4.	The evaluation of the learning success according to the WMO competency assessment.	2025	
		Action 3. To enhance the financial affordability.	3.1.	To increase the budget line for the state program for the technical support of the drought monitoring. Reform in the remuneration system the State Emergency Service of Ukraine (SESU), considering the needs of both women and men	2022-2032	
			3.2.	The creation of the special financial fund to increase the budget line to support technology	2022-2032	
		Action 4. Organization measure	4.1.	The establishment of a Drought Monitoring and Water Scarcity Center	2022-2024	
		Action 5. Economic and Legislative measures	5.1	The development of effective insurance legislation	2021-2024	
			5.2	To create a legal framework for the use of satellite information for drought monitoring in Ukraine	2022	
Flood's hazard assessment and mapping	Implementation of technology: first stage - 5,3% of the	Action 1. Research	1.1	Research on a modern scientific and methodological basis of gender-sensitive vulnerability of the water sector to floods and to perform the ranking of vulnerable areas for the	2021-2022	Scheduling risk Cost risk Performance risk

	county territory, rivers of Danube catchment by 2027; second stage – 8,7% of the country territory, rivers of Dniester catchment by 2030; whole country by 2033.			phased implementation of adaptation measures.		
			1.2	Performing of ranking of vulnerable areas for the phased implementation of adaptation measures.	2021-2022	
		Action 2. Training of high skilled experts	2.1.	The preparation of the special education program	2022-2023	
			2.2.	The accreditation of the education program by National Agency of the Quality of Education	2023	
			2.3.	The training of high skilled experts for the implementation and functioning of technology form which at least 51% are women	2023-2025	
			2.4.	The evaluation of the learning success according to the WMO competency assessment.	2025	
		Action 3. To enhance the financial affordability.	3.1.	To increase the budget line for the state program for the technical support of the floods monitoring	2022-2032	
			3.2.	The creation of the special financial fund to increase the budget line to support technology	2022-2032	
			3.3	Reform in the remuneration system for the State Emergency Service of Ukraine (SESU) considering the needs of both women and men	2022-2023	
		Action 4. Organization measure	4.1.	The establishment of a Floods Monitoring and Forecast Center	2022-2024	
		Action 5. Economic and Legislative measures	5.1	The development of effective insurance legislation addressing the needs of all members of rural communities	2021-2024	
			5.2	To create a legal framework for the use of satellite information for drought monitoring in Ukraine	2022	

CONTENT

List of Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
ATC	Amalgamated Territorial Communities
BMF	Biodegradable Mulch Film
CA	Conservation Agriculture
CC	Climate Change
CC1	Cyclomatic complexity equals 1
CC2	Cyclomatic complexity equals 2
CC3	Cyclomatic complexity equals 3
CCCOA	Coordination Centre of Climate Oriented Agriculture
CMU	Cabinet of Ministry of Ukraine
CO2	Carbon dioxide
COA	Climate-orientated agriculture
CSI	Climate-Smart Irrigation
DBE&DWQ	National Dnieper Basin Environmental and Drinking Water Quality Program
DBN	State construction norms of Ukraine
DICA	Drip irrigation in combination with conservation agriculture practices
DSTU	State Standards of Ukraine
EBRD	European Bank for Reconstruction and Development
EFAS	European Flood Awareness System
EIB	European Investment Bank
EU	European Union
EUBP	European Bioplastics
EUMETNET	European Meteorological Network
FAO	Food and Agriculture Organization UN
FFS	Farmer field school
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GIS	Geographical Information System
GMO	Genetically modified organisms
GR	Government Relations
IA	Institute of agriculture, NAAS
IAMAIP	Institute of Agricultural Microbiology and Agro-Industrial Production, NAAS
IANRM	Institute of Agroecology and Natural Resource Management, NAAS

IBRD	International Bank for Reconstruction and Development
IFC	International Finance Corporation
IFIs	International financial institutions
IIA	Institute of irrigated agriculture, NAAS
IMET	Integrated Management Effectiveness Tool
INRM	Integrated Natural Resources Management
ISP	State organization “Institute of Soil Protection of Ukraine”
IWPLR	Institute of water problem and land reclamation of NAAS
KfW	Kreditanstalt für Wiederaufbau
MAPF	Ministry of Agrarian Policy and Food of Ukraine
MCTD	Ministry for the Communities and Territories Development of Ukraine
MDETA	Ministry for the Development of Economy, Trade and Agriculture of Ukraine
MEPNR	Ministry of Environmental Protection and Natural Resources of Ukraine
MFU	Ministry of Finance of Ukraine
NAASU	National Academy of Agrarian Sciences of Ukraine
NAIU	National Association of Insurers of Ukraine
NASU	National Academy of Sciences of Ukraine
NDC	Nationally determined contributions
NFIP	National Flood Insurance Program
NFSC	National Commission, which carries out state regulation in the sphere of financial services markets (the National Financial Services Commission)
NGOs	Non-Governmental Organizations
NL	The Netherlands
NMCGPE	National and Methodological Centre of Graduate and Postgraduate Education
NMHS	National Meteorological and Hydrological Services
No-Till	No-till Lab community
NRC ISSA	National Research Centre Institute of Soil Sciences and Agrochemistry, NAAS
NUBIP	National University of Life Sciences and Bioresources
OAU	Kharkiv, Kherson, Mykolaiv and other agriculture universities
PES	Payment for ecosystem services
PPH	Personal peasant household
PPP	Plant protection products
PR	Public Relations
RES	Renewable Energy Sources
SAWR	State Agency of Water Resources
SESU	State Emergency Service of Ukraine

SFA	State Forestry Agency
SOA	State Oblast Administration
SSF	Small Scaled Farms
State Geocadastre	State Service of Ukraine for Geodesy, Cartography and Cadastre
SUPD	Single-use Plastics Directive
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UaSP	Association Ukrainian Soil Partnership
UFPA	Ukrainian Forest Project Agency
URIFFM	Ukrainian Research Institute of Forestry and Forest Melioration named after G. M. Vysotsky
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UVP	JSC "Ukrvodproekt"
VR	Verkhovna Rada
WBG	World Bank Group
WMO	World Meteorological Organization
WUAs	Water users' associations

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Chapter 1 Technology Action Plan and Project Ideas for Sector A: Agriculture sector

1.1 TAP for the Agriculture sector

1.1.1 Sector overview

Climate-driven changes in Ukraine mainly threaten the country's food security, economic growth, and environmental security with a direct impact on Agriculture, Forestry and Other Land Use (AFOLU).

Among others, the next climate change consequences already affected agricultural production and these effects would grow:

- Increase in temperature. Following the World Bank forecast, the temperature will increase in the range of 0.5-1.5 ºC shortly (period 2021-2040) and will reach +5C in every region of Ukraine by the end of the century (World Bank, May 2021).
- Increase in climate aridity. Projections of maximum and minimum temperature show that an average monthly maximum temperature above 30 ºC will increase in the territory of the entire Southern and Central part of Ukraine. The number of ice days and nights will reduce dramatically. A rise in temperature in summer will result in heat waves and an increase in aridity in the climate in Ukraine.
- Changes in precipitation regimes. Annual precipitation in Ukraine increases with time, with larger changes projected by the end of the century. The significant changes in annual precipitation redistribution are expected towards more precipitation in winter and less precipitation in summer.

The agricultural sector is an extremely important component of the Ukrainian economy. The country has almost 32 million hectares of arable land, and its area is equal to one-third of the EU's arable land area. At the same time, half of the arable land has Chernozem soil that is the most unique productive type of soil. Due to this and the wide use of modern technologies, Ukraine has become the world's third-largest grain exporter after the United States and the EU.

The production and export of agricultural products (over 20 % of t total export value) remain the main driving force of the Ukrainian economy.

At the same time, the farming structure is not homogeneous in terms of the land bank under processing and the income level, respectively. Based on the available statistic data, the owners/users of the counted agriculture land (27.8 million hectares) can be classified within the next three groups:

1. Personal peasant household (PPH up to 2 hectares). There are 3 975 100 PPH registered which managed about 30% of total agricultural land bank in Ukraine (27.8 million ha). The problem is to distinguish the production share of Personal peasant household (PPH), because there is no statistical report from their side. However, there are 3 975 100 PPH which are registered in Ukraine. Many of them have a poor level of agricultural technologies and rely on farming as the only economic base of life.

2. Farm companies have 0-10K hectares among which the Small-Scale Farms (SSF) can be identified. Small Scaled Farms operate the land bank from 0 up to 500 ha. Moreover, following the official statistic, the two groups of SSF might be distinguished: (i) with the land bank from 0 to 100 ha and (ii) with the land bank from 100-500. Totally, SSFs process 41% from the national agricultural land bank and consist of about 68% of registered farms in the total structure of Ukrainian farming. In 2019, the share of SSFs in the production of main crops was 28% for wheat, 25% for maize, 42% for barley, 33% for sunflower seeds and 40% for soya beans.

   While the SSFs which size bigger than 100 ha mainly focused on the production of key crops, the SSF up to 100 ha are dominant in the production of potatoes, vegetables and melons (92%); fruit, berries, and grapes (79.74%); livestock products, including milk (73.14%), meat production (36%); wool (87.5%); eggs production (44.8%) and other livestock products, including honey (98%).

3. Agro-holdings (10K -50K+ hectares). There is a huge vertical integrated agrarian company as a usually consistent set of smaller farms but managed by Head Quarters company.

Each of these entities has a different level of abilities for climate change adaptation and mitigation as well as they cause different social and economic effects on the life level of population and the state food security.

Effect of income's volatility is caused by farm's size. Changes in the price on key crops might affect SSFs (especially SSFs operated land bank from 100 to 500 ha) much more than the other types of farms, considering the significant share of these crops in the structure of the production of the small-scale farmer, and that such kind of farms has a lower level of product's diversification with comparison to bigger farms.

Following this observation, the Ukrainian farmer proposes a production solution based on the crops' price expectations rather than resource availability. Farmers are not ready to pay for accurate soil productivity conditions, water availability, hydrometeorological data and forecasts, and insect and disease control to improve production. This is caused by low interest in high technologies (the lack of knowledge, education, etc.) and the cost of the relevant services.

For farmers possessing a land bank of more than 10000 hectares, it is affordable to develop their own research and development and pay for the aforementioned technologies. The small and medium-sized farmers make their solutions based on their own experience and consultancy obtained from suppliers' input. This increases the vulnerability of the agricultural sector to climate change's consequences.

Only the big agricultural producers and input suppliers impact the agricultural policy development, while the interests and needs of small and medium-sized farmers are less considered. Therefore, SSF farmers adapting to climate change with higher vulnerability need other tools and mechanisms that will not be developed if the current conditions persist.

The overview of the national policy priorities, legislation, and regulation framework shows that adaptation to climate change is not a national priority due to the country's numerous challenges. These include the indefinite extension of the armed conflict in the east, an urgent reform agenda of the Government, COVID-19 pandemic, increasing fiscal deficit and ongoing economic crisis, preparation for the implementation of land reform and land market's development, decentralization reform, potential impacts of border carbon adjustment mechanism (European Green Deal), strengthening policies on climate change mitigation and environmental security (GOV-PO 2021), and seeking measures to stabilize and strengthen the economy (GOV-CM 179.2021). Besides these, adaptation policies are considered to be secondary to mitigation. However, without comprehensive, appropriate and timely adaptation strategies and policies, the ecological, economic, and food security of Ukraine and the welfare and health of its citizens are threatened by impending climate change impacts. Effective adaptation policies and strategies are also critical for the long-term development of agriculture and forestry to ensure the availability of resources and ecosystem services essential for sustaining food production, economic development, and societal wellbeing. In response to these impacts, there will be more migration.

However, the implementation of climate change adaptation measures in general, and the technologies presented in this report in particular could be driven and incentivized by the national legislation, regulations and programs listed in Table 1.1.

Gender issues can influence the process of technology transfer and implementation for the agricultural sector and water management, therefore, during the implementation of TNA activities on the all stages, attention was payed to gender balance, including both women and men as a target audience and mainstreaming gender dimension throughout the process. Thus, at the first stage, the group of national experts was developed for technology prioritization, considering the gender balance and equality. The gender balance has been maintained at the second stage.

Moreover, the analysis of gender issues in agriculture has been elaborated and described in the first report. Accordingly, it was observed that men are the major decision makers and assets owners in agriculture in Ukraine. However, the proposed adaptation technologies are gender-neutral and offer equal benefits for both men and women.

Table 1.1. National legislation, regulation and programs driving the climate change adaptation policy on agriculture.

Type	Title	Number	Enacted/ revised	Main contents
Land Code			2002. Last revision – May 2021	It is foreseen that the use of land may not harm the rights and freedoms of citizens, the interests of society, but worsen the environmental situation and the natural qualities of the land
Water Code			1995. Last revision – Nov 2020	The Water Code, in combination with measures of organizational, legal, economic, and educational impact, contributes to the formation of water and environmental legislation and environmental safety of the population of Ukraine, as well as more efficient use of water.
Forest Code			1994. Latest revision – 2021	The law defines the concepts of forest plantations and forest resources, which include some agroforestry practices. The law establishes a framework for the forest's management.
Law of Ukraine	About the state support of agriculture in Ukraine	1877-IV	2005. Last revision – December 2020	Defines the types of agricultural activities that ensure food security and are supported by the state, including: - the production of crop products, in particular crops, as well as the cultivation of berries, fruits and vegetables, flowers and ornamental plants (in open or closed soils), mushrooms, seeds, spices, seedlings and algae, as well as its processing, processing and / or preservation; - afforestation, including the creation of protective forest plantations, the collection of wild mushrooms and berries, other wild plants, their processing and conservation. - the provision of agricultural services (sowing, harvesting, storage of agricultural products).
	On Land Protection	39	2003. Last revision – 2021	This Law defines the legal, economic and social bases of land protection in order to ensure their rational use, the reproduction and increase of soil fertility, other useful properties of land, the preservation of ecological functions of soil and environmental protection.
	On adjustment of some legislative acts of Ukraine concerning conditions of circulation of the agricultural lands	552-IX	2020	The Law provides the legislative base for land market. Along with the private, business, and state ownerships, the law provides the ownership right of arable land to amalgamated territorial communities.
	On amendments to some legislative acts of Ukraine to improve the system of management and deregulation in the field of land relations	1423-IX	2021	The law aimed to regulate the use of land leading to the weed spreading. This can cause a fine for the conservation of agricultural producers, considering the absence of regulation and definition for the conservation of agriculture and using weed as covering crop.
	On Amendments to the Land Code of Ukraine and Other Legislative Acts to Improve the System of Management and Deregulation in the Field of Land Relations		2021	The law directs to simplify the agricultural land management and facilitates an access to land resources. Among others, the law abolishes requirements for the intended use of agricultural land.

	About association of territorial communities	157	2015. Last revision – 2020.	The law provides the budget for the redistribution of income. Following the law, the amalgamated territorial communities would define as a main budget holder, which can define the main direction of the community development and support the development of local infrastructure.
	On Nature Environment Protection	41	1991. Last revision – 2020	Determines the legal, economic and social foundations of the organization for environmental protection in the interests of present and future generations.
	On Farming	45	2003. Last revision – 2008	The law aims to create conditions for the implementation of citizens' initiatives for the production of marketable agricultural products, their processing and sale in domestic and foreign markets, as well as to ensure the rational use and protection of farmland, legal and social protection of Ukrainian farmers.
	On Environmental Impact Assessment	29	2017. Last revision – 2020.	Establishes the legal and organizational framework for the environmental impact's assessment aimed at preventing environmental damage, environmental safety, environmental protection, rational use and reproduction of natural resources, in the decision-making process of economic activities that may have a significant impact on the environment, taking into account public and private interests.
	On agricultural extension services	38	2004. Last revision - 2021	This Law defines the legal basis for the implementation of agricultural advisory activities in Ukraine, regulates relations in this field, and aims to improve the welfare of the rural population and rural development. This Law is a base to develop the advisory to disseminate the adaptation technologies.
President Order	About the Goals of sustainable development of Ukraine for the period up to 2030	722	2019	Among others, the Order aimed to take urgent action to combat climate change and its consequences.
	On enacted the Decision of National Security and Defense Council of Ukraine on Environmental security, as of March 23, 2021.	111	2021	The order defined the list of regulations and institutional capacities which should be improved to increase the national environmental security including the adaptation to issues related to climate change
Cabinet of Ministers of Ukraine Order	On approval of the National Economic Strategy for the period up to 2030	179	2021	The strategy provides the basis for the development by ministries, other central executive bodies of action plans, drafts program and strategic documents, drafts laws, and other legislation towards the state economic development.
	The statement of Rules of the maintenance and preservation of the shelterbelt located on the agricultural lands	650	2020	The Order determines the basic requirements for the shelterbelt maintenance and preservation on the agricultural land, a set of measures to ensure the implementation of functions for agroforestry reclamation.

	The National Action Plan to combat land degradation and desertification.	271-p	2016	The national action plan has to be introduced in order to facilitate the set of activities towards to adaptation measures, such as the dissemination of agroforestry, improving the agriculture technologies in order to water-saving and soil preserving etc.
	On amendments to the Procedure for use of funds provided by the state budget for financial support of activities on agriculture by reducing the cost of credits	384	2021	The order define the type and order of providing state subsidies for the small farmers including the partial compensation for advisory
	Irrigation and drainage strategies in Ukraine for the period up to 2030	668-p	2019	The purpose of this Strategy is to determine the strategic directions of state policy on irrigation and drainage, ensuring the sustainable eco-balanced development of agriculture in Ukraine.
	On approval of the plan of measures to implement the Strategy of Landing and Drainage in Ukraine for the period up to 2030.	1567	2020	Among others, the action plan is to define the prior measures to achieve next: • reforming the public administration system for irrigation and drainage on the basis of integrated water resources management according to the basin principle. • the preservation and reproduction of soil fertility, the protection of territories and settlements from the harmful effects of water, achievement and maintenance of good condition of river basin districts. • the restoration and increase of areas of irrigated lands, drainage systems. • creating preconditions for increasing the competitiveness of national agricultural production on the world market. • improving the quality of irrigation and drainage services and transparency of tariff formation.
State Forestry Agency	Rules of felling of the main use (forest resources)	364	2009	Rules establish norms and requirements for timber logging in the order of felling of the main use (hereinafter - felling), which is based on compliance with the principles of continuous, inexhaustible, and rational use of forest resources, the preservation of their reproduction condition, ecological and other useful properties.
Draft	Strategy on Environmental Security and Climate Change adaptation		2021	The strategy provides the connection between Climate Change adaptation as part of state policy on environmental security
	The Second National Determined Contribution		2021	The second NDC provides a recommendation to the measures of agriculture towards decreasing CO2 emissions, including agroforestry and conservation agriculture.

1.1.2 Action Plan for Technology A1: Drip irrigation in combination with conservation agriculture practices (DICA)

1.1.2.1 Introduction

Despite the importance of irrigation, the irrigation and reclamation system's current technical conditions are estimated as lower than satisfactory, partly ruined, or destroyed. For the last 10 years, only 20% of the total potential irrigation system capacity has been used. In other words, it means that not more than 500 thousand hectares of arable land are irrigated from a potentially possible 2,2 million hectares of arable land.

The direct loss in the agricultural sector and national GDP has annually exceeded $3.5 billion for the past ten years due to the poor capacity of irrigation and drainage systems. At the same time, a one-time $3 billion investment should be made in irrigation infrastructure to expand its irrigation capacity up to 1,180,000 hectares. Particularly it means that Ukraine has lost ten times more than the total budget requested for the modernization of irrigation and drainage system.

In order to address this, the "Irrigation and drainage strategy of Ukraine by 2030" was adopted in 2019 and the Action Plan on the Strategy Implementation (2020) has created an enabling environment to accelerate the development of the country's irrigation infrastructure and capacity.

Over the first stage of TNA Project implementation, the Drip irrigation was selected in combination with conservation agriculture practices (DICA) as the most crucial climate change adaptation's action for agriculture (TNA 2019).

The DICA is a win-win technology that addresses both mitigation and adaptation needs, as it reduces GHG emissions while increasing crop production in drought conditions. Following the experts' estimation, the DICA is efficient for application in unsatisfactory agrochemical, physical, mechanical and hydrophysical properties, such as high sand content, significant content of dust and silt, soil compaction, low content of moving macronutrients, and low moisture content. For Ukraine, the prior delamination zones is located in Steppe (Kherson, Mykolaiv, Odesa, Zaporihzya, Dnipropetrovsk, Donetsk, Lugansk oblast). However, the fast growing tendencies to crop production's losses have been observed in Forest Steppe zones (Khmelnytskyi, Cherkasy, Vinitsa, Kirovograd, and partly Lviv oblasts).

The DICA technology is mainly affordable for the medium and large agro-producers (agro holdings), first and second groups defined above.

Along with the private investment, the significant improvement is required for developing the technology within the national irrigation infrastructure, particularly pump-power facilities.

DICA technology is a combination of four key stages:

1. The formation of the crop-rotation scheme is carried out following the agro-climatic features of the farm, the agrochemical soil condition and the economic feasibility of its cultivation for the farmer. Depending on soil-climatic conditions and the specialization of a farm, crop rotations vary according to the composition and alternation of crops, the number of fields and their size. Therefore, crop rotations are divided into types according to the production purpose and the cultivation of certain crops and sorts according to the ratio of crops.
2. The installation of subsurface drip irrigation is combined with efficient water usage regimes. The implementation of this technology requires the preliminary preparation and the approval of project documentation for the irrigation system. In addition, it is subject to regulation by the Law on Environmental Impact Assessment No. 29 dated 18.12.2019.
3. The application of the no-till or mini-till practices for soil processing. The technological basis for the transition to conservation agriculture (No-till) is the availability of hard components: seeding equipment for direct seeding technology with the appropriate predetermined design of the sowing colter. For that type of soil with unsatisfactory properties - low humus content and

high bulk density, after the first cycle of crop rotation, it is recommended to sow cover and green manure crops.

4. Enhanced application for integrated pest management's principles.

Even general estimation of crop production for economy efficiency demonstrates the significant advantages of DICA application for soybean and grain maize production in comparison to conventional agriculture. The DACA application will increase the corn yield at least two times in very approximate and average estimation. For example, with an average income of around $ 1,5 thousand per ha, the farmer would cover capital and maintenance costs on crop production in two years (see Table 1.2.).

The detailed description of technology is available at link.

1.1.2.2 Ambition for the DICA TAP

To define the ambitions of DICA dissemination the next data were counted and analyzed:

- *The scope of the technology*. *A* number of farmers for whom DiCA technology could be the affordable and total size of land bank processed by them under the major market crops.
  Currently, the market capacity for DICA scaling up is defined by the medium and large-scale farms (as was mentioned before the DICA technology mainly unaffordable for small-scaled farms operating less than 100 ha of arable land). Following the official statistical data[2], there are 2350 counted farmers with land bank upper than 1000 ha which produce the cereal and leguminous crops.
  Adaptation reasoning. Drought risks and temperature changes (current and forecasted). The last year has demonstrated significant production losses due to the drought's appearance (Annex 2). Following the existing weather forecast, changes in precipitation and drought will accelerate to the end of the century and will heavily affect the agricultural production all over Ukraine. Though the temperature increasing all over Ukraine can bring additional benefits and increase yields in case of applying adaptation measures toward the the optimization of the soil moisture.
- *Economic conditions.* Prices' expectation for the major market crops (legumes and cereals) in the short and long term. Following the World Bank estimation[3], the price of grain and cereals will constantly increase in the nearest decade. This will stimulate agro producers to increase production capacity. On the other hand, uncertainty caused by the opening land market could slow down the investment into the new technologies at least in a short term. Finally, the competition with the other agricultural technologies refers to climate change and green economy such as organic farming and biofuel production from crop residue should be counted according to the assessment of technology potential.
- *Existent technical conditions.* Despite the importance of irrigation, the current technical conditions of irrigation and reclamation system are estimated as lower than satisfactory, partly ruined or destroyed. For the last 10 years, only 20% of the total potential irrigation system capacity has been used. In other words, it means that no more than 500 thousand hectares of arable land are irrigated from a potentially possible 2,2 million hectares of arable land.
- *Enabling environment.* Priorities of agriculture policy development. Following Irrigation and drainage strategy in Ukraine by 2030 (GOV-CM 668-p.2019) and the Action Plan on the Strategy Implementation (GOV-CM 1567.2020.), the relevant environment should be developed at the national level to scale up irrigation up to 2,5 million ha. This goal is repeated as a key national priority of economic development by 2030 (GOV-CM 179.2021). At the same

[2] State Statistical Service of Ukraine. 2020. Farm grouping by the size of the major crop harvested area, 2020. http://www.ukrstat.gov.ua/

[3] World Bank. 2001. Commodity Price. https://www.worldbank.org/en/research/commodity-markets

time, joining to EU Green Deal[4] and goals determined in the Second NDC[5] could stimulate farmers, looking for more green solutions to move to CA production, as the CA is defined as one of the other recommended technologies for that. Additionally, the lack of knowledge and relevant specialist would impact technology dissemination.

- *Upscaling potential of technology*. According to approximate estimates, about 600,000 hectares of land are cultivated under the conservation of agricultural technologies (and its different varieties - no-till, mini-till, strip-till and etc.) in Ukraine. Although some farmers refused to use the CA, changes in climate conditions are pushing farmers to switch to this technology. Increase in the procurement of machines required for CA technology implementation shows the boosting interest in this technology in the last year. Thus, CA farming in Ukraine continues to shape, even in the absence of state targeted support and a generally scientifically weak base.

As a result of analyses, the main conditions that define ambitions for technology action plan development are:

- ✓ In the nearest 3-5 years, the key DICA technology's consumers will be farmers focusing on cereal and leguminous crops production, operating the land bank within 1000 -5000 ha and located in the Southern region of Ukraine (with developed irrigation infrastructure).
- ✓ The main oblasts for technology scaling up by 2025 are Kherson, Mykolaiv, Odesa, with the total land bank under the cereal and leguminous crops are around 2,7 mln ha.
- ✓ Considering the significant production losses due to the abnormal aridity in other regions in the last year, it is possible to assume that farmers from the other regions will change their technologies toward the CA and irrigation installation. Thus, in a longer-term prospect (by 2030), there is a high chance that DICA technology would be scaled up in other oblasts focusing their production on the cereal and leguminous crops: Vinnytsia, Kirovograd, Poltava, Kharkiv, Zaporizhian, Dnipropetrovsk. In these oblasts, total areas under cereal and leguminous crops are about 5.8 million ha.

Following the expert assessment for the TNA project, only up to 15 percent of farmers would be able to apply DICA technology in Kherson, Mykolaiv, and Odesa oblasts by 2030. This share will be even smaller (around 7% of farmers) in Vinnytsia, Kirovograd, Poltava, Kharkiv, Zaporizhya, Dnipropetrovsk oblasts due to the less development of irrigation infrastructure (Table 1.2.).

Table 1.2. Ambition on DICA dissemination by oblasts in Ukraine.

	Geographical Scope	**Arable lands, thsn ha**	**Farms, numbers**	**Arable land per farm, thsn ha**
Ambition by 2030	Kherson	405	235	1.723
	Mykolaiv			
	Odesa			
	Vinnytsia	290	165	1.758
	Kirovograd			
	Poltava			
	Kharkiv			
	Zaporizhya			
	Dnipropetrovsk			
Total/average	**9 oblasts**	**695**	**400**	**1.738**

[4] European Green Deal. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

[5] Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR). 2020. The Second National Determined Contribution. https://mepr.gov.ua/news/36563.html

The summarized ambition for TAP by 2030 is to scale up DICA in the area of 695 thousand hectares of arable lands, processing by the 400 farms.

1.1.2.3 Actions and Activities selected for inclusion in the TAP

The summary of barriers and measures to overcome barriers.

The most 14 crucial barriers for DICA dissemination in Ukraine were selected and described in Adaptation Barrier Analysis and Enabling Framework Report (TNA 2020). Furthermore, over the national TNA presentation meeting (March 24-27, 2021), five of the most important barriers were selected by participants (national experts) in the next order:

1. Poor conditions of irrigation infrastructure. Following the Strategy of irrigation and drainage in Ukraine by 2030, only 10 percent of the total irrigation infrastructure's capacity is used. Therefore, another part requires to be renovated and reconstructed. However, restoring the performance of damaged parts of the irrigation infrastructure will require considerable investment and the development of the relevant equipment. Tentatively, about $ 3 US billion should be invested in irrigation infrastructure to expand its irrigation capacity up to 1,180,000 hectares.

Existent enabling measures in terms to improve the irrigation infrastructure are next:

- The conditions of effective budgeting for irrigation development following agriculture production needs were formed. As a result of the recent administrative reform, the Ministry of Agriculture (December 2020) was restituted. The irrigation and Reclamation Sector was incorporated into the structure of the Ministry of Agriculture. Following the budgeting for the renovation of irrigation system would be distributed by the agricultural requirement.
- In order to improve the water management and Water Resources Distribution, the water management department of the River Basin was established as the result of reforming the water sector in 2019. This provides grounds for transparent access to water resources and improves the control of the water quality.
- Improving inter-sectoral cooperation towards climate change. The department aimed to work with climate change, and environmentally relative issues are foreseen as a part of the Ministry of Agriculture for the first time.
- Developing and accepting the "Irrigation and drainage strategy in Ukraine by 2030" (GOV-CM 1333-p.2020), in 2019 and the Action plan for the Strategy implementation (2020).
- The increase in irrigation capacity is foreseen as a key component of national economic development for the next decade[6].
- The acceptance of the new program of state support for developing irrigation (with total amount 100 million UAH in 2021)
- Increase in the technical support for irrigation from the international donor organizations such as the World Bank Group (IFC) (on-going project On the development of climate-orientated agriculture and EBRD (ongoing current portfolio of projects is €4,027 million including the pilot project on melioration in Odesa oblast).
- Increasing the private investment in irrigation. Thus, the amount of irrigated area in 2020 was extended to 19 thousand hectares in comparison to 2019 and reached 551 thousand hectares. According to the annual working plan of the State Water Resource Agency[7], in 2021, the irrigated area will be increased up to 625 thousand hectares.

2. The absence of an effective agricultural land market leads to inefficiencies in the agricultural sector: limited access to finance since land cannot be used as collateral; reduced incentives for the investment

[6] National Economic Strategy 2030. 2021. https://www.kmu.gov.ua/npas/pro-zatverdzhennya-nacionalnoyi-eko-a179

[7] State Agency of Water Resources of Ukraine. 2021. https://u.to/V9RhGw

and sustainable use of land; reduced rental and tax revenue and asset value for landowners. The farmers are not interested in long-term investments into the land.

Existent enabling measures in terms to form the effective agricultural land market are next:

- For the two last years, the regulatory framework has been developed to launch the land market. Following the Strategy on irrigation and drainage (GOV-CM 1333-p.2020.), the agricultural land market is envisaged to be open in July 2021. Furthermore, issues are envisaged for improving land management of the community land within the massive of agriculture land, the prevention of raiding, stimulation irrigation and deregulation of the land management system by the Laws of Ukraine #2498-VIII (GOV 2020) and 1423-IX (GOV 1423-IX.2021).
- To improve the infrastructure capacity in terms of transparent land market, the development of the State Agrarian Register[8] and land tenure monitoring system was established.
- The inventory of agricultural land[9] was completed in 2020.
- To provide the primary rights to buy the arable land for the small-scale farm, Agriculture Loan Guaranty Fund[10] was established.

Thus, agricultural land market will be opened in the upcoming month. However, there are expert's assumption that it will slow down the agricultural activity in the beginning due to the uncertain process of land market operation at this stage.

3. The Lack of state financial supporting mechanisms. Mainly, the state financial support for the agricultural sector is directed towards increasing production, creating employment and strengthening the capacity of export for agricultural and food products. On the other hand, payment/subsidies are insufficient for ecology or ecosystem services or support for climate change adaptation.

Existent enabling measures in terms to overcome the lack of state financial support is following:

- The partial compensation of agricultural machinery and equipment of domestic production[11]
- Financial support for measures in the agricultural sector by reducing the cost of loans
- Financial support for farms and agricultural cooperatives
- State support for irrigation. The program was launched in 2021.

All the s tate's support programs have limitations or are insufficiently developed to cover farmers' needs (see Annex 3).

4. Insufficiently skilled workforce is one of the most complicated barriers to overcome, which is highly time-consuming. This barrier is typical for each technology presented in this study. It was caused by a set of reasons, such as the low conditions of life and the wage disparities in rural areas, the high level of working migration, absence of the relevant education programs on CA and irrigation, the insufficient interest of young people to work in the agriculture sector and other.

Existent enabling measures in terms to increase the amount of skilled workforce are following:

- 240 both public and private institutions of higher education on agriculture and environmental sciences.

[8] State Agrarian Register .https://www.ar.gov.ua/

[9] State Geo Cadaster. 2021. Information on conducting works for the Inventory of Agricultural Land of State Ownership. http://dzk.gov.ua/metodychni-rekomendatsiyi-shhodo-dokumentatsiyi-iz-inventaryzatsiyi-zemel-silskogospodarskogo-pryznachennya/

[10] Draft Law of Ukraine. On the Fund of partial guarantee of credits in agriculture. https://agro.me.gov.ua/ua/news/agrarnij-komitet-pidtrimav-zakonoproekti-pro-fond-chastkovogo-garantuvannya-kreditiv-ta-fermerski-gospodarstva

[11] Agropolit 2021. Presentation "State support of agricultural sector - programs for 2021: animal husbandry, compensation for the purchase of agricultural machinery, loans, farmers, cooperatives, drought, irrigation, organic products, potato growing". https://is.gd/AfYiDd

- The Law of Ukraine On Professional higher education was accepted in 2019 (GOV 2745-VIII.2019), this regulation creates conditions for practical education in combination with production.
- State support program was provided on cost partial reimbursement for extension services for farmers (total budget is 10 mln UAH, see Annex 3).

5. Relatively high investment cost. The DICE is a comprehensive practice combining the two technologies: surface drip irrigation and conservation agriculture. In this regard, the DICA's economic and financial barriers are the complex barriers of each technology plus the general irrigation infrastructure barriers.

Considering the relatively high investment cost, along with other financial barriers, the existent enabling measures in terms to make technology more affordable would be the same as they were detailed described above under Barrier 1."Poor conditions of irrigation infrastructure", Barrier 3 "The Lack of state financial supporting mechanisms" and below in subsection 2.1.2.3.

Actions selected for inclusion in the TAP

Measures to overcome the above-stated barriers are selected as actions of Technology Action Plan for DICA:

Measures (identified as actions) to improve the regulatory and institutional mechanisms for DICA integration and dissemination.

- The implementation of Water Re-USE Directive to improve the water resource availability for irrigation.
- The development of legislation towards the integrated approaches on irrigation system construction and water management.
- To create the regulation mechanisms to transfer the ownership rights on the objects of the irrigation infrastructure from the state to water users' organizations free of charge.
- To develop legislation on land consolidation.
- To increase the number of banks which will participate in the program on Financial support for measures in the agricultural sector by reducing the bank interest

Measures (that are selected as actions) to increase the capacity of human resource availability for the technology development.

- Facilitating the professional network among farmers and promoting the successful examples of technology implementation.
- Modeling the water resource distribution for agricultural needs on the basis of the climate change scenarios and drought risk assessment.
- Moving towards decreasing the wage's disparity.
- Developing the relevant courses of in-service education for farmers with further dissemination through the NGO or professional networks.
- To motivate younger generation launching the summer schools on natural resources management and agriculture at the school level in regions

Measures (that are selected as actions) to increase funding and financial accessibility to overcome economic and financial barriers.

- Increasing cooperation with donor organization to extend financial technical support, loan and grants.
- Increasing the budget for the improvement of irrigation infrastructure under the National Dnieper Basin Environmental and Drinking Water Quality Program (DBE&DWQ).
- Forming revolving funds based on the fee for the water use and environmental tax for the facilitation of irrigation infrastructure at the level of united village communities and water user associations.
- Extending the existent target state subsidies for partly compensation of purchase expenses on agricultural machinery and equipment by the irrigation equipment and machinery.

- Increasing the capacity of the Partial Agricultural Credit Guarantee Fund to decrease the loan ratio.
- To develop the cross-subsidization program for agro-producers and agro-service providers/input producers
- To foresee safeguard and priority to buy the land plots under irrigation under the land market providing the loan for holidays;
- To foresee extra funds for the cheap loans for irrigation implementation;
- To include technology in the green finance program and develop the green investment tools, carbon credits for the technology's implementation

The complimentary investment measures toward increasing the technological capacity for DICA dissemination:

- Improving the regulation and technical potential to develop the efficient system of water distribution and rotation within the Dnieper River Basin.
- The creation of facilities for the production, repair and renewal of pumping equipment and irrigation equipment.
- Improving the networks of irrigation systems and equipment's distributors.
- The modernization and renovation of state pumping stations for inter-regional water supply systems.
- The replacement of pumping and power equipment at main pumping stations, pumping stations and drainage stations.
- Investment into the climate smart irrigation's automated information systems towards increasing the use efficiency of water and energy.

Actions identified for the implementation of selected activities (measures)

Action 1. Enhanced capacity building to land consolidation under irrigation and sustainable agriculture practices.

Activities

1.1. The completion of the Draft Law on Land consolidation for considering the priority of rights to keep intact the land bank for those farmers who have installed irrigation and applied the conservation of agriculture, DICA consists of components which are covered by the hectares of land for a year creating the special ecosystem. It takes a long term from two to five years to reach full technology's efficiency. As usual, the quality of land under CA improves with time. It should be counted in the land cost while the land market opens.

The development of the land consolidation to support farmers for achieving the DICA application. Due to the price of land under DICA could be higher, the farmer should prioritize the cheaper loan or extended financial support to buy a land plot.

1.2. To Adjust the Cabinet of Ministries Order#348 "Procedure for the use of funds provided by the state budget for financial support of activities on agriculture by reducing the cost of credits" in terms of providing farmers caring the climate-orientated agriculture practices with additional benefits.

1.3. To develop the system of indicators and baselines for climate-oriented agricultural technologies. The development of the system of indicators and baselines for climate-oriented agriculture technologies allows to identify and estimate the environmental and social consequences of technology application and benefits received from the application. The application of adaptation technologies might co-occur climate-change mitigation and has a positive social and environmental impact. Thus, applying such win-win technology as a DICA could be a subject of green investment, developing ecosystem payments, and other financial tools and mechanisms. However, it is necessary to calculate the green effect of DICA for developing a system of indicators of technologies' impact on environmental, direct, and external costs, etc.

1.4. To examine water resource accessibility for irrigation in terms of their physical availability and quality per oblast. Simultaneously with this to increase laboratories capacity for water analysis.

1.5. The development of the legislation towards the consolidated approaches on irrigation system construction and water management. According to this, the farmer and agro-producers may cooperate to contribute in the defined region to develop a common irrigation system and maintenance of infrastructure around their fields.

Action 2. Scaling up DISA technology.

Activities

2.1. The pilot implementation of technology at the farm level within the selected amalgamated territorial communities. One of the targets would contribute to developing common irrigation infrastructure that farmers will use.
2.2. Field Farm School. For further technology transfer, the field farm school will be launched based on the farm-to-farm visit.
2.3. The pilot implementation at the oblast level on the contribution to investment into developing the local infrastructure. Thus, the donor organization can provide loans or grants to farmers to contribute to local infrastructure's development by additionally receiving profit. Considering the ambitions defined above and the existent example of DICA implementation, Kherson oblast should be strongly recommended for the pilot implementation.
2.4. Scaling up the proposed models to other 8 oblasts, defined as ambitions.

Action 3. Enhancing the financial affordability.

Activities

3.1. To increase the budget line for the state program for partly compensation of purchase expenses on agricultural machinery and equipment by the irrigation equipment and machinery. It is important to foresee support for the imported machinery and equipment for the next three years and increase compensation on the domestic machinery developed for conservation agriculture.
3.2. To increase the budget line to support programs for irrigation development.
3.3. To form revolving funds to facilitate irrigation infrastructure at the level of amalgamated village communities. Farmers could contribute to the irrigation's infrastructure development by getting back the land tax.

Action 4. Increasing capacity of skilled humane resources for the technology's implementation.

Activities

4.1. Establishing the Coordination Center of Climate Oriented Agriculture. In cooperation with the national academy key stakeholders and based on the pilot farm fields, the coordination center aimed to teach farmers based on the principle of learning by doing.
4.2. To develop the online video courses on DICA implementation based on the lesson learnt and sharing the best examples of DICA implementation.

Actions to be implemented as Project Ideas.

DICA is a complex technology for wide dissemination, which requires simultaneous development infrastructure, investment, and technologies. However, before developing relevant regulations and infrastructure at the national level, it makes sense to implement the model on a smaller scale. At the same time, there is already existent experience to implement the DICA. The project idea is to create and develop the Coordination Center in the South, combining research and practice to disseminate technology and improve infrastructure for further technology development.

It will rather help to implement technology particularly for farm's needs and create the local infrastructure in cooperation with local communities for long-term and effective water usage.

All actions are gender-neutral and envisage equal opportunities for all age males and females for their implementation.

1.1.2.4 Stakeholders and Timeline for the implementation of TAP

Below, the stakeholder's overview has been presented in Table 1.3. The overall list of stakeholders has been provided in Annex I.

Table 1.3. Stakeholder analysis by activities for the implementation of DICA TAP

Actions	Activities	Stakeholders	Time frame
Action 1. Enhanced capacity building	1.1. For the completion of the Draft Law on Land consolidation	VR; MAPF; State Geocadastre; FAO;USDA; SAWR	2021
	1.2. To adjust the Cabinet of Ministries Order #384	MAPF; MDETA; MFU; CMU	2022
	1.3. To develop the system of indicators and baselines	NAASU; SI Derzhgruntokhorona; IWPLR; IA; NRS ISSA; IAMAIP; GEF; FAO	2022-2023
	1.4. To examine water resource accessibility for irrigation	MEPNR; MAPF; SAWR; EBRD; GEF; UNDP;OCED;IWPLR;IIA; State laboratories; Private laboratories	2021-2024
	1.5. Legislation towards the consolidated approaches on irrigation system construction and water management	VR;MEPNR; MAPF; SAWR; EBRD; GEF; UNDP; OCED; IWPLR; IIA; State Geocadastre; MCTD	2022-2024
Action 2. Scaling up DISA technology	2.1. The pilot implementation of technology at the farm level	EBRD; IFC; EIB; Agriculture producers; Agriculture Service Providers; Irrigation Equipment Service Providers; Regional department of SAWR; ATC[12]	2021-2022
	2.2. Field Farm School	EBRD; IFC; EIB; Agro producers, IWPLR; IIA; NAASU; NAESU Dorada and private NGOs	2022-2023
	2.3. The pilot implementation at the oblast level	MAPF; EBRD; IFC; EIB; Agriculture producers; Agriculture Service Providers; Irrigation Equipment Service Providers; A Regional department of SAWR; ATCs; IWPLR; IIA; SOAs; UVP	2023-2025
	2.4. Scaling up the proposed models to the other 8 oblasts		2025 -2030
Action 3. Enhancing the financial affordability.	3.1. To increase the budget line for the state program for partly compensation of purchase expenses on machinery and equipment	MAPF; MDETA; MFU; CMU; State and private banks	2022-2030 (annual base)
	3.2. To increase the budget line to support programs for irrigation development		

[12] ATC – Amalgamated Territorial Communities are independent administrative unit which consist of a few villages and totally populated more than 5 thousand people. Following the recent decentralization reforms, ATC was created and received rights independently to develop education, health, environmental and other public services. ATCs are represented by the local authorities which are elected by people and legally authorized to manage all assets of the community including the land as well as to form and distribute local budget. Local authorities have the right to create public entities to realize the activities.

	3.3. To form revolving funds for the facilitation of irrigation infrastructure	MFU; ATCs; SOAs; Agriculture producers; SFS; Sate and private banks	2023-2029
Action 4. Increasing capacity of skilled HR	4.1. Establishing the Coordination Center of Climate Oriented Agriculture	FAO; UNDP; USDA; NAASU; Agriculture producers; IWPLR; IA; NRC ISSA; IIA	2022-2024
	4.2. To develop the online video courses	NMCGPE; OAU; UaSP; No-Till; NAAASU	2023

1.1.2.5 Estimation of Resources Needed for Action and Activities

The estimation of resources needed for action and activities was counted per activity and summarized in Table 1.5.

For estimation, the next approaches were applied:

- for Actions 1, 3 and 4, the average market cost of labor hours for the same services plus the assumed budget of the project for technical support (based on the existent international development projects in Ukraine).
- for Action 2. the financial needs counted as the sum of capital cost of equipment for irrigation and cost for its installation (TNA 2020), the simplest machinery for CA technology and the cost of irrigation project's blue paper developing. The cost per hectare was multiplied on ambitions defined in this study (see Table 1.4).

Table 1.4. Minimal and average budget of implementation Action 2.

Geographical Scope	Arable lands, thsn ha	Farms, numbers	Arable land per farm, thsn ha	Min. capital investment, $ mln	Min. capital investment per farm, $ mln	Average capital investment, $ mln	Average capital investment per farm, $ mln
Kherson	405	235	1.723	420.28	1.778	630.42	2.682
Mykolaiv							
Odesa							
Vinnytsia	290	165	1.758	271.56	1.65	407.34	2.468
Kirovograd							
Poltava							
Kharkiv							
Zaporizhya							
Dnipropetrovsk							
Total/average	**695**	**400**	**1.738**	**691.9**	**1.72**	**1 037.75**	**2.575**

The minimal cost was counted for the cheapest type of equipment for irrigation and machinery for CA. In the period 2025-2030, it was foreseen that the capital cost would be decreased with time. The average level of inflation was counted as well. The cost on the Estimation of Environmental Impact (GOV 2017) was not counted in this estimation as they should be calculated per each business case.

Table 1.5. Estimation of resources needed for action and activities for the implementation of DICA TAP

Actions	Activities	Tentative budget, mlln $ US	
		Minim	Average
Action 1. Enhanced capacity	1.1. The completion of the Draft Law on Land consolidation	0.025	0.025
	1.2. To adjust the Order #384 of cabinet ministry	N/A	N/A
	1.3. To develop the system of indicators and baselines	0.100	0.150

building	1.4. To examine water resource accessibility for irrigation	0.480	0.720
	1.5. Legislation towards the consolidated approaches on irrigation system construction and water management	N/A	N/A
Action 2. Scaling up DISA technology	2.1. The pilot implementation of technology at the farm level (3 farms)	5.334	8.046
	2.2. Field Farm School	0.015	0.024
	2.3. The pilot implementation at the oblast level	111.572	153.468
	2.4. Scaling up the proposed models to the other 8 oblasts	354.93	532.246
Action 3. Enhancing the financial affordability.	3.1. To increase the budget line for the state program for partly compensation of purchase expenses on machinery and equipment	2.8	4.5
	3.2. To increase the budget line to support programs for irrigation development	3.9	5.4
	3.3. To form revolving funds for the facilitation of irrigation infrastructure	0.015	0.023
Action 4. Increasing capacity of skilled HR	4.1. To establish the Coordination Center of Climate Oriented Agriculture	0.150	0.250
	4.2. To develop the online video courses	0.008	0.012
Total		**479.3**	**704.8**

1.1.2.6 Management Planning

Risks and Contingency Planning

The development of legislation and changes in the state's budget planning is complex and unique work per each case. It depends on the ability of relevant national and international experts, policy development priorities, political lobbies. Still, generally, the main risk refers to changes within the government in Ukraine and by the reorganization of major national beneficiaries. In this regard, the most important point to finalize technical work (prepare final draft law) ensures close collaboration with the middle-level management of the governmental stakeholders involved and negotiated with each newly appointed top government.

Regarding performing research, study, or developing a methodological approach, the main risk refers to unclear responsibilities of institutions at national and local levels. This leads to challenging the results of research and assessment and conflicts among stakeholders. To achieve a positive result, forming inter-organizational working groups brings the board all leading experts in the field and includes international experts.

The installation of technologies may delay challenges such as delay in implementation caused by the appropriate weather conditions, trading limitation (import quotas) on necessary inputs for technology implementation, etc.

The other risks of technology implementation might refer to increase shadow water supply and possible conflicts for the access to water resources among different groups of agricultural producers and other local consumers. It could be provided by the lack of relevant and transparent regulation and mechanisms of its implementation at the national level.

Some ecological risks are possible in the case of low quality of environmental impact assessment. Technology exploitation might increase soil pollution and land degradation processes in case of insufficient water usage and quality control.

Finally, the implementation of all actions could be faced with delay or changes in the activity's implementation caused by COVID-19 or other restrictions refer to the pandemic.

The major factors that may cause risks identified for the implementation of DICA TAP.

1. The unpredictability in the implementation due to constant changes within the government in Ukraine due to the reorganization of major national beneficiaries and the elections.
2. Challenging the final research and assessment results caused by unclear responsibilities of institutions at national and local levels.
3. Environmental risk referring to gradual climate changes and extreme weather events as long drought, which can cause a delay in the technology's implementation.
4. Increasing shadow water supply caused by conflicts for access to water resources among different groups of agricultural producers and other local consumers and increasing cost of electricity and water.
5. Increasing the soil pollution and land degradation processes in insufficient control on water usage and quality.
6. Delay or change in implementing the project caused by COVID-19 or another pandemic (if any).
7. Low technical capacity at the national and local levels could halt the project's progress.
8. Lack of state budget due to other duties caused by unpredictable military activities or financial crises.
9. The risk of insufficient interest or involving from the ATCs side

Next Steps

The immediate requirement to proceed with TAP is to adopt the law on land consolidation. This is an issue of emergency considering the upcoming open of the land agriculture market to provide the priorities and protect the rights of technology's owners.

From the technical point of view, it is not possible to start massive DICA technology dissemination without relevant data about water availability. Thus, providing the assessment of water resource accessibility for irrigation in terms of their physical availability and quality per oblast is immediate security for further TAP implementation. Simultaneously with this, we require to increase laboratories' capacity for water analysis.

1.1.2.7 TAP overview table for Drip irrigation in combination with conservation agriculture practices (DICA)

Sector	Agriculture							
Sub-sector	Crop production							
Technology	Drip irrigation in the combination with conservation agriculture (DICA)							
Ambition	Technology would scale up **on 695 thousand hectares** by 2030. Approximately 400 farms will implement technology all over Ukraine, mainly in the South oblasts.							
Benefits	Economic, social, and environmental − increasing the efficiency of land and water natural resource management; − the prevention of losses in the result of droughts and other natural disasters; − the diverse and efficient use of resource; − the conservation of production efficiency; − increase in yield; − the reduction of CO2 emissions following the tillage reduction and increasing energy efficiency to strengthen adaptation benefits: − additional humidification (precipitation); − avoiding wind and water erosion; − the adjustment of temperature mode (ground). − sustainable climate-resilient agricultural production under different weather conditions and addressing the needs of all members of society, including the vulnerable groups, − improved coordination of climate -related activities and actions, improved livelihood of village communities of 8 oblasts, including those the most exposed and vulnerable to climate impact							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Indicators for Monitoring of implementation**	**Budget per activity**
<u>Action 1.</u> Strengthen Enabling environment	1.1. The completion of the Draft Law on Land consolidation	State budget (2021); International organizations providing the technical support	The Ministry of Agrarian Policy and Food. State Geocadastre	2021	The unpredictability in the implementation	Draft Law submits for further processing and adoption	A number of meetings of working group and number of members of working groups Approved Law on Land Consolidation (gender disaggregated)	USD 25 thousand
	1.2. To adjust the Cabinet of	State budget (2022)	The Ministry of Finance of Ukraine;	2022	Unpredictability in the implementation	The amendment for farmers caring the	A Number of meetings of working	N/A

	Ministries Order #384		Ministry of Agrarian Policy and Food.			climate-oriented agriculture practice adopted	group and number of members of working groups Amended Order#384 (gender disaggregated)	
	1.3. To develop the system of indicators, including gender-related and baselines to reflect the progress of environment and adaptation	International programs of technical support and development. Budget fund of NAASU	The Ministry of Agrarian Policy and Food; National Academy of Agrarian Sciences	2022 - 2023	Challenging the results of research and assessment	Cabinet of Ministry The order cabinet ministry approved baseline and indicators for implementation and standardization	A number of indicators including gender- related and baselines; number of Guidelines, Standards published	USD 100-150 thousand
	1.4. To undertake water resources availability assessment	International programs of technical support and development. Budget fund of NAASU. Private sectors co-funding	The Ministry of Agrarian Policy and Food; State Agency of Water Resources; Institute of water problem and land reclamation	2021-2024	Delay or change in the implementation of project	Information system on the availability of water resources for irrigation developed and public accessible	Interactive maps of irrigated lands and available water spots; the number of water's characteristics to indicate its quality for irrigation; number of laboratories improved; number of potential beneficiaries based on gender disaggregated data	USD 480-720 thousand
	1.5. Legislation towards the consolidated water management,	State budget (2022 -2024)	The Ministry of Agrarian Policy and Food; Ministry for Communities and Territories	2022 - 2024	Unpredictability in the implementation	Draft Law and regulations submits for further	A number of meetings of working group and number of members of working groups,	N/A

	considering the needs of vulnerable groups as well		Development; State Geocadastre;State Agency of Water Resources;			processing and adoption	including the representatives of women associations, vulnerable groups Approved legislation on water management	
Action 2. To scale up DISA technology	2.1. The pilot implantation on the farm level	The loans and subsidies within the international programs of technical support; State program of support; Own resources and private investments; Local budgets (ATC)	Farmers, Utility company of Amalgamated village community; State Agency of Water Resources.	2021-2022	Low technical capacity Delay or change the project implementation Increasing shadow water supply. Increasing the soil pollution	The DICA practice is implemented at least by three farms within the one ATC. The irrigation infrastructure within one ATC improved (the pump station built or reconstructed, etc.) Productivity increased. The variety of crops produced extended.	At least on 14 thousand hectares or 2% share of total ambitions reached; number of farms (gender disaggregated based on property ownership) and size of their land bank (ha) number of crops; crop yield increasing, t.,	USD 5.334 - 8.046 million
	2.2. Field Farm School	Service providers and farmers own budgets. International programs of technical support and development (USDA). Co-funding form Academy	The Institute of Irrigated Agriculture. Institute of water problem and land reclamation. NAASU. NAESU Dorada	2022 - 2023	Delay or change in the project's implementation	At least 40 new farmers and 5 services providers learned how to work with DICA	The Number of farmers participated at FFS; number of SP; number of AVC jointed (gender disaggregated)	USD 15–24 thousand
	2.3. The pilot implementation at the oblast level	Loans and subsidies within the international programs of	The Ministry of Agrarian policy and Food; State oblast administration;	2023-2025	Low technical capacity Delay or change in the project's implementation To increase the soil pollution	The DICA practice is implemented at the oblast level. The common system of	20% share of total ambitions reached; number of farmers (gender	USD 31.572-198.468 million

		technical support; State program of support; Own resources and private investments; Local and Oblast level budgets	Farmers; ATC; Regional; State Agency of Water Resources			water distribution and monitoring water got developed. The irrigation infrastructure within one oblast was improved. Production efficiency was increased. Biodiversity was improved.	disaggregated); land bank size under technology ; the scope of infrastructure was improved	
	2.4. To scale up the proposed models to the other 8 oblasts, with special consideration of need of most exposed and highly vulnerable communities			2025-2030			100% ambitions completed; the number of farmers gender disaggregated; land bank size under technology, ha; scope of infrastructure was improved	USD 554.93-832.2 million
Action 3. To enhance the financial affordability.	3.1. To increase the budget line for the state program on partial compensation of domestic machinery cost	The state budget of Ukraine	The Ministry of Finance of Ukraine; Ministry of Agrarian Policy and Food	2022-2030 (annual base)	Th lack of state budget due to other duties caused by unpredictable military activities or financial crises.	The state support programing on domestic production machinery for CA and irrigation for farmers increased gradually over 10 years at least in 20 times.	Draft annual state budget with amount on state support. MAPF annual budget plan. The number of beneficiaries receiving the compensation, gender disaggregated	USD 2.8-4.5 million
	3.2. To increase the budget line to support programs for irrigation development					The state support programing on domestic produce machinery for CA and irrigation for farmers increased gradually over 10 years at least in 20 times.		USD 3.9-5.4 million
	3.3. To form revolving funds for the facilitation of	Local budgets of ATC	Ministry for Communities and Territories	2023-2029	Delay or change in implementation	Amendment to tax cod developed. The local supporting funds conducted	A number of ATCs involved; number of financial mechanisms	USD 22.8 thousand

	irrigation infrastructure		Development of Ukraine; the Ministry of Finance of Ukraine; Amalgamated Territorial Community				developed.	
Action 4. Increasing capacity of skilled humane resources considering gender issue	4.1. Establishing the Coordination Center of Climate Oriented Agriculture (CC)	International programs of technical support and development. Budget fund of NAASU Co-funding from agro-service providers and private organization	The National Academy of Agriculture Sciences; Institute of irrigated agriculture; Institute of Water problem and water management	2022-2024	Low technical capacity Delay or change the project implementation. The unpredictability in the implementation	The CC established based on the public-private initiatives and in cooperation with farmer launching the trainings and research	A number of farmers participate (gender disaggregated); number of the best practice involved; number of field research launched Coordination Center of Climate Oriented Agriculture established and operational	USD 150-250 thousand
	4.2. To develop the online video courses	Grants and technical aid of international organizations (such as USAID), Regional budgets, funds of business entities	The National and Methodological Center of Graduate and Postgraduate Education. The National Association of Agricultural Advisory Services of Ukraine	2023	Delay or change in the implementation of project.	On-line courses developed and place on all on-line educational platform of oblast level agriculture universities and non-governmental initiatives. Dedicated training in support of women leadership	A number of online courses offered Number of Universities and NGOs involved, number of subscribers and viewers, dedicated training in support of women leadership	USD 8-12 thousand

1.1.3 Action Plan for Technology A2: Agroforestry practices

1.1.3.1 Introduction

In Ukraine, agroforestry is mainly presented as liner field protection forest belts which looked like a mixture of perennial species planted in fields in a few lines and aimed to protect the field against different types of soil erosion. However, the adaptation potential of shelterbelts has not been fully counted yet. The agroforestry practices allow effective agricultural activities to protect crops from damaging winds, improve the microclimate of fields, preserve water-saving, regulate spring and stormwater runoff, reduce soil erosion, etc. As a result, agroforestry builds resilience to climate change in agriculture due to reducing negative climate change consequences and increasing productivity. Besides, agroforestry is win-win practice supporting climate change mitigation because of carbon sequestration and absorption.

In general, the agroforestry application is a complex technology, which depends on the country's particularities. Considering the historical uncertainty status of land under agroforestry in Ukraine, the shelterbelt establishment and reconstruction have to follow the next steps in Ukraine:

1. First stage – the inventory of existing boundaries of shelterbelts and their further registration in State Land Cadastre. The shelterbelt inventory is a three-stage process: (I) Local authorities of amalgamated territorial communities initiated the inventory of land under the agroforestry within the land massive of ATC; (II) the local ATC authorities or state company perform the registration to identify land plots under shelterbelt with further reflection in the Public Cadaster Map and transmit rights for shelterbelt management to the lessee (farmer of utility company); ATC, lessee or state owner of a shelterbelt, launching the forest management with the purpose to estimate plantation conditions.
2. Second stage – planting project preparation. As mentioned before, the shelterbelt is alive construction, providing certain environmental effects, and it is important for the country’s environmental security. Based on this, the establishment of the shelterbelt must follow the regulation (GOV-CM 650.2020) to maintain the shelterbelt’s environmental functions. Besides, the lessees focus on the economic efficiency of shelterbelt plantation combining plants to receive timber and non-timber goods. Therefore, developing the plating/planting? Through the authorized organizations, the project is the way to reach triple effects from agroforestry implementation, such as maximizing the environmental and economic effect and minimizing the loss of crop production in fields through the shelterbelt under climate change.

   Designing a planting project consists of the (I) pre-project assessment aimed to collect input data such as soil quality, climate and precipitation conditions, etc.; (ii) the selection of the most appropriate shelterbelt construction and placement; and (iii) species selection.

   The minimum forest cover required for the protection of field varies widely and depends on the agroclimatic zone and soil type; for the soil of the clayey and loamy forest-steppe zone, it is 2.5%, and for the sandy soils of the steppe - 9.8%.

   The composition and position of tree and shrub species determine the resilience and long life of the shelterbelts and their protective value.

   The species selection should be performed at baseline with the climate-smart forestry recommendations (FAO 2020). When selecting a range of tree and shrub species for the shelterbelt, the species' biological characteristics should be considered and their interaction as well as natural and climatic conditions and land reclamation tasks.

The supportive species should be selected from shade-tolerant species capable of growing in the second layer of the stand and not competing with the main spot for light, water, and minerals.

3. Third stage – Shelterbelts planting. The planting stage involves pre-planting trimming, logging, uprooting (if requires), soil cultivation, planting, and cropping (if envisaged) on the basis of the requirements of relevant national legislation (GOV-SFA 2020) and on the basis of the received logging ticket.

   Planting and sowing should be made in parallel rows with the following spacing between the two rows:

   • in the Forest-Steppe zone for all types of soils and northern part of the Steppe zone in typical and ordinary chernozems (black soil) – 2.5–3 m;

   • in the southern chernozems (black soil0 – 3 m,

   • in dark chestnut and chestnut soils – 3–4 m;

   • oin sands of all zones – up to 3 m.

   In Forest-Steppe and Steppe, soil cultivation should maximize the accumulation and conservation of soil moisture.

   Shelterbelts should be planted by using seedlings, saplings, rooted cuttings, or by sowing seeds of not less than 2nd quality class (local collection from the best tree stands or collected in other areas provided by silvicultural zoning).

4. Fourth stage - Repair and maintenance work. The loss of newly planted seedlings could be observed up to 20-25% in the first year. The reconstruction and establishment of shelterbelt are foreseen as the further maintenance actions. The second year-maintained activities include the re-planting of lost or damaged plants, fertilizing, PES management. Further, the timing and cultivation measurements require following the planting project documents.

Finally, the shelterbelt manager (end-user) is obligated to protect the shelterbelt and takes civil and criminal liability for its conditions. Particularly it means that end-user must protect plants (trees) from illegal allows a producer to react to markets, labor limitations, and changing goals.

Forest Farming – grows and protects high-value specialty crops under the forest canopy, adjusted to the correct shade level and the preference of crops. This is done by thinning an existing forest to leave the best canopy trees for the continued timber production while creating ideal growing conditions for the understory crop. Additionally, to timber products, this type of agroforestry allows receiving non-timber forest products such as mushrooms of honey. logging or damage.

To manage different risks better and increase the economic efficiency, the end-user can apply different agroforestry practices for shelterbelt reconstruction, for example:

Alley cropping. This is defined as planting rows of trees and/or shrubs to create alleys where agricultural or horticultural crops are produced. Trees may include valuable hardwood veneer or lumber species; fruit, nut, or other specialty crop trees/shrubs; or desirable softwood species for wood fiber production. As an additional benefit, the alley cropping is suitable for producing medical and essential oil herbs or fodder crops within the alley. Organic producers may choose tree species that fix nitrogen.

The versatile nature of this practice

A more detailed description of technology implementation is provided in Barriers Analysis and Enabling Frameworks.

1.1.3.2 Ambition for the Agroforestry practices TAP

To define ambitions for the potential to scale up agroforestry in Ukraine, the next issues were counted and analyzed:

- *The availability of Input resources.*
- *Land availability.* Following the national regulation, the land under shelterbelt is classified as agricultural non-arable land. Considering the official data, shelterbelts should cover around 440 000 hectares of agricultural land. However, this number is approximate, as the shelterbelt inventory has not been performed since the Soviet Union collapsed. As a result of the state's collapse and ensuing land reform, about 70 percent of the land area under shelterbelts remained the part of unused state reserve lands or counted as a part of public lands. The other 30 percent of the shelterbelts is under ownership (mainly under the state organizations). However, due to the complexity of legislation, the protection, maintenance, and restoration of all shelterbelts were not carried out. The land under the shelterbelt was counted as arable land and transferred for farming purposes; another part of shelterbelts was lost due to illegal logging. Thus, there is no accurate data on shelterbelts. Following the information received under the GEF project implementation carried by FAO in Ukraine, around 55 percent (in Southern oblasts) and 75 percent (Central Ukraine) from the official information are real data about shelterbelt which has been remained.
- *Available planting materials.* The availability of planting materials and machinery are essential conditions that defined the timing of technology distribution. Growing the planting materials for shelterbelt is time-consuming. Moreover, the planting material stock and quality requirements will change under the climate change toward increasing demand for climate change resilient breeds. There is not enough capacity to satisfy increasing needs in planting materials for shelterbelt reconstruction at the current stage. In these conditions, the non-certified market players often distribute invasive and in-vitro plants. The state does not focus on updating regulations regarding in-vitro and GMO seedlings production and distribution considering climate change. The positive side is that there are still enough numbers of state nurseries under state forest enterprises. Improving their technological basis, increasing the stock of planting materials in the next 3-5 years would be possible.
- *Technological capacity.* The lack of technological and institutional capacity could be observed at each stage of agroforestry implementation from forest management inventory (plantation condition inventory) up to planting and maintenance. For example, only the organization authorized to perform forest management inventory is State Forest Project. A few organizations are skilled enough to develop planting projects considering the climate change resilience breed selection and develop relevant technological maps. However, it is not enough to cover even existent demand. Besides, there is a lack of machinery for uprooting and forest planting, limited laboratories to launch the relevant soil observation, etc. The technology capacity can slow down the process of technology dissemination significantly and impact ambitions.
- *Market liquidity.* The market analysis has shown the growing interest in agroforestry from business and local authorities. Following the recently adopted legislation, local authorities can establish utility companies to manage shelterbelts within the ATC land bank. Moreover, they can transfer rights on shelterbelt management to the private sector (farmers, service providers, etc.). Currently, there are 1470 amalgamated territorial communities registered in Ukraine. Some of them operate from 30 up to 700 hectares of shelterbelts. At the same time, the interest in shelterbelt reconstruction is the part of the national program of forest sector development that corresponds to the farmer's interest. The highest interest in shelterbelt reconstruction is observes in Kherson oblast (South of Ukraine) as this is the oblast with extreme climatic conditions and the consequences of climate change.

Resuming mentioned above, the next ambitions for agroforestry technology implementation were defined for TAP: the technology would be developed as the mix of **climate-orientated agroforestry**

practices presented as field **protection shelterbelts** (established and reconstructed) on the area around **85 thousand hectares by 2030** overall of Ukraine with focus in south oblasts.

1.1.3.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers.

The 12 barriers for the transfer of agroforestry practice and further dissemination were selected and screened attentively in Barriers Analysis and Enabling Frameworks (TNA.2020). Furthermore, in the national TNA presentation meeting (March 24-27, 2021), participants selected the most essential barriers by voting. Traditionally the financial and economic barriers, as well as the lack of technological capacity, were recognized as crucial. However, 63% of participants were recognized as the unclear legislative mechanism of shelterbelt management and corruption caused by these uncertainty regulation mechanisms as the top challenges for the agroforestry development.

1. *The unclear legislative mechanism of shelterbelt management and corruptions processes caused by it.*

There are a couple of uncertain issues referring to shelterbelt management: the uncertainty of land ownership rights; unclear mechanism of shelterbelt land inventory and registration in State Geo Cadastr and uncertain mechanism for shelterbelt maintenance (trimming, cleaning, etc.).

Under each issue, the specific state authorities cooperate with shelterbelt end-users and considerable uncertainty in regulation. Because of this, such cooperation could be based on the "gray schemes" (financial or land frauds).

1.1. Land ownership rights uncertainty. Following the land reform at the beginning of the 90th last century shelterbelts, the economic turnover eventually fell out. They were not subject to parceling and remained parts of the reserve or general use's funds outside the farming and residential areas (GOV 2002). For many years, they have not had formal owners. This fact brings to the significant decrease in the shelterbelt's numbers partly due to age, unfordable weather conditions, shadow logging and partly because they were shared among farmers as part of their arable plots.

Existent enabling measures towards solving the uncertainty with land ownership's rights on shelterbelt:

- Ukrainian Law 2498-VIII, "On Amendments to Certain Legislative Acts of Ukraine for Resolving the Issue of Collective Land Ownership, Improving Rules for the use of land in Agricultural Land, Preventing Raiding and Stimulating Irrigation." classified the status of land under shelterbelt as agricultural, non-arable lands (suitable for any other agriculture activities except crop production). Following this law, the ATC received ownership rights for the field protection of shelterbelts. They can transfer rights on shelterbelt management to other users (public or private) on the basis of the long-term rental agreement or managed it themselves via an ATC utility company.
- The legislative models of shelterbelt management were developed[13], including the template of long-term rental agreements and were implemented in 7 ATCs in Kyiv, Kherson, Mykolaiv, and Poltava oblasts in 2020.
- Ukrainian Law. 2019."On the adjustment of some legislative acts of Ukraine concerning the conditions of circulation of the agricultural lands" provides the opening of the agricultural land market in Ukraine. It increased the interest of farmers to manage the shelterbelt along with their fields and legalized the land's plots under shelterbelt.

1.2. The unclear mechanism of shelterbelt land inventory and registration. Following the ATCs, they are obligated to perform an inventory of shelterbelts with further registration in the State Geocadastre. However, there is not a certain procedure for performing land tenure work and identifying shelterbelt within the massive of arable lands. Often, archive maps where the shelterbelt is marked are not available

[13] UkrInform. 2020. Shelterbelt management models have been developed in Ukraine. https://www.ukrinform.ua/rubric-economy/3047994-v-ukraini-rozrobili-modeli-upravlinna-lisosmugami.html

for ATC authorities. The local authorities of State Geocaaster also do not have the proper right to support the identification of shelterbelts. The land under the shelterbelt is often registered as arable land and has an owner. In this case, it is necessary to work with State Geocadastre closely to develop a solution for each particular case about the consolidation or exchange of land. There are no proper mechanisms to satisfy this well in these terms, as there is a deep lack of relevant human resources from both the ATCs and the State Geo Cadastre.

Existent enabling measures for improving the shelterbelt's land inventory and registration:

- The Order of Cabinet Ministers of Ukraine. 2019 No. 476 "On Approving the Procedure for Land Inventory and the Recognition of Some Decisions of the Cabinet Ministers of Ukraine provides the framework for arable land inventory (GOV-CM 476.2019)
- Partly available archival materials of agroforestry reclamation developed before 1992[14].
- The availability of open-data resources on remote sensing for the last 30 years.

1.3. Uncertain mechanism for shelterbelt maintenance (forest management). According to the Forest Code, shelterbelts' plantations belong to forests (GOV 1994). Therefore, a special type of permit is required for any maintained work such as trimming, felling, logging, etc. The permit is mandatory for all shelterbelt owners. The permit is called a Logging ticket (GOV-CM-R). The logging ticket is issued by the territorial bodies of the State Forestry Agency (State Oblast Forestry Department) based on materials of forest management (inventory of shelterbelt plantation). However, the process to receive the Logging ticket is not clear and not transparent. Sometimes it takes a few months and refers to the complex bureaucratic process.

Existent enabling measures for improving the shelterbelt's land inventory and registration refer to priorities on reforming the forestry sector in Ukraine, particularly afforestation. With this purpose, the Ministry of Environmental Protection is working to develop regulations on private forestry, which may simplify the management of private forest plantations, including agroforestry. Besides the current Cabinet of Ministry Regulation # 761 "Order issuing special permits for use of forest resources" creates enabling framework to develop regulations on simplifying the process to receive the Logging ticket.

*2. The financial and economic barriers*correspond to a high capital cost for the shelterbelt's reconstruction and inventory and further significant maintenance costs caused by the long-term pay-off period. Capital costs include not only the cost of planting a forest belt ($2200 per hectare on average) but also the cost of land inventory and registration ($180-220 per shelterbelt), forest management (inventory of shelterbelt plantation - $ 40-50 per shelterbelt) and developing the planting project documentations (from $ 2000 per shelterbelt). At the same time, the maintenance cost is summarized as expenses on replanting damaged plants in shelterbelt, technological processing such as PES control and fertilizing, and cost for shelterbelt protection.

Existent enabling measures to increase the financial capability for agroforestry dissemination the next:

- The State Financial support program for the development of vineyards, horticulture and hop cultivation[15]. In the case of mixed agroforestry systems including the planting of horticulture plant's species and/or nuts, the farmer can receive from state fund's reimbursement such as: (i) 80% cost compensation on planting material for fruit trees, berry plants, grapes, and hops (after planting); (ii) 30% cost compensation on the work to install drip irrigation systems and the purchase of materials necessary for such work (after the complete completion of installation work); and (iii) partial cost reimbursement for purchasing equipment for processing home-grown fruits, berries and grapes for juices, wine materials and others.
- Due to the administration reform (GOV 2915), the ATC could form their own budget and redirect the money for shelterbelt inventory.

[14] State Oblast Archive Departments. https://archives.gov.ua/ua/

[15]Ministry of Agriculture Policy and Food. 2021. State Financial support program on the development of vineyards, horticulture, and hop cultivation. https://agro.me.gov.ua/ua/pidtrimka/sadivnictvo/uryadova-programa-finansovoyi-pidtrimki-rozvitku-sadivnictva-vinogradarstva-ta-hmelyarstva-2020

- Farmers have started to recognize agroforestry as the way to diversify their business and the source of additional income. Thus, the mixed agroforestry practices could significantly decrease the pay-off period and maintenance costs. Potentially, farmer can increase their profitability by: (i) increasing crop's yield by 20-36% which depends on the type of shelterbelt; (ii) reducing the risk of losses due to adverse climatic conditions by diversifying production activities and the concomitant production of additional products up to 100%; (iii) receiving additional timber and non-timber goods from the shelterbelt (from 1. 5 to 60 thousand USD dollars per ha). For more detailed description, please see the report.

3. Lack of technological capacity. First, there is the lack of seedlings and insufficient nurseries production capacity in comparison, the demand for the supply of planting materials; the seedlings show a significant (almost 1.5 times) overproduction of regular forest planting material. In 2013, in total, over 46 million seedlings were grown. However, only 12 percent of them are suitable breeds for agroforestry. In addition, there are a certain number of private nurseries which can supply fruit trees, nuts, and other seedlings for shelterbelt planting. However, the quality of the produced planting materials by private nurseries is a matter of quality especially considering the lack of regulation on the production and distribution of in-vitro and GMO planting materials.

Additionally, the variety of agroforestry practices is not wide enough, especially considering the consequences of climate change. Finally, due to low interest in agroforestry for the recent decades, technology and machinery have been developed poorly to satisfy the growing demand.

Existent enabling measures to overcome the lack of technological capacity refer to existing institutional infrastructure. For example, there are around 350 nurseries in the structure of the state forest enterprises, the technological base of which could be improved and modernized to satisfy needs in planning materials. Moreover, the different research institutes are incorporated into the structure of the State Forest Agency and could provide a relevant research base for developing relevant technologies and breading. Nurseries and seedling's production could be profitable businesses. In this regard, producing planting materials and developing breeding nurseries is a potentially interesting sector for private investment and international projects of technical development. The Order. №228/2021 of the most recent president of Ukraine, "About some measures for the preservation and reproduction of forests." provides regulatory bases to develop the technological capacity for agroforestry.

Actions selected for inclusion in the TAP.

The further measures that are selected as action could be recommended to be included in TAP for agroforestry:

Measures (that are selected as actions) aimed to simplify and improve the legislative mechanism of shelterbelt's management to prevent corruptions.

- To develop legislation on land consolidation to improve land tenure and asses to shelterbelt.
- To improve the shelterbelt monitoring system and self-planted forest.
- To create the applicable models of shelterbelt and reserve land management for farmers and ATC aimed to implement the law of Ukraine 1423-IX ("On amendments to some legislative acts of Ukraine to improve the system of management and deregulation in the field of land relations").
- To develop the regulation to simplify the process of shelterbelt inventory.
- To improve the mechanism to receive the Logging ticket.
- To develop the legislation on private forestry.
- To amend the Forestry cod and change the status of agroforestry.
- To develop the mechanism to change the purpose for the use of land aimed at reducing the area of arable land to 37-41% of the country's territory by removing more than 3 degrees from the arable land, lands of water protection zones, degraded, unproductive and contaminated agricultural land by 2025.

- To develop the lease agreements (emphyteusis) of shelterbelt for the different type of consumers, servitude should be sought.
- To create the civil inspections from ATC representatives to define activities for the shelterbelt's maintenance.

Measures (that are selected as actions) for overcoming the financial and economic barriers:

- To increase the technical support on agroforestry, developing from the international donor organizations such as the World Bank Group (IFC), EBRD, EIB etc.
- To develop the market of climate action's incentive payments.
- To redistribute the oblasts environmental funds directly among the ATCs with target disposal for shelterbelt inventory purposes.
- To stimulate the local authorities of ATC in order to create the utility company for shelterbelt and other self-planted forest management.
- To develop the graduate system of eco-payments.
- To extend the budget of the state support programs relevant to agroforestry development, Annex 3.
- To extend the list of equipment and types of machinery applying for agroforestry and nursing purchasing partly to compensate by the state program on the Partial compensation of agricultural machinery and equipment of domestic production.

Measures (that are selected as actions) for overcoming the lack of technical capacity:

- Local public companies are equipped to plant shelterbelts and wood residue recycling.
- To increase the amounts of container nurseries to produce ball-rooted planting stock.
- The technical modernization of state nurseries.
- To develop online guides and application for species selection, stock monitoring, pre-ordering and purchasing for the establishment of shelterbelt.
- To extend the agroforestry practice with plants resistant to climates change, such as plants and crops, in order to produce bioenergy from biomass, nuts etc.
- To extend research programs focusing on the quantitative risk assessment of climate change impacting agroforestry by sub-sector and agroclimatic zoning.
- To extend research on the impact of GMOs and invitro-plants due to applying them for agroforestry.

Actions identified for the implementation of selected activities (measures)

Action 1 to develop enabling institutional and regulatory environment for agroforestry.

1.1. To adjust and adopt Draft Law "On land consolidation".
1.2. To complete the shelterbelt inventory at the country level.
1.3. To develop a system to identify the land plots recommended to establish the new shelterbelts with further mapping them and provide this information openly to the public.
1.4. To set-up on-line shelterbelt monitoring system including the forest management monitoring.
1.5. To establish fully authorized system to receive the Logging ticket on the basis of the shelterbelt monitoring system.

Action 2. To enhance the financial affordability for agroforestry dissemination.

2.1. To perform a feasibility study on selected pilot plots to develop climate credits tools for agroforestry.
2.2. To create the payment-ecosystem funds within the selected ATC with further scaling up at the country level
2.3. To extend the budget line for state support program on the development of vineyards, horticulture and hop cultivation.

Action 3. To improve the technical potential for the best agroforestry practice scaling up

3.1. To create an electronic catalog of nurseries stock (available seedling and nurseries including climate resilience and economically efficient species).
3.2. To develop an app on shelterbelt species selection by the climatic conditions with online monitoring of available seedling stock.
3.3. To develop an online marketplace with the forwarding contract of plant material purchasing.
3.4. To modernize the state nurseries with the purpose to increase their production capacity and potential. As an example, to construct the greenhouses with a root-balled tree system.

Actions to be implemented as Project Ideas.

As a pilot project to establish the container nurseries to produce ball-rooted planting stock on the base of existent state agroforestry enterpriser for further distribution of the planting materials for farmers, local authorities on the forward based contracts.

All actions are gender-neutral and envisage equal opportunities for all age males and females for their implementation.

1.1.3.4 Stakeholders and Timeline for the implementation of TAP for agroforestry

Below, the stakeholder's overview has been presented in Table 1.6. The overall list of stakeholders has been provided in Annex I.

Table 1.6. Stakeholder analysis by activities for implementation TAP (agroforestry)

Actions	Activities	Stakeholders	Timefr ame
Action 1. To develop enabling institutional and regulatory environment for agroforestry	1.1. The completion of the Draft Law on Land consolidation	VR; MAPF; State Geocadastre; FAO; USDA; SAWR	2021
	2.1. To complete the shelterbelt inventory on the country level.	Local authorities of ATCs; State Geocadastre; Private Land Tenure company; Sate Regional Institute of Land Tenure	2021-2024
	3.1. To develop a system to identify the land plots recommended to establish new shelterbelts	Local authorities of ATCs; State Geocadastre; Private Land Tenure company; URIFFM; Agroproducers; IA	2022-2023
	4.1. To set-up on-line shelterbelt monitoring	MEPNR; MAPF; SFA; WBG; GEF; UNDP; URIFFM; State Geocadaster	2022-2025
	5.1. To establish fully authorized system to receive the Logging ticket	MEPNR; SFA; WBG; GEF; UFPA; State Oblast Administration Forestry Departments	2022
Action 2. To enhance the financial affordability for agroforestry dissemination.	2.1 Feasibility study on selected pilot plots to develop climate credits tools for agroforestry.	MEPNR; EBRD; IFC; EIB; Agriculture producers; Agriculture Service Providers; Private Banks, International NGO	2021-2022
	2.2 To create the payment-ecosystem funds	MCTD; NFSC; ATCs; State and Private banks	2022-2025
	2.3 To extend the budget line for state support program on the development of vineyards, horticulture, and hop cultivation.	MAPF; MDETA; MFU; CMU; State and Private banks	2022-2030 (annual base)
	2.4 To develop "cheep" credit lines for shelterbelt reconstruction and establishment	Private and State Banks	2022-2030
Action 3. To improve the technical	3.1. To create an electronic catalog of nurseries stock	MEPNR; SFA; USAD; GEF; UFPA; State Oblast Administration Forestry Departments; URIFFM; State Forestry	2022
	3.2. To develop an app on shelterbelt		2022-

potential for best agroforestry practice scaling up	species selection	Enterprisers, Public and Privat Nurseries	2024
	3.3. To develop an online marketplace with forwarding contract of plant material purchasing		2022-2025
	3.4. To modernize the state nurseries	MEPNR; SFA; URIFFM; EBRD; IFC; EIB; State nursery	2022-2029

1.1.3.5 The Estimation of Resources Needed for Action and Activities

The estimation of resources needed for action and activities was counted per activity and summarized in Table 1.7.

The estimation of resources needed for action and activities was performed following the average cost of shelterbelt inventory, planting, and other operations (see above p. 37) and considering the average market cost of labor hours for the relevant activities. Additionally, the technical support projects (on the existent international development projects in Ukraine) were analyzed to count possible financial needs for activities (1.3., 1.4., 2.1.,3.1., and 3.2.).

Table 1.7. The estimation of resources needed for action and activities for the implementation of TAP for agroforestry

Actions	Activities	Tentative budget, mln $ US	
		Minim	Average
Action 1. To develop enabling institutional and regulatory environment for agroforestry	1.1. The completion of the Draft Law on Land consolidation	0.025	0.025
	1.2. To complete the shelterbelt inventory on the country level.	15.3	18.7
	1.3. To develop a system to identify the land plots recommended to establish new shelterbelts	0.45	0.65
	1.4. To set-up on-line shelterbelt monitoring	0.50	0.75
	1.5. To establish fully authorized system to receive the Logging ticket	0.11	0.25
Action 2. Enhancing the financial affordability for agroforestry dissemination.	2.1. Feasibility study on selected pilot plots to develop climate credits tools for agroforestry.	0.07	0.12
	2.2. To create the payment-ecosystem funds	N/A	N/A
	2.3. To extend the budget line for state support program on the development of vineyards, horticulture and hop cultivation.	3.6	5.85
	2.4. To develop “cheep” credit lines for shelterbelt reconstruction and establishment	70	90
Action 3. To improve the technical potential for the best agroforestry practice scaling up	3.1. To create an electronic catalog of nurseries stock	0.015	0.025
	3.2. To develop the app on shelterbelt species selection	0.05	0.065
	3.3. To develop an online marketplace with forwarding contract of plant material purchasing	0.08	0.1
	3.4. To modernize the state nurseries	0.8	1.2
Total		**91.63**	**117.74**

1.1.3.6 Management Planning

Risks and Contingency Planning

Considering that agroforestry is public good technology and deeply depends on the relevant state policy and support, it might face unpredictability in the implementation due to constant changes within the government in Ukraine due to the reorganization of major national beneficiaries and the elections.

To manage, this risk is necessary to work with national authorities and middle-level governmental management to develop all necessary technical documentation. Therefore, the risk of changes in middle-level management is lower. However, any changes in the government would cause a delay in the TAP implementation.

As well as the risk of delay, change in implementation would be caused by the technology implementation's high dependency on climate conditions or extreme weather events, such as long droughts or no-typical seasonal frosting. Better planning is required to perform fieldwork, such as forest management, to manage this risk. Finally, the terms and conditions of TAP implementation depend on the restrictions which refer to the COVID-19 protocol or another pandemic appearance.

Additionally, the TAP implementation for agroforestry is susceptible to technical and labor capacity availability at the national and local levels. Low technological capacity could be halting the project's progress, especially in the part of shelterbelt inventory. To overcome this risk, it is possible only by developing a network of actors involved in the shelterbelt's reconstruction to optimize available resources. As a result of the inventory, the total amount of land under the shelterbelt might not match the official counts. There is a high risk of conflicts for land resources among the local farmers and population.

Another risk here is called 'the loss of function,' which refers to the loss of shelterbelt's functions or productivity. The negative consequences would happen if the methodology were inaccurately developed to select plant species for agroforestry planting. To avoid this risk, the pool of experts working on the developing methodology and scientifically based approaches to implement TAP should include the national representatives of different agencies, institutes, and organizations, both private and public. Moreover, international expertise should be presented in each working group.

It may be last but not least, it is the risk of lack of budget due to other duties caused by unpredictable military activities or financial crises.

Next Steps

The main requirements for further TAP provision and agroforestry development are performing for land inventory under shelterbelt with further registration in GeoCadastrial Map. Inventory is the only way to legalize the introduction of agroforestry and secure land ownership for performing agroforestry works. This step is gaining particular importance in connection with the upcoming opening of the land market, scheduled for July 2021.

1.1.3.7 TAP overview table for agroforestry practice

Sector	Agriculture							
Sub-sector	Agroforestry							
Technology	Agroforestry for the establishment and reconstruction of field protection's shelterbelts							
Ambition	**The ambition is to disseminate technology on 85 thousand hectares, by 2030 overall Ukraine.**							
Benefits	Economic, social, and environmental. - Shelterbelts improve financial sustainability by providing production diversification. Different agroforestry practices could bring additional income up to $60 000 per hectare. - Agroforestry enables carbon sequestration potential attractive for green investment. - Shelterbelts generate both environmental and socio-economic benefits . There are social benefits as the shelterbelt is a piece of nature which increases the landscape attractiveness and may be developed as a recreation zone or as a wild natural zone - Contribute to job creation for both women and men The adaptation benefits resulted of agroforestry implementation: - Developing the orchards and mixed agroforestry will diversify production, reduce the risks of losses from climate change and increase food security at local and national levels, - Additional humidification (precipitation). The creation of field protection shelterbelts will increase crop productivity by improving soil quality and thermal regulation, along with increasing soil moisture, through soil infiltration - Protection from the sand storms - The adjustment of temperature mode - Reduce surface runoff and maintain soil fertility							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Indicators for Monitoring of implementation**	**Budget per activity**
<u>Action 1.</u> To develop enabling institutional and regulatory environment for agroforestry	1.1. The completion of the Draft Law on Land consolidation	State budget (2021); International organizations providing the technical support	The Ministry of Agrarian Policy and Food. State Geocadastre	2021	The unpredictability in the implementation	Draft Law submits for further processing and adoption	A number of meetings of working group and a number of members of working groups, including representatives of women associations, vulnerable groups Law on Land consolidation produced and	USD 25 thousand

							approved	
	1.2. To complete the shelterbelt inventory at the country level.	ATCs and oblast level budgets; International programs of technical support and development	Amalgamated territorial communities; State Geocadastre; State organizations – shelterbelt owners; farmers	2021-2024	Low technical capacity Delay or change the project implementation Lack of finance. Risk of land resource conflicts	The shelterbelt inventory completed on the 85 thousand ha and shelterbelt registered	The produced and approved methodology on shelterbelts inventory Register numbers of shelterbelts in State Cadaster Map (gender disaggregated by the ownership); amount of budget spending; number of hectares. Full inventory of shelterbelts performed	USD 15.3-18.7 million
	1.3. To develop a IT approaches to automatically identify the land plots recommended to establish the new shelterbelts	The international programs of technical support and development; State budget 2022	The Ministry of Agrarian Policy and Food; State Forest Agency; State Geocadastre; Institute of Soil Protection	2022 - 2023	The unpredictability in the implementation Risk of land resource conflicts	About 40 thousand of newly established shelterbelts and agroforestry by regions.	A number of shelterbelts; number of ATC; number of farmers (gender disaggregated)	USD 450-650 thousand
	1.4. To set-up online shelterbelt monitoring	The international programs of technical support and development available , including for most vulnerable communities Oblast and state	The Ministry of Agrarian Policy and Food; State Forest Agency; State Geocadastre; Ukrainian Forest Project Agency	2022-2025	The unpredictability in the implementation Delay or change the project implementation Lack of state budget	On-line shelterbelt system available on-line	A number and scope of experts and organization involved (gender disaggregated); registration of copy rights on IT product. Operational monitoring system with an webbased interface	USD 500-750 thousand

		level budget (2022-2025)						
	1.5. To establish fully authorized system to receive the Logging ticket	State budget (2022)	The Ministry of Agrarian Policy and Food; State Forest Agency	2022	The unpredictability in the implementation	The fully automated Logging ticket services set up	Number of users registered and applied to receive logging ticket (gender disaggregated);	USD 110-250 thousand
Action 2. To enhance the financial affordability for agroforestry dissemination.	2.1. Feasibility study on selected pilot plots to develop climate credits tools for agroforestry considering the gender issue	The loans and subsidies within the international programs of technical support; Private investments	The Ministry of environmental protection and natural resources; Farmers or other owner of shelterbelt, Utility company of Amalgamated village community; Private bank	2021-2022	Low technical capacity Delay or change the project implementation.	The feasibility study implemented on the pilot area at least 3 thousand hectares of shelterbelt hectares including the most vulnerable and remote areas) . The pilot carbon credit tools were developed and tested.	Number of credit tools selected and tested; methodological approaches to define baseline in agroforestry; technological maps and planting project of agroforestry applied	USD 70 -120 thousand
	2.2. To create the payment-ecosystem funds considering te needs of all members of society, including vulnerable groups	ATCs budget and private investment	National Financial Services Commission; ATCs; Private Banks	2022 - 2025	Low technical capacity; Delay or change the project implementation	The payment ecosystem funds established for 50 ATC. Allocated around 300 miln of hryvnas for shelterbelt maintenance.	A number of payment ecosystem schemes developed and implemented; number of actors involved (gender disaggregated);. Operational fund based on payment-ecosystem fund	N/A

	2.3. To extend the budget line for state support program on the development of vineyards, horticulture, and hop cultivation.	State budget (2022)	The Ministry of Agrarian policy and Food; Ministry of Finance of Ukraine	2023-2030	The lack of state budget due to other duties caused by unpredictable military activities or financial crises.	The state support programing on the development of vineyards, horticulture, and hop cultivation increased gradually over 10 years at least in 20 times.	A Number of farmers and shelterbelt owners received support (gender disaggregated); Sate budget (annual); percentage of ambitions completed, the % of support received by the most vulnerable communities/ farmers	USD 3.6 – 5.85 million
	2.4. To develop "cheep" credit lines for shelterbelt reconstruction and establishment, with focus on most vulnerable farmers	Private and commercial banks	Private, state and public companies, owners of shelterbelt	2022-2030	The unpredictability in the implementation Lack of relevant regulation	The shelterbelt was restored and established in the 85 thousand hectares	A number of farmers and shelterbelt owners took loans (gender disaggregated); Banks' credit portfolio	USD 91.63 - 117.74 million
Action 3. To improve the technical potential for best agroforestry	3.1. To create an electronic catalog of nurseries stock	The Budget of Ukraine State Forest Agency; Budget fund of NAASU.	The Ministry of environmental protection and natural resources; State Forest agency	2022	The Lack of finance; Risk of 'loss of function'; Low technical capacity; Delay or change the	The catalog available online. The average number of subscribers about 15 thousand.	Minutes of meeting of working group; Protocol of data exchange between nurseries	USD 15 -25 thousand

practice scaling up	3.2. To develop the app on shelterbelt species selection	The Budget fund of NAASU.	The National Academy of Agrarian Sciences; Ukrainian Research Institute of Forestry and Forest Melioration	2023-2024	project implementation.	The app has been developed and downloaded by 40 thousand users.	Number of species by zoning; protocol of criteria for spices selection; statistics of users	USD 50 -65 thousand
	3.3. To develop an online marketplace with forwarding contract of plant material purchasing	Private investment of IT companies; Private and state banks; The loans and subsidies within the international programs of technical support	State forest agency; Utility companies; Private and national banks	2022-2025	Delay or change in implementation	Market place has been set up online; number of registered users about 40 thousand; number of contracts – 17-18 thousands annually	Annual return and trading balance; statistic of users (gender disaggregated);	USD 80 - 100 thousand
	3.4. To modernize the state nurseries	Loans and subsidies within the international programs of technical support; Budget of state forest enterprisers; Banks;	State forest Agency; State forest enterprisers	2022-2029	Low technical capacity Delay or change the project's implementation	At least 300 state nurseries have been modernized all over Ukraine	Purchase order on equipment; project documentation on reconstruction, number of newly established employment for both women and men	USD 800 - 1200 thousand

1.1.4 Action Plan for Technology A3: Integrated Pest and Disease Management (biodegradable mulch film, BMF)

1.1.4.1 Introduction

One of the most harmful consequences of climate change to agriculture is spreading atypical or rapid development of typical pests, weeds, and crop diseases. Moreover, crop diseases and pests can adapt to chemical plant protection products (PPPs or pesticides). Thus, PPS imposes a serious negative impact on human health and the environment and has short-term efficiency. Another weakness of PPS for the national consumer is their high price and dependence on cheap and low-quality imports.

Applying the Integrated Pest and Disease Management, technologies were prioritized as key technologies for adapting agriculture to climate change in the first stage of the TNA project implementation in 2019 (TNA. 2019).

Integrated PES management consists of various strategies to replace or abandon chemical plant protection products partially. Thus, the technology of mulching with biodegradable films (BMF) was recommended to improve vegetable cropping in increasing yields and combating unpredictable weather influences (TNA., 2020). Mulching with biodegradable films improves water retention in soil and forms a protective barrier from the germination of weed seeds and a thermal barrier. The biodegradable film is made of organic components of plant and animal origin and can be destroyed by chemical reactions under the influence of microorganisms, the sun, and oxygen.

Biodegradable films have different varieties and parameters. The selections depend on the purpose of mulching, technological process, crops, and terms of application. According to its technical characteristics, the film can have an average diameter of 8 to 80 microns, which directly affects its life cycle from 3 to 24 months and a width of 50 to 280 cm. Available types of film - transparent, black, and color that have different techniques and species designations.

One of the most significant benefits of this technology is the price. It is relatively cheaper and affordable for all categories of farmers. Applying this technology, there is no requirement for changes in machinery or significant capital investments. The film can be stacked either using a special film-laying machine or manually. For a large amount of cultivated area, it is advisable to purchase specialized equipment, such as bed-maker and mulching film layer (as in mulching with conventional plastics). The seeds sowing with the application of the BMF can be done by applying existing seeding equipment, and it is still possible to use those seeders for the traditional sowing without films. Therefore, it does not entail high costs for designing, producing, and purchasing new sowing machines.

In the second report, a detailed analysis (TNA.2020) of technology application was done for vegetables, particularly for tomatoes as one of the leader of vegetables produced in the world. In Ukraine, tomato is in the top five most popular vegetables and part of the traditional food basket named "Borschoviy nabir"[16]. In 2019, about 2 325 thousand tons of tomatoes were produced in the greenhouse and open air. However, during the recent decade, a significant shortage in the production of tomatoes has been observed in Ukraine. Partly, it is caused by the fact that the main regions of open-air tomato production are in the South (Kherson and Mykolaiv oblast) and West (Zakarpatya), which are affected by the unpredictable climate conditions, including long-term droughts. Thus, in 2019, Transcarpathian (Western part of Ukraine) farms lost part of the harvest due to the massive flooding of greenhouses. In the South, in the season of harvesting soil, the tomato was delayed, and constant weather changes contribute to the spread of disease and, accordingly, adversely affect the yield. In this case, the application of biodegradable films might help to mitigate the risks of drought and shift in planting seasons.

[16] Ministry of finance of Ukraine. Price of Borschoviy nabir. https://index.minfin.com.ua/ua/markets/wares/foods/borzch.php

Even though a few service providers are present in the market of biodegradable films, it still has low capacity and slow development. Agro-producers prefer plastic counterparts over BMFs, due to the higher purchase price of the BMFs. However, farmers still prefer to use conventional polythene. They do not count the environmental price for conventional polythene application as they still throw it out in the forest or shelterbelts or burn it.

Besides of positive direct effect on crop production, the development of BFM technology has a few sides effects, such as:

- the creation of value adds chain in the processing of the starch contained crops requires as a feedstock for biodegradable films.
- the development of the industrial sector for BF production.
- the diversification of crop production in terms of producing the feedstock for BF.

The development for the sector of biodegradable film production will bring to decrease the average price of technology and makes it even more affordable.

A more detailed description of technology implementation has been provided in Barriers Analysis and Enabling Frameworks.

1.1.4.2 Ambition for the Integrated Pest and Disease Management (biodegradable mulch film) practices on TAP

Competitively to the previous technologies, the BMF application is business-oriented technology. Ambitions for TAP could be mainly defined by the potential capacity of market, multiplying by the trend of technological development and price forecasting.

Following the official statistic data for the last years, the stable trend of open field vegetable production is slightly growing in Figure 1.2. The open-air vegetable was harvested from 446 thousand he in 2019 and 458 thousand ha in 2020.

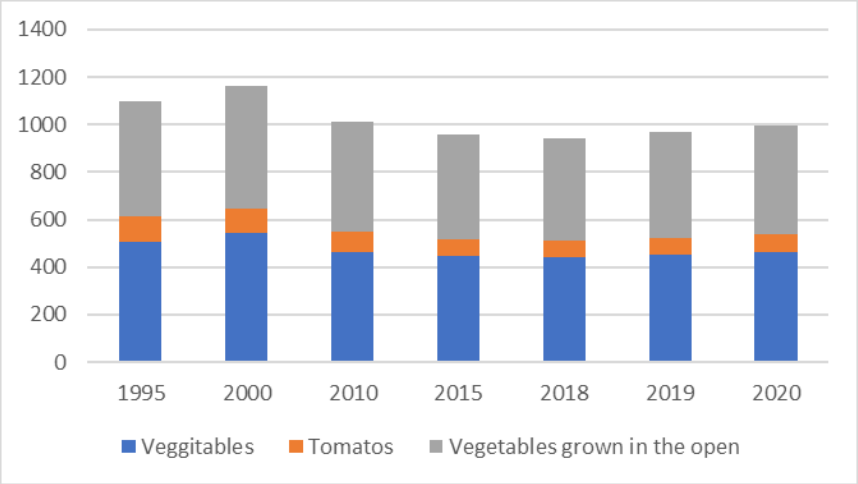

Figure 1.2. Share of open-air vegetables production in Ukraine, thousand hectares.

Source: State Statistical Services of Ukraine. 2020 (SSS.2020)

While, leading regions in vegetable production are located in the zone of highest climate risk, such as Kherson, Mykolaiv, and Lviv oblasts Figure 1.3.

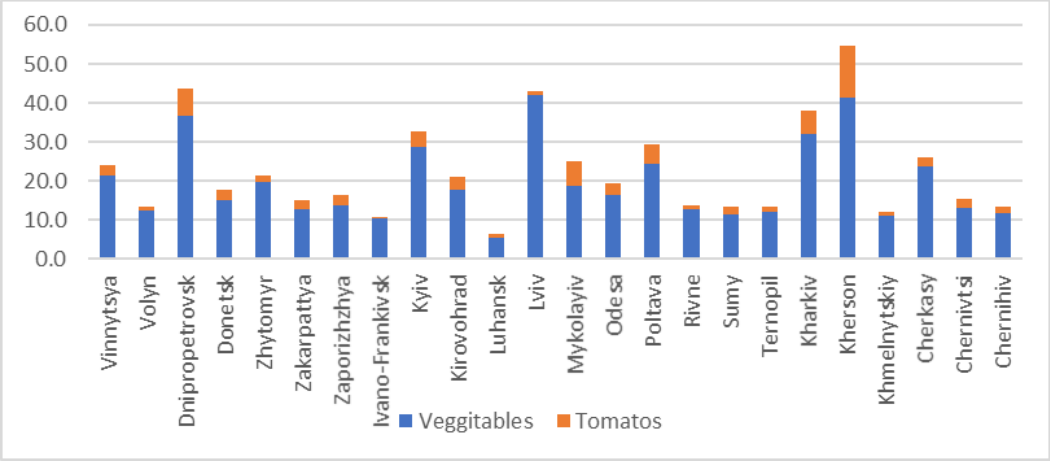

Figure 1.3. Harvested area under vegetables including tomatoes by oblast, thsd ha

Source: State Statistical Services of Ukraine. 2020 (SSS.2020)

Moreover, more than 90 percent of vegetables are grown by peasant households with an average land bank size of around 2 hectares. Considering the harvested area under vegetables (Figure 1.3.), it can be argued that around 35,000 - 200 000 peasant households may be potentially interested in using the technology.

The more difficult task is to assess the time due to the limited supply of BMF in the national market and comparatively low interest in developing this technology. Analyzing the available offers from SP on BMF, we can assume that currently, they could cover up to 15 percent of the demand described below. Considering the development of technologies for BMF production and increasing regulation (GOV 1489-IX.2021) on conventional plastic usage, we can assume that it might take from 4 to 6 years to develop enough potential to cover about 90 percent of potential demand.

Considering the points mentioned above, the next ambitions were defined for BMF technology for TAP implementation: the technology can be disseminated among **the 100 thousand farmers (vegetable producers) for the next 7 years by 2028 and would cover around 180 thousand hectares.**

The technology would be implemented by 100 thousand farmers, vegetables, and other open field crop producers for the next 7 years (by 2028). They are mainly concentrated in Kherson, Mykolaiv, and Lviv oblast and cover around 180 thousand hectares. For this purpose, at least a BMF manufactory will be established to satisfy the market's increasing demand.

The technology could be the most demanded in oblasts with high climate change risk in the next two to three years, such as Kherson, Mykolaiv, Lviv. At least an extra plant for BMF production should be established in Ukraine to cover the demand defined above.

1.1.4.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers.

The 8 barriers were selected for biodegradable mulching film technology and screened attentively in the Barriers Analysis and Enabling Frameworks (TNA 2020). Further, all barriers were discussed additionally over the national TNA presentation meeting (March 24-27, 2021) and participants to define the next barriers which can affect the further TAP implementation significantly: (i) the lack of regulation on the conventional plastic film application; (ii) the insufficient level of technological capacity, particularly lack of raw materials and technologies for BMF to arrange domestic production and; (iii) low demand (low popularity of BMF among customers.

The lack of regulation on the conventional plastic film and chemical pesticides application. Because farming in Ukraine has a completely different history of development and state support, Ukrainian agro-

producers are not oriented to the circular economy or waste recycling. Conventional agriculture dominates, including the vegetable production in greenhouses made of fossil-based plastic. At the same time, this problem has not been raised enough at the national level. Even though Ukraine signed an Association Agreement with the EU, the relevant step has not been taken to implement EU Packaging Waste Directive (PWD) and Single-use Plastics Directive (SUPD). Moreover, no relevant regulation or mechanisms prevent farmers from throwing out the used plastic outside the shelterbelt and forests. They often burn it, which causes massive fire as a result. Thus, there is no restriction or stimulus for farmers to refuse to use fossil-based plastic or utilize it safely. Besides thermo and water regulation functions, the BMF is the way to reduce the load from applying chemical pesticides significantly. However, there are no relevant authorities and organizations at the institutional level to provide standards, regulations, and certification harmonized with international standards for pesticide and other chemicals compounds used in agriculture production, storage, and application. In these conditions, there is no way to evaluate if farming systems are following the EU Green Deal and other environmental requirements or just how safe they are.

Existent enabling measures strengthening the institutional base for the regulation of the usage of fossil-based plastic are associated with:

- The recently adopted Law of Ukraine 'On the restriction of circulation of plastic packages in the territory of Ukraine' (GOV 1489-IX.2021.) will bring to the reduction of plastic production and regulation of its circulation.
- To develop the Draft of Law on Household and Other Waste Management[17]
- The Concept of the State target program of development of vegetable growing for the period till 2025 (GOV-CM 1333-p.2020).
- The Law of Ukraine On Nature Environment Protection. (GOV41.1991.)
- compliances under the implementation of Green Deal (EU Green Deal 2020) conditions and Carbon border adjustment mechanisms as part of it. [18]

The insufficient level of technological capacity. Low demand for BMFs, the lack of regulatory policy, lack of national technologies for deep recycling or another source to produce the feedstock for BMFs result in an international production's monopoly and dependencies on imported feedstock. The BMF market is represented by the two BMF producers, international and national: Ginegar and IMMER Group (JC IMMER Ukrplastic, IMMER Digital, and IMMER Design Studio). However, only the IMMER Group presented on the national market as SP, which has an entire manufacturing cycle of flexible biodegradable plastic materials applicable for a wide variety of crop production technologies. Due to low demand and lack of political motivation, potential producers are not interested in investing money in developing the domestic manufacturing of BMF production. The development of technology requires high capital investment. Thus, producers need cheap financial resources. However, due to low market liquidity, they are not looking for them.

Enabling measures to overcome this barrier lies in attracting investments into developing the national biodegradable plastic production. The capacity of global bioplastics production is set to increase from around 2.1 million tons in 2020 to 2.8 million tons in 2025 and remains the stable trend to grow.[19] At present, one-fourth of the production capacity is located in Europe, although this share is predicted to grow upto 28% by 2025. However, it is a matter of competition in the EU for the land resource to produce the feedstock for bioplastic. At the same time, Ukraine has an overproduction of starch-contained crops that can be used for bioplastic production. Thus, moving the EU's production to Ukraine towards cheaper inputs could be an attractive prospect for the nearest future. Following the National

[17]Draft of Law on Household and Other Waste Management. http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511=66998

[18] Carbon border adjustment mechanisms. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12228-EU-Green-Deal-carbon-border-adjustment-mechanism-_en

[19] 15th EUBP Conference. 2021. https://www.european-bioplastics.org/

Economic Strategy, Ukraine aimed to increase the production of highly profitable crops and increase efforts in the creation of highly technological clusters in agriculture (GOV-CM 179.2021). The production of the feedstock and development of domestic production BMFs do not belong to the agricultural production and have limited access to the cheap loan money. However, biotechnological development refers to agriculture can be part of the working agenda for such international donors as EBRD or USDA. Moreover, Under the agreement between the Ukrainian government and the European Commission in 2018, Ukrainian cluster organizations can integrate into the European and international cluster communities and receive financial and technical support through the EU Neighborhood Program. It creates a positive environment to develop biotechnology, including BMF production.

The low demand (low popularity of BMF among the customers). There are complex reasons that caused the low demand for BMF technology. Among others, there is (I) low priority of CC adaptation measures in the country, which impacts negatively both on motivation to develop the market and switch to the innovative sustainable business models; (ii) low interest in innovative sustainable business models from the farmer's side; (iii) the absence of stimulus to invest into much environmentally orientated agriculture technologies; (iv) insufficient information on BMF, biotechnology, circular economy approach at the level of the small and medium-sized farmers.

Enabling measures to implement TAP for BMF in Ukraine are in good development for the institutional potential of the agricultural sector.

There is strong institutional potential to provide the research and experimental test of different types of bioplastics and their impact on agriculture production. The Academy of Agrarian Science of Ukraine consists of 164 research state enterprises and can cover the full set of research in terms of advantages of different types of BMF application; provide a recommendation of the best approaches and zoning for application BMF; arrange research in terms to identify the best feedstock to launch the national production of bioplastic etc.

Different studies show that small and medium-sized farmers' most reliable knowledge sources are big and successful ago-producers, other farmers, or input provider consultants. The agro holdings are leading in the agricultural market of Ukraine in terms of technology transfer and implementation. As usual, they have their own RD, and they can buy and test different approaches. Thus, agro-holdings can develop a circular economy, and both produce BMF and supply it.

The Strategy of economic development by 2030 envisaged the support in creating the research productions clusters. This could be a good base to start developing biotechnology in Ukraine, including the BMF.

Actions selected for inclusion in the TAP.

The further measures that are selected as action could be recommended to be included in TAP for Integrated Pest and Disease Management (biodegradable mulch film).

Measures (that are selected as actions) aimed to gain the development of regulation on the conventional plastic film and chemical pesticides application.

- To improve the existent environmental national legislation in terms to increase responsibility and control on fossil-based plastic films disposal.
- To facilitate the development of the strategical document for biotechnology and circular economic development.
- To initiate changes in the tax system and supporting payments for accelerating bio-based plastic films production and application in agriculture.

Measures (that are selected as actions) aimed to increase the technological capacity for BMW production and dissemination:

- To develop the enhanced value-added chains for business models for crops with the high amount of starch as the main feedstock of BMF production.

- To develop the partnership between science and business while the academy gets access to the business research facilities and field.
- To develop the biotechnological clusters with circle production type on the basis of agro holding to produce feedstock for bio-plastic films production.
- To increase the production potential of bioplastic.

Measures (that are selected as actions) aimed to stimulate the demand for integrated pest management, including the BMF technology:

- To conduct national studies of cost-benefit analysis that compare different pest control technologies with a focus on the ecosystem services on the basis of life cycle assessment by agro-climatic zones.
- To provide Extension services with guides on the technology implementation by oblast following the climate conditions and technological capacity.
- To provide dedicated trainings for rural women entrepreneurs.
- To create an online resource to find and book the available machinery and equipment necessary for BMF processing for different types of farmers.

Actions identified for the implementation of selected activities (measures)

Action 1. To amend regulation on fossil-based plastic films application.

1.1 The Amendment Law of Ukraine On environmental protection in terms of extending the system of fines for improper disposal of fossil-based plastic films.

Action 2. To enhance the policy on biotechnology and circular economy

2.1 To develop the bioeconomy/circular economy strategy for Ukraine, including bioplastic production as an important part of it.

Action 3. To improve the financial regulation to stimulate the bioplastic films production and application.

3.1. To develop the regulation of flexible tax system for imported deep processing corn starch equipment and other feedstock materials required for bioplastic production.
3.2. To develop the eco-system payment schemes to support farmers using the BMF and biopesticides.

Action 4. To increase technological capacity to improve BMF supply.

1.1. To develop the enhanced value-added chains for BMW production from corn and wheat.
1.2. To launch the experimental cluster on the basis of circular economy principals with BMF as one of the end products.

Action 5. To gain the research and practice-based knowledge to improve demand on BMF.

5.1 To launch empirical research on BMF application for different ago climatic zones and crops and make them publicly available.

Actions to be implemented as Project Ideas.

Launching the cluster is recommended as a TAP project idea on the basis of circular economy principles in one of the main corn production regions. The launch of cluster allows combining proposed actions such as combining research and practical implementation, increasing supply capacity and stimulating demand in the pilot scale. The cluster could be launched in the location in which present: at least by the one big agro-producers, academy representative institution and with well-developed infrastructure. The next oblasts could be recommended as Poltava, Chernigiv, Cherkasy, Odesa for pilot cluster development.
All actions are gender-neutral and envisage equal opportunities for all age males and females for their implementation.

1.1.4.4 Stakeholders and Timeline for the implementation of TAP for Integrated Pest and Disease Management (biodegradable mulch film)

Below, the stakeholder's overview has been presented in Table 1.8. The overall list of stakeholders has been provided in Annex I.

Table 1.8. Stakeholder analysis by activities for the implementation TAP (BMF)

Actions	Activities	Stakeholders	Timefr ame
Action 1. To amend regulation	1.1. The Amendment Law of Ukraine On environmental protection	VR; MEPNR; MAPF; Institute of Soil Protection; IANRM; NGOs	2022
Action 2. To enhance the policy	2.1. To develop the strategy on bioeconomy/circular economy	CM; MDETA; MEPNR; MAPF; NUBIP; IANRM; NGOs	2022 - 2023
Action 3. To improve the financial regulation	3.1. To develop the regulation of flexible tax system for imported deep processing corn starch equipment	MFU; MDETA; MAPF; NFSC; WBG	2023
	3.2. To develop the eco-system payments schemes to support farmers using the BMF and biopesticides.	MCTD; NFSC; ATCs; State and Private banks	2022 - 2023
Action 4. To increase technological capacity to improve supply	4.1. To develop the enhanced value-added chains for BMW production	MAPF; NAASU; USAD; IFC; EBRD; NUBIP; IA; IANRM	2022-2024
	4.2. To launch the experimental cluster based on the circular economy principals	MCTD; MAPF; USAD; IFC;EBRD; State Oblast Administration; ATC; NAASU; Agro-producers; Service Providers; Private banks	2022-2028
Action 5. To gain the research and practice-based knowledge	5.1. To launch an empirical research on BMF application for different ago climatic zones	NAASU; GEF; UNDP; Institute of Soil Protection; IANRM; NGOs; farmers	2022

1.1.4.5 Estimation of Resources Needed for Action and Activities

Resources needed for action and activities defined for TAP were analyzed on the basis of expert opinions, the average cost of technology implementation and relevant market price in the labor market and the size of international technical support projects. The results of need's assessment have been provided in Table 1.9.

Table 1.9. Estimation of resources needed for action and activities for the implementation of TAP for BMF

Actions	Activities	Tentative budget, mlln $ US	
		Minim	Average
Action 1. To amend regulation	1.1. The Amendment Law of Ukraine On environmental protection	0.025	0.03
Action 2. To enhance the policy	2.1. To develop the strategy on bioeconomy/circular economy	0.080	0.100
Action 3. To improve the financial regulation	3.1. To develop the regulation of flexible tax system for the imported corn starch equipment for deep processing	0.025	0.03
	3.2. To develop the eco-system payments schemes to support farmers using the BMF and biopesticides.	0.025	0.03
Action 4. To increase technological capacity to improve supply	4.1. To develop- the enhanced value-added chains for BMF production	0.100	0.150
	4.2. To launch the experimental cluster based on circular economy principals	12	22
Action 5. To gain the research and practice-based knowledge	5.1. To launch empirical research on BMF application for different ago climatic zones	0.100	0.150
Total		**12.355**	**22.49**

1.1.4.6 Management Planning

Risks and Contingency Planning

The TAP implementation on the Integrated Pest Management (BMF) technology might face risks: (in) political indifference; (ii) partial default caused by the absence of relevant high skilled specialists to develop the biotechnology; (iii) the risk of delay or changes in implementation.

As mentioned above, the national expert recognizes the development of the relevant regulation on the fossil-based plastic application as the key driver of developing the technology. However, currently, issues that refer to the stimulation of developing biotechnology to replace the toxic plastic usage are not in the pipeline of state environmental policy. Thus, it is crucial to raise these issues and focus the governmental attention to find a way to solve them. It could facilitate international donor organizations as well as national non-governmental organizations.

The essential risk of implementation of TAP refers to the absence of relevant high-skilled specialists to develop biotechnology. As mentioned before, the deep processing of the biological feedstock, biotechnology, and even circular economy requires highly skilled specialists. In this case, this kind of specialist would be hired in time (possible in the region in Ukraine), the project could be partly defoliated. Managing this risk involves better HR planning and should foresee relevant budgets for wages and other bonuses.

Finally, the possible risk to each project is delay or changes in implementation. It should be managed depending on the reason brought to delay or will bring to delay. The main things are analysis of on-going activities regularly to estimate the situation and anticipate delays.

Next Step

The main requirements are to amend the existing Law of Ukraine on environmental protection and to raise the problem of fossil-based plastic film application at the national level for further TAP provision and development of the Integrated Pest Management technologies. It is also important to provide brief guidelines on how the inputs apply for agriculture production would be counted under the implementation of the Green Deal. The same importance and urgency have the performing empirical research on BMF application for different agro-climatic zones with further wide dissemination of the result. The result should be online available and disseminated either among the ATCs and oblast level Department of Agriculture and among farmers and SPs.

1.1.4.7 TAP overview table for Integrated Pest and Disease Management (biodegradable mulch film)

Sector	Agriculture
Sub-sector	Vegetable production
Technology	Integrated Pest and Disease Management (biodegradable mulch film)
Ambition	Adoption of the technology by the **100 thousand farmers (vegetable producers) for the next 7 years**, by 2028, and would cover around **180 thousand hectares**.
Benefits	Economic, social, and environmental - To increase in yield by an average of 30% for all commodity groups of agricultural crops and for some up to 75%. - The reduction of water, fertilizers, and PPPs costs by an average of up to 40% for all commodity groups of agricultural crops and for some by 3 times. - To increase the export potential of agricultural products through quality improvement. - To control on spreading of weeds and pests. - Increase mitigation co-benefits through the reduction of GHG emissions into the atmosphere by reducing input costs for the use of mineral fertilizers and herbicides. Adaptation benefits: - To provide the thermoregulation function. - Microclimate modification in plant and soil environments. - Heat preservation and soil temperature increase, photosynthesis improvement. - The control of humidity level - Moisture protection or water saving. - Adaptation to agro-climatic season's shifting.

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
Action 1. To amend regulation	1.1. The Amendment Law of Ukraine on environmental protection	State budget (2022). International organizations providing the technical support	The Ministry of environmental protection and natural resources; IANRM	2022	The political indifference.	Law amendment was adopted. Reduction of the pollution caused by plastic film disposal.	The number of adjustment and recently established size of penalties.	USD 25-30 thousand

Action 2. To enhance the policy	2.1. To develop the National Strategy on bioeconomy/circular economy in Ukraine by 2030	NAASU annual budget line; International programs of technical support and development	The Ministry for Development of Economy, Trade and Agriculture of Ukraine; National University of Life Sciences and Bioresources	2022-2023	The political indifference. Partial default of activity implementation; Delay or changes in project implementation	Defined the direction for the biotechnology implementation; New research units were established within the academy and business	Number of technologies recommended for development; number of research unit established; statistical data	USD 80-100 thousand
Action 3. To improve the financial regulation	3.1. To develop the regulation of flexible tax system for imported deep processing corn starch equipment	State budget (2023). International organizations providing the technical support	The Ministry of Finance of Ukraine; National Financial Services Commission.	2023	The political indifference.	At least one company was established as the official SP of international dealers on the equipment for bio-based plastic	Number of machineries imported.	USD 25-30 thousand
	3.2. To develop the eco-system payments schemes to support the farmers using the BMF and biopesticides.	ATCs and state level budgets; International programs of technical support and development.	Ministry for Communities and Territories Development of Ukraine, Amalgamated territorial Communities	2022 - 2023	The political indifference. Partial default of activity implementation.	At least three different payment eco-system schemes were developed and draft regulation for their implementation was prepared	The working group minutes of records; Guideline to implement the PES schemes were developed and published, considering the needs of low-income, vulnerable farmers	USD 25-30 thousand
Action 4. To increase technological capacity to improve supply	4.1. To develop the enhanced value-added chains for BMF production, including from gender perspectives	NAASU annual budget line; International programs of technical support and development	Ministry of Agrarian Policy and Food; National academy of agrarian sciences.	2022-2024	Partial default of activity implementation; Delay or changes in project implementation	The value-added chains at least for three goods were developed and tested	The regional covering, budgets, infrastructural analysis, market analysis for each good developed and presented, including from gender perspectives	USD 100-150 thousand

	4.2. To launch the experimental cluster on the basis of the circular economic principles	Private investments; The loans and subsidies within the international programs of technical support;	State Oblast Administration. Agro-producers, business; ATC	2022-2028	Partial default of activity; Low technical capacity; Delay or change the project implementation	The agro bio technological cluster was established within an oblast with the production cycle from corn production to BMF production. The cluster produce and distribute the BMF enough to cover 90 thsd hectares.	A Number of unites involved (number of women-led units): agro producers (gender disaggregated), manufacturing; research laboratories and etc. Number of farmers applying the BMF (gender disaggregated).	USD 12-22 millions
Action 5. To gain the research and practice-based knowledge	5.1. To launch empirical research on BMF application for different ago climatic zones, considering gender perspectives and needs	The Budget fund of NAASU. International programs of technical support and development.	The Ministry of Agrarian Policy and Food; National academy of agrarian sciences.	2022	Partial default of activity; Low technical capacity;	The detailed recommendation how to apply BMF by zones and agro-technology was published on-line and in a hard copy.	A number of readers up-load the recommendation; Number of viewers gender disaggregated, if possible	USD 100-150 thousand

1.2.1 Brief summary of the Project Ideas for Sector Agriculture

All actions selected for TAP per each technology might be classified as institutional, investment, and informational. All of them correspond to each other and towards developing an enabling environment to reach the target specified for each technology. The action recommended as a project idea was selected as the technology "backbone" action, which means that implementing project ideas causes a situation of a technology to be adopted. In other words, the project idea triggers a "change" in the technology's adoption and dissemination.

The second criteria of project ideas selection were its feasibility and commercial attractiveness. Considering the lack of state financial support, the project ideas should be economically attractive for potential investors, both national and international investors. Therefore, it increases the chance that technology will be implemented and will attract further investments.

In terms of DICA technology, the Coordination Center of Climate Oriented Agriculture (CCCOA) was selected in the South of Ukraine. The CCCOA aims to consolidate existing practical examples of irrigation and CA, develop networking among farmers and strengthen practical implementation by scientific knowledge and research. Furthermore, considering that CCCOA would be based on the academy, it will allow absorbing the best practical knowledge for further developing the practical tool of irrigation policy implementation. Thus, the project idea will help implement technology particularly for farm needs, create the local infrastructure in cooperation with local communities for the long-term and effective usage of water and support the development of regulation and institutional aspects of irrigation and drainage policy.

For agroforestry practice, the establishment of container nurseries was selected to produce ball-rooted planting stock on the base of the existent state agroforestry enterpriser. Beyond the regulatory and institutional barriers, the technically crucial problem is the lack of planting materials for the massive dissemination of agroforestry. The production of the relevant planting materials is time-consuming. Establishing the nursery with an annual production capacity of about two million seedlings annually will satisfy the needs of an oblast at the first stage of technology development. In case of the low domestic demand at the first stage, the export of seedlings is a high profitable business.

In the TAP for Integrated Pes Management and BMF application, a project idea was selected to create a production cluster based on agro holding to develop a circular economy, including the production feedstock for BMF and BMF application. This is a massive project idea implementation that can lift Ukraine agro-production at different levels, including biotechnology such as biodegradable films and biopesticides.

The next steps for TAP per technology were selected considering the essential requirement to strengthen the institutional (legislative) capacity. The subsequent development and implementation of the TAP are impossible, or its development is fraught with serious risks.

As a result, the Next steps which should be implemented as actions for TAP development per technology in 2021 are:

<u>DICA</u>

- To adopt the Draft Law on Land consolidation
- To examine water resource accessibility for irrigation

<u>Agroforestry</u>

- To complete the land inventory under shelterbelt with further shelterbelt registration in GeoCadastrial Map

<u>Integrated Pest Management (BMF)</u>

- To amend the existing Law of Ukraine on environmental protection and to raise the problem of fossil-based plastic film application at the national level.
- To develop guidelines on environmentally recommended input material (fertilizer, pesticides, packages, covering, etc.) for agriculture production in Ukraine.

1.2.2 Specific Project Ideas

Establishing the Coordination Center of Climate Oriented Agriculture (CCCOA)

Background information	Background. Global agriculture is evolving with the people's demand for food, the availability of technologies and acceleration of climate change. Increased production must be met with higher yields, because the increasing area of land under agriculture carries major environmental costs. Human beings need agriculture that can feed the world without depleting its natural resources and considering the climate change. The Sustainable Development Goals (SDGs) of the United Nations established targets for achieving the inclusive economic growth, social development, the conservation of natural resource and biodiversity and adaptation to climate change by 2030. The spread of climate-orientated agriculture (COA) practices, a combination of drip irrigation and conservation agriculture (CA) are a global trend in agricultural development. In Ukraine, COA farming technologies are distributed by manufacturers themselves without wide scientific support and state regulatory support. In order to redirect the agricultural system and address the challenges related to its optimization in Ukraine, there is a need to strengthen the policy and institutional environment, ensuring inter-sectoral collaboration to promote a balanced approach to economic development, land use and environmental protection. This approach will help steady ways to increase productivity and income, strengthen resilience to climate change and reduce greenhouse gas emissions, thereby improving the health of the planet. Taking results of the different studies conducted in Ukraine in 2018-2021, it is possible to note: • Every region of Ukraine has farmer leaders in CA. These farms had adapted and implemented CA technologies, no-till, mini-till, etc., and achieved significant results. • CA technologies are not very popular among land users since 1) it requires a new approach of production different from the one applied for decades and other knowledge, it is so-called another philosophy of agriculture, 2) CA requires application required specific inputs and equipment, 3) CA implementation needs several years of transition from conventional tillage. Summarizing points mentioned above, only middle farmers with 300-5000 ha of land can implement CA because small farmers cannot afford the transition to CA while big agro-holding does not want to implement it. These middle farmers and agronomists demonstrated huge interest in CA during the FFS training cycle. • Local authorities recognize the effects of climate change on agriculture, but they do not understand the value and importance of CA in combating desertification, even in the Kherson region where the huge Oleshky desert is spreading. • NAAS (National Academy of Agrarian Sciences) and SI (scientific institution of NAAS) do not conduct proper research on CA technologies and scientists are not aware of CA and CSA approaches. • Scientific institutions confine the training of future agronomists to old, soviet approaches and technologies of conventional tillage. • Both scientists and agro-executives realize the danger of climate change and interested in the transition to COA in cooperation between science and business, but they do not know how and in what direction they should move. • Irrigation is intensely developing in the Kherson oblast and another oblast of Ukraine; however, the farmer does not develop irrigation infrastructure in another oblast of Ukraine despite the moisture deficit. Therefore, to develop COA and share the best existent experience such as DICA technology, it is proposed to launch The Coordination Centre of Climate-Oriented Agriculture.

Objectives and outputs	*Objectives.* CCCOA will facilitate the increase of the potential of human resources and improve the uptake of climate orientated technology through the the strengthening of collaboration between R&D institutions (academies) and farmers, adopting and scaling the best practices and establishing climate-oriented agricultural professional networks. Output 1. The implementation and dissemination of DICA among farmers and agro-enterprises, of at least 100 entities. One of the missions of CCCOA is to help land users to implement and develop COA and DICA instead of conventional tillage. The target is to cover at least 100 000 ha of arable lands in the Steppe and forest-steppe zones of Ukraine during the first 3 years of work. *Source of funding: farmers and agrarian companies.* Output 2. Online learning. At least three online courses are designed to strengthen stakeholder's capacities in the economic efficiency of COA and basic approaches to the management of integrated water resource. The online course will support the demonstration and scaling up of the best practices on DICA in the production landscape essential for controlling soil erosion and improve agricultural productivity. Moreover, there should be a course for a representative of local authorities on integrated water management. Finally, the Guideline of the best COA practices is to be elaborated. Output 3. Research. Research institutes conducted a study on the availability of water resources, their quality, and their impact on the technology in the different climatic zones in cooperation with farmers and on their fields.
Link to country development priorities	The establishment of CCCOA aims to implement the next priorities of countries: • The sustainable development goals of Ukraine for the period up to 2030 • The National Economic Strategy for the period up to 2030 • The National Action Plan to combat land degradation and desertification. • Irrigation and drainage strategies in Ukraine for the period up to 2030. • the plan of measures to implement the Strategy of Landing and Drainage in Ukraine for the period up to • The second national determination for contribution (once would be adopted) • Strategy on environmental security and adaptation to climate change (once would be adopted
Scope and activities	*Project Scope and Possible Implementation.* The project implementation area is all over Ukraine, with a focus on the arid zones. The main polygon: the Southern State Agricultural Research Station of the Institute of Water Problems and Land Reclamation of the National Academy of Agrarian Sciences of Ukraine with HQ based in Kyiv, main office of Institute. Project link to the GEF project "Integrated Natural Resources Management in Degraded Landscapes (INRM) in the Forest-Steppe and Steppe Zones of Ukraine" was implemented by FAO in 2018-2021 and could continue, the development of DICA technologies was established. *Project activities* Output 1**.** Activities: 1.1. Organizing, conducting, and participating in training, field days, and other relevant events. The set of field training with FFS approach. Field training aims to disseminate practical and theoretical knowledge for the application of conservation agriculture and climate-smart agriculture practices in the steppe and forest-steppe zones of Ukraine. The target audience is decision-makers responsible for introducing DITA technologies in the cultivation process in the steppe and forest-steppe zones of Ukraine, particularly farm managers, farmers, agronomists, academic experts, executives, and others. Concept: farmer-to-farmer visits with one or two experts provided by international or SI (scientific institutions). Training is one day or half-day

	long and consists of a theoretical part (2-3-hour in conjunction with invited speakers) and a practical part (3-5 hours outside with hosting farm speakers) on the hosting of farm's fields. In addition, the hosting farm has to demonstrate for practice (fields) achievements of used DICA technologies. The farmer or agronomist will hold the second part of the training as a speaker. Several participants– 20-30 persons, following the current pandemic situation. Some invited speakers: 2-3 persons. Quantity of training (at least 48 pieces of training annually): 5-7 per year. Topics of training should cover all important issues of DICA implementation for farmers. They should be demonstrated in fields in an appropriate seasonal time of field operations: crop rotation, crop protection with IPM approach, irrigation in CA, harvesting and cover crops, soil cultivation in DICS, shelterbelts management, economic and business issues. Source of funding: NAAS, project GCP/UKR/004/GFF, agricultural service providers. 1.2. Field events organized by private companies, agricultural service providers. Every year, every big and many small companies, agricultural service providers conduct field events to demonstrate their technologies. In case of relativeness of its technologies to irrigation and CA, 1.3. Webinars. The objective of webinars is to spread theoretical and practical knowledge about soil protection technologies in agriculture under climate change in Ukraine. The quantity of webinars: 6-10 per year. The organizing and source of funding: CCCOA, research institutes and universities, ATC, NGOs, and others**.** 1.4. Communications: PR and GR. Achievements, results, and innovative approaches **were** recorded and disseminated in Media o Web site for publication information about DICA and activities of CCCOA and its stakeholders. o Webpage and group in social networks. o Cooperation with agrarian Mass Media, including magazines, websites, YouTube channels, and others. <u>Output 2. Activities:</u> 2.1. Bottom-up online learning course consisting of at least 8 developed lectures on sustainable agriculture focusing on COA for universities. 2.2. Textbook for improving the uptake and adaptation of sustainable agriculture for the end-users developed and disseminated among all agriculture and environmental science universities based on materials of online learning course. 2.3. Bottom-up online learning courses have been circulated in universities with agriculture and environmental sciences programs. 4. Selecting, collecting evaluation, and recording the best SA practices used by farmers and companies. 2.5. Digest edition in 2022. The source of funding: NAAS, international project of technical support. <u>Output 3. Activities:</u> 3.1. For launching the research on water resource availability for irrigation by ATC, at least five institutions will be involved. 3.2. COA field research launched in farmer's fields, at least 10 farmers were involved. It is a crucial issue for the dissemination and implementation of CA among farmers. The source of funding: Budget of NAASU, farmers and companies
Timeline	Total of 3 years: Year 1 *<u>Output 1. Activities:</u>*

	1.1. Organizing, conducting, and participating in training, field days, and other relevant events – 20% have been completed by the end of the first year 1.2. Field events were organized by private companies, agricultural service providers -– 20% have been completed by the end of the first year 1.3. Webinars – 40% have been completed by the end of the first year 1.4. Communications: PR and GR. Achievements, results, and innovative approaches were recorded and disseminated in Media • Web site was developed for the information of publication about DICA and activities of CCCOA and its stakeholders • Webpage and group in social networks were created and maintained <u>*Output 2. Activities:*</u> 2.1. Bottom-up online learning course consisting of at least 8 developed lectures on sustainable agriculture focusing on COA for universities. – was *Completed by the end of the first year.* *2.4.* Selecting, collecting evaluation, and recording the best SA practices used by farmers and companies. – *has started* <u>*Output 3. Activities:*</u> *3.1. For the research on water resource availability for irrigation* by ATC, at least five institutions were involved. – and launched by the end of the year *3.2. COA field research was launched in farmer's fields,* at least 10 farmers were involved. – launched by the end of the year Year 2 <u>*Output 1. Activities:*</u> 1.1. Organizing, conducting, and participating in training, field days, and other relevant events – 70% were completed by the end of the first year 1.2. Field events were organized by private companies, agricultural service providers -– 70% were completed by the end of the first year 1.3. Webinars – 70% were completed by the end of the first year 1.4. Communications: PR and GR. Achievements, results, and innovative approaches were recorded and disseminated in Media • Cooperation with agrarian Mass Media, including magazines, websites, YouTube channels, and others - at least 150 publications in mass media including on-line <u>*Output 2. Activities:*</u> 2.3. Bottom-up online learning courses were circulated in universities with agriculture and environmental sciences programs. – were launched 2.4. Selecting, collecting evaluation, and recording the best SA practices used by farmers and companies. – was completed 2.5. Digest edition in 2022 –was launched and published <u>*Output 3. All activities on-going*</u> Year 3 <u>*Output 1. Activities:*</u> 1.1. Organizing, conducting, and participating in training, field days, and other relevant events – 100% were completed by the end of the first year 1.2. Field events were organized by private companies, agricultural service providers -– 100% were completed by the end of the first year 1.3. Webinars – 100% were completed by the end of the first year 1.4. Communications: PR and GR. Achievements, results and innovative approaches were recorded and disseminated in Media • Cooperation with agrarian Mass Media, including magazines, websites, YouTube channels, and others - at least 150 publications in mass media including on-line <u>*Output 2. Activities:*</u> 2.2. Textbook for improving the uptake and adaptation of sustainable agriculture for the end-users was developed and disseminated in all agriculture and

	environmental science universities based on materials of online learning course. – was published *Output 3. Activities:* 3.1. The research on water resource availability for irrigation by ATC, at least five institutions were involved. – completed. Results were described, analyzed, and published 3.2. COA field research was launched in farmer's fields, at least 10 farmers were involved– was completed. Results were described, analyzed, and published
Budget	Total of USD: $ 200-250 thousand including: • USD $50- 60 thousands – for the Output 1 • USD $70 thousands- for the Output 2 • USD $ 80- 120 thousands – for the Output 3
Sources of funding	International programs of technical support and development; Budget fund of NAASU; Co-funding from agro-service providers and private organization Staff permanent: Project manager; three field officers/experts on SA; communication specialist; assistant. Experts: international and national expert on COA, CSA, irrigation, CA etc. Partnership: relevant international NGO, Academy and FAO
Measurement/Evaluation	Number of farmers participate; number of the best practice involved; number of field research launched; number of farmers implemented DICA; area of dissemination, ha.
Potential risks	(i) Low technical capacity; (ii) Delay or change in the project's implementation; (iii) The unpredictability in the implementation
Project beneficiaries	Ministry of Agriculture Policy and Food Prodaction; National Academy of Agriculture Scienses of Ukraine; farmers.
Responsibilities and coordination	Responsibilities and Coordination: The Coordination Centre of Climate-Oriented Agriculture can be founded by NAASU and IWPLR as a structural unit of Kyiv Agrarian University (earlier established) based on the public-private partnership. The project would be launched under the support of the international program of technical development. The main source of maintaining funding is the budget of NAASU and IWPLR. However, the CCCOA will be developed as a public-private initiative that will allow private investors to participate, manage and contribute to the Center activities.

Chapter 2 Technology Action Plan and Project Ideas for Sector B: Water sector

2.1 TAP for B1: Water sector

2.1.1 Sector overview

The water sector plays a crucial role in the operation of many industries and population in Ukraine. The water sector is being severely affected by displays of climate change and by human activity. Key vulnerabilities to climate change include a rise in temperature and shifts in precipitation patterns, resulting in flood and/or drought frequency, water availability and water discharge seasonality (TNA Ukraine 2019). Flood in Western Ukraine only in June 2020 led to the immediate allocation of EUR 25.6 million to partially compensate losses, whereas the overall figure to compensate losses reached EUR 70 million by the end of 2020 (Lazaryeva 2021). Water use dynamics is slowly changing, showing the growing demand for water coupled with growing water scarcity. These changes may negatively affect agriculture, energy, transport, and social sectors, dependent on water resources. Human economic activity could be of adverse nature, mainly through discharge of chemical pollutants into water bodies, increased water intake for economic purposes (such as irrigation or technological processes), and increased urbanization and expected persistence of this trend in the future. The fact is given that Ukraine has lower availability of water resources in comparison to the European countries, water stress is already felt in the most of southern regions and is expected to persist even in the remainder of the country in the nearest future.

There are numerous attempts to arrange and regulate the operation of the water sector. They include, but not limited to, the documents and policies, which are indicated in Table 2.1.

Table 2.1. Documents and policies in water sector in Ukraine

The name of the policy	Enacted/revised	Main contents
Water Code	1995. Last revision – Nov 2020	The Water Code, in combination with measures of organizational, legal, economic and educational impact, contributes to the formation of water and environmental legislation and environmental safety of the population of Ukraine, as well as more efficient use of water.
Law of Ukraine "On Nature Environment Protection"	1991. Last revision – Nov 2020	Determines the legal, economic and social foundations of the organization of environmental protection in the interests of present and future generations.
Association Agreement between the European Union and Ukraine	2014	Inter alia, presumes subsequent implementation of the EU Directives in water sector, namely Water Framework Directive 2000/60/EC; Floods Directive 2007/60/EC; Marine Strategy Framework Directive 2008/56/EC; Urban WasteWater Directive 91/271/EEC; Drinking Water Directive 98/83/EC; Nitrates Directive 91/676/EEC.
Law of Ukraine adopting the State Targeted Programme for the development of water economy and ecological sanitation of the Dnieper river basin by 2021	2012	Addresses climate change adaptation issues and the implementation of river basin management principles. Particular measures include: − The development of water management and land-melioration by improving the ecological status of drained and irrigated areas; − Providing rural population with centralized water-supply; − Protection rural settlements and agricultural land from negative water influence; − Integrated flood control and protection areas in the Tisza, Dniester, Prut and Siret river basins; − Ecological enhancement of the Dnipro river basin and drinking water quality improvement; − The implementation of integrated river basin approach in water management.

Decree of the Cabinet of Ministers of Ukraine No. 336 "For Approving the Procedure for the Development of the River Basin Management Plan"	2017. Last revision – Sep 2020	Establishes the Procedure for the Development of the River Basin Management Plan.
The Law of Ukraine "On drinking water and drinking water supply" 2918-III	2002. Last revision – Sep 2019	Determines the legal, economic and organizational basis of functioning of system for the supply of drinking water.
The Law of Ukraine "On Environmental Impact Assessment" No. 2059-VIII	2017. Last revision – Jun 2020.	Establishes the legal and organizational framework for environmental impact assessment aimed at preventing environmental damage, environmental safety, environmental protection, rational use and reproduction of natural resources, in the decision-making process of economic activities that may have a significant impact on the environment, taking into account public and private interests.
Decree of the Cabinet of Ministers of Ukraine No. 758 "For Establishing the Procedure for Implementation of State Water Monitoring"	2018. Last revision – Sep 2020	The Procedure defines the basic requirements for the organization of state water monitoring, the interaction of central executive bodies in the process of its implementation and the provision of state authorities and local governments with information for decision-making on water status.
The Law of Ukraine **"**On the approval of the National target program of development of water management and ecological improvement of the Dnieper river basin until 2021**"** No. 4836-VI	2012	The Program aims to determine the main directions of state policy in the field of water management to meet the needs of the population and sectors of the national economy in water resources, conservation and reproduction of water resources, implementation of integrated water resources management by basin, the optimization of water consumption, prevention and elimination of consequences of harmful effects of water.
The Law of Ukraine on "State Program 'Drinking Water of Ukraine' for 2011–2020" No. 2455-IV	2005. Last revision – Sep 2019	The purpose of the Program is to ensure the rights of citizens of Ukraine to a have sufficient standard of living and environmental safety by providing drinking water in the required amounts and in accordance with established standards.
The Decree of Cabinet of Ministers of Ukraine "On the approval of the Concepts of combating land degradation and desertification" No. 1024-r	2014	Establishes measures aiming at combating land degradation and desertification.
The Decree of Cabinet of Ministers of Ukraine "On the Approval of Strategy for Irrigation and Drainage in Ukraine until 2030" No. 688-r	2019	Establishes a plan and amounts of land that need to be irrigated by 2030.

Gender aspects of adaptation should be taken into account when considering the process of technology transfer. The TNA (2020) Adaptation Report indicates significant gender bias in terms of business and management in Ukraine (only 32% of employers are women). In other words, men are more often head of companies or hold positions that involve decision-making. Despite that, we consider the three technologies of the water sector (Climate-Smart Irrigation, Drought Risk Assessment and Mapping and Flood Risk Assessment and Mapping and) as gender-neutral technologies, whose beneficiaries are men and women equally. At this moment, we do not have the statistics or other observations to state the opposite. However, one of the spheres where women could participate more is all kinds of activities related to data collection, software development and use, data interpretation, which could be of service for all three technologies.

2.1.2 Action Plan for Climate-Smart Irrigation

2.1.2.1 Introduction

Climate-Smart Irrigation technology has been chosen by experts as the winning technology within the first stage of TNA Project in Ukraine in 2019. Later on, the technology has received the highest score. The technology has significant adaptation and mitigation benefits; in particular, it prevents crop loss from improper watering; the diminished use of water which leads to the decreased amount of nutrients reaching water bodies; indirectly promotes conservation of biodiversity through cleaner water; contributes to the enhanced management of water under the climate change, balancing the availability of water supply and irrigation demand. Less electricity is needed for water transportation, so less CO_2 would be emitted into the atmosphere in case of technology-wide deployment. Economic and environmental benefits of Climate-Smart irrigation include increased crop yield, optimized water consumption, the potential of job creation for equipment and software maintenance. One of the important traits of technology is that it allows agriculture to implement and use contemporary information and telecommunication technologies. A detailed description of the technology is available at link (in Ukr.).

A primary climatic zone for the technology implementation in Ukraine is Steppe, especially Kherson, Odesa, and Mykolaiv regions. Kherson region is thearidest area, and it has Kakhovsky Irrigation Channel – a major irrigation channel in Southern Ukraine. Within the last 28 years, Ukraine's average temperature increased by 2℃, which induced the migration of climatic zones to the North. It is giving a sign that Steppe will extend to Odesa, Kirovograd, Cherkasy, Poltava. Kharkiv, Luhansk, Donetsk, Dnipro, Mykolaiv, Kherson, Zaporizhzhya regions, and the Crimean Peninsula. These regions would also require Climate-Smart Irrigation, however, in the middle run.

This technology is slightly more expensive than conventional irrigation: for instance, the cost of conventional irrigation is USD 2833/ha, whereas the cost of Climate-Smart Irrigation is USD 4251/ha. The spread of this technology is restrained not only with financial or informational limitations of Agri producers, but also with the physical availability of irrigation infrastructure, as well as water availability.

2.1.2.2 Ambition for the TAP

The Strategy for Irrigation indicates that available water infrastructure (water supply, the capacity of main and distribution canals, number and capacity of different pumping stations, etc.) are sufficient to withdraw and supply water for the irrigation of at least 1.5-1.8 million ha, envisaging the expansion of irrigation in the area of 1 million ha by 2030. Actual irrigation in 2019 reached 0.532 million ha. It is clear that agri holdings process 30% of arable land (TNA Ukraine 2019), and there are medium-size farmers, we suggest the implementation of CSI in a maximum of 0.5 million ha (0.3*1.5 million ha + 0.05 million ha = 0.5 million ha) by 2037.

Thus, the ambition for CSI spread in Ukraine is the **implementation of CSI on 0.5 million ha by 2037**.

This target is very ambitious, as it is equal to the currently entire irrigated area, and, besides, the current annual increment of irrigated areas reaches only a maximum of 20 thousand ha (Khvororstyany 2020); however, a more realistic figure is 10-15 thousand ha (Bodnar et al 2020). This ambition is in line with the Strategy for Irrigation and Drainage until 2030 (2019), and the Concepts of combating land degradation and desertification (2014).

***Gender prospective**:* Climate-Smart Irrigation is a gender-neutral technology, whose beneficiaries are men and women equally. However, one of the spheres where women could participate more in this technology implementation and use, is activities related to data collection, software development and use, and data interpretation.

2.1.2.3 Actions and Activities selected for inclusion in the TAP

The summary of barriers and measures to overcome barriers

There are economic, financial barriers, as well as barriers of other nature, described in detail in Adaptation Barrier Analysis and Enabling Framework Report (2020). In particular, economic and financial barriers include:

- The high cost of technology;
- The high cost of capital;
- Difficulties with an access to capital.

Non-financial barriers include:

- The inconsistency of property rights;
- Water for irrigation tariff is insufficient for capital assets renovation;
- The limited availability of local suppliers of equipment and services;
- The lack of awareness and limited knowledge of the benefits of technology;
- Obsolete and physically missing infrastructure for irrigation;
- The lack of detailed assessment of water available for irrigation;
- The unauthorized and untreated extraction of water for irrigation from the artesian field;
- No legislation regulating climate-smart irrigation technology.

To overcome economic and financial barriers, Special funding program, Long-term soft loans, and Import tax exemption for imported equipment is needed. The purpose of the Special funding program is to provide finance to companies that can potentially implement the technology and banking system. The donor of the funding program could be one or several International Financial Organizations that provide financial aid for climate change adaptation activities. The summary of these financial institutions is provided in Table 2.2.

Table 2.2. International Financial Organizations that could provide financial aid for Special Funding Program to implement CSI technology

IFO	Cooperation with Ukraine	Remark
Global Environment Facility (GEF)	Yes	Provided USD 14.8 million in Ukraine
Green Climate Fund (GCF)	**No**	**Negotiations need to be started**
Adaptation Fund	**No**	**Negotiations need to be started**
European Bank for Reconstruction and Development (EBRD)	Yes	Provided EUR 14.739 billion in Ukraine
European Investment Bank (EIB)	Yes	Provided EUR 6.4 billion in Ukraine
Kreditanstalt für Wiederaufbau (KfW)	Yes	Provided EUR 245 million in Ukraine

GEF requires special attention, as it has three focal areas of cooperation in Ukraine: Climate Change, Land Degradation, and Biodiversity. Within the first focal area, USD 3.4 million remain to be allocated and utilized (compared to USD 11.4 million already allocated and used) (GEF 2021).
Adaptation Fund helps developing countries to build resilience and to adapt to climate change. GCF is a Fund aimed at helping developing countries to reduce their GHG emissions and to adapt to climate change. Ukraine has formally a status of a country with a market economy and Annex I country, so it does not qualify for the aid of GCF and Adaptation Fund. Therefore, negotiations to cooperate with these Funds have to be started as soon as possible.

A relatively new tool to finance, among other things, adaptation projects that have legislatively been permitted since August 2020 is securities, in particular Green Bonds. According to the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine Concerning the Simplification of Attracting

Investments and Introduction of New Financial Instruments" #738-IX dated 16th June 2020, Green Bonds are securities issued for specific eco-friendly projects, including those aimed, inter alia, at projects of organic agriculture, the saving of water and land resources, climate change adaptation and GHG emission reduction. This tool is expected to be implemented in Ukraine since the 1st July, 2021, and respective changes on taxation are expected to be enacted in 2021. Green bonds may become a decent financial tool in the long run.

Non-financial barriers are diverse. There is a barrier of the inconsistency of property rights that can be addressed by means of the creation of water users' associations (WUAs) within river basins. WUAs are expected to receive to their balance inter-farm networks and to manage latter. This will allow such organizations to identify areas requiring irrigation and obtain loans. As of February 2021, in Ukraine, there is only one Water Users Association (Kherson region). Intra-farm irrigation networks have to be transferred to the local governments and further managed as a part of the decentralization process, and credit or investment resources can be mobilized by local governments. For this particular technology implementation, we rely on WUAs and not on Territorial Amalgamated Communities (TACs) like in described above DICA technology because CSI presumes different scope of irrigation, different sizes of fields, as well as other types of crops to be irrigated.

The barrier of obsolete and physically missing infrastructure for irrigation is complex. It could be addressed by means of modernization of networks in several regions; the replacement of equipment at main pumping stations; equipping of inter-farm systems with the modern means of water accounting; the introduction of reserve capacities, which should be determined individually by the results of technical inventory and energy audit; the assessment of demand and need to expand the irrigation area in particular areas.

WUAs may slowly increase the water tariff for irrigation until the tariff reaches the size of prime cost. Water tariff for irrigation would cover not only the cost of electricity and labor but also the innovation and development expenditures. WUAs have to obtain pumping stations on their balance from the State Water Agency of Ukraine.

The barrier of limited availability for the local suppliers of equipment and services could be addressed with the adaptation and adjustment of software of imported weather stations, such as IMET, Davis, etc,. as they are developed for weather and plant conditions of other countries. Ukraine has its own domestic output of hardware for irrigation, whereas "smart" components and software are foreign, being fully presented in Ukraine by the US, Austrian equipment etc. The existing domestic production facilities such as "Fregat", producing sprinkler machines could be used to produce equipment that could be of use for both conventional and Climate-Smart Irrigation. The cooperation of machinery producers with IT companies (to guarantee the consistent development of hardware and software for the technology) is needed, as well as detailed mid-term studies, adjusting the default settings (factors) of water demand for different crops.

Although the preliminary findings are in place, the barrier of lack for the detailed assessment of water available for irrigation could be addressed with the analysis and modeling of available water run-off in the long run, as climate change and droughts are expected to persist.

The barrier of lacking legislation that regulates climate-smart irrigation technology could be addressed with the extension of the existing National Standard DSTU 7735:2015 "Technics of Water Supply. Terms and definitions of basic concepts", were developed by The Institute of Water Problems, NAASU, and adopted in 2015 (URTCSCQP 2015) with further amendments.

Low awareness on the benefits of technology could be tackled by the means of awareness raising campaigns that could be conducted by Advisory Services in Ukraine (within technical aid programs). However, market participants indicate that the most efficient measure to increase awareness is to conduct webinars or offline events with the existing technology users (so that they could share their experience). Information in mass media is the second efficient measure, followed by trainings (Fig.2.1).

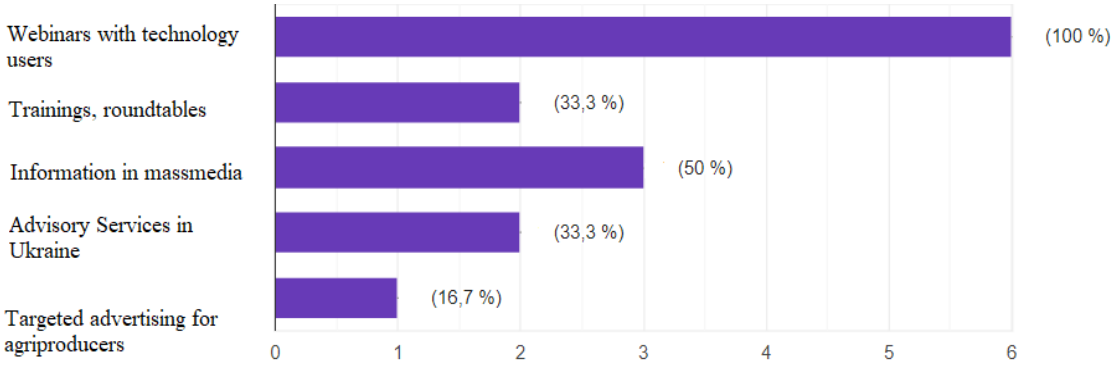

Figure 2.1. Measures aimed at increased awareness on Climate-Smart Irrigation

Actions selected for inclusion in the TAP

Measures that are selected as actions to be included in TAP for CSI are as follows:

- Overcoming of financial barriers. This measure has to be "translated" into action, because financial barriers in Ukraine exist for nearly all projects. Limited access to finance impedes investments in agriculture in Ukraine (OECD 2015), especially for small and medium enterprises. Interest rates are usually high and volatile, being higher than that in developed countries, aiming at compensating the high risk of doing business in Ukraine. Overcoming of financial barriers would help to implement relatively new technologies, this will accelerate economic growth and indirectly promote an increase in yields.
- The assessment of Long-term water availability for irrigation. As it was mentioned above, there are preliminary results of water availability, however, water withdrawal is a dynamic process, depending not only on the level of economic activity, but also on the precipitation's amounts and climate-change's impact. This measure could go in parallel with the establishment of a Fund to overcome financial barriers.
- The adjustment of Machinery and Equipment. Imported "smart" component of CSI should be adjusted for Ukrainian weather conditions and crops. Imported equipment has the default settings (coefficients) developed for climatic conditions and crops of other countries. To ensure the adjustment and localized correction factors, mid-term studies are required in Ukraine. Despite currently the market of equipment is saturated mostly by the imported "smart" component, Ukrainian companies have necessary background to saturate the market with domestic equipment as well, bearing in mind that Ukraine has a solid machine-building base and well-developed IT specialists' market.
- Economic and Legislative Stimuli is enabling CSI. To enable the implementation of CSI development, Water Users Associations are required to be created. To ensure that, the Draft Laws On the organizations of water users and stimulation of hydraulic amelioration of lands #5202 dated 04.03.2021 (to create Water Users Associations) (VR 2021) and Draft Law on Amendments to Certain Legislative Acts Regulating the Transfer of Reclamation Systems for Temporary Use # 3852 dated 15.07.2020 (VR 2020) are required to be adopted, so that WUAs would have legal basis to become fully operational and to obtain pumping stations to their balance. The smooth transferring of property rights is required for pumping infrastructure from State Agency of Water Resources to WUAs. The main types of property rights include complete property, trust property or preferential rent. Moreover, the Government needs to decide whether to allow the construction of new pumping stations, or to privatize the already existing ones (Khvorostyany 2020). The extension of the existing National Standard DSTU 7735:2015 is required to include provisions on CSI. The simplification of deployment of new technologies is required. For instance, irrigation facilities irrigating areas of more than 300 thousand ha and using water bodies more than 1 km2 have type CC3 of complexity (similar to that of nuclear power plants. Smaller irrigation facilities have type CC2 of complexity (similar to that of multi-apartment building), which, in turn, requires lots of paperwork. Instead, smaller irrigation facilities have to become type CC1 of complexity. To ensure that, State Building Standard DBN B.1.2-14-2009 is required to be amended (SBSU 2009).

- Awareness raising and knowledge sharing. Due to the lack of information and technical constraints, all of previously installed stations are not fully operational. Information dissemination could potentially increase the number of stations; other barriers should be overcome. Therefore, raising awareness is important for the successful implementation of wide-scale technology.

Activities identified for the implementation of selected actions

Action 1. In-depth research

Activities:

1.1. The assessment of water available for irrigation in the medium and long-run. There are some preliminary assessments of water availability, but they are required to be worked out in detail. Wide inclusion of women into the study is highly recommended.

1.2. The adjustment of imported equipment to local conditions, i.e. Study to develop adjustment factors for local crops and weather conditions. Wide inclusion of women into the study is highly recommended.

Action 2. Overcoming of financial barriers

Activities:

2.1. The development of special funding program, aimed at the provision of long-term soft loans. The Fund is to be provided by international donors. Later, the fund is required to be distributed by commercial banks operating in Ukraine.

2.2. The adoption of import tax exemption for imported equipment for CSI

Action 3. Enabling economic and legislative stimuli

Activities:

3.1. The adoption of Law of Ukraine "On water Users Associations"

3.2. The transition of irrigation machinery and elements of CSI system from State Agency for Water Resources to Water Users Associations.

3.3. The extension of the existing National Standard DSTU 7735:2015 to include provisions on CSI.

3.4. The amendment of the existing State Building Standards of Ukraine. System for ensuring the reliability and safety of construction sites. General Principles of Security, Reliability and Constructive Safety of Buildings, Buildings Structures and Foundations DBN B.1.2-14-2009 stand to simplify the complexity of irrigation systems.

Action 4. Awareness raising and knowledge sharing

Activities:

4.1. The spread of information about CSI. Wide inclusion of women into the process is highly recommended.

4.2. The enhancement of networking of CSI value chain actors. Wide inclusion of women into the process is highly recommended.

Actions to be implemented as Project Ideas

The development of special Funding program is suggested as Project Idea, aiming at the provision of long-term soft loans for CSI spread. Ukraine is a globally renowned agricultural producer. The harvest, inter alia, depends on water availability. Climate change and droughts are expected to persist. Domestic market is already severely affected by drought – for e.g., economic losses only in crop raising, caused by drought 2019-2020, resulted in loss of UAH 65 million (USD 2.3 million) (Khvorostyany 2020). Global agri commodities prices to some extent depend on the supply of agriproducts from Ukraine, especially of sunflower oil and wheat. Therefore, the creation of preconditions attaches crucial importance to enable irrigation and water saving in Ukraine.

2.1.2.4 Stakeholders and Timeline for the implementation of TAP

In order to conduct the research, potential stakeholders include but not limited to the Institute of Water Problems and Melioration, the National Academy of Agrarian Sciences of Ukraine, Ukrainian Hydrometeorgological Institute, NASU and State Emergency Service of Ukraine, as well as the Institute of Irrigated Agriculture, the National Academy of Agrarian Sciences of Ukraine.

To overcome the financial barriers, actions are needed from Ministry of Finance of Ukraine and State Fiscal Service of Ukraine. An important group of stakeholders is international financial institutions, domestic banks and insurance companies.

In order to develop and implement economic stimuli, immediate actions are required from the Supreme Council of Ukraine, the Ministry of Agrarian Policy and Food of Ukraine, the Ministry of Finance of Ukraine, the Ministry for Communities and Territories Development of Ukraine, as well Water Users Associations (in future, as they are yet to be created).

For raising awareness, the National Association of Agricultural Advisory Services of Ukraine might be employed.

Actions of all these entities are needed to ensure the proper and timely spread of Climate-Smart Irrigation by agri holdings and farmers. Another stakeholder includes manufacturers and sellers of equipment, its elements and the installation and maintenance of equipment.

The overall list of stakeholders in provided in Annex I.

Scheduling and sequencing of specific activities

All activities which are suggested can be done simultaneously, some of them are going to start as early as in 2022. Due to the fact that some preliminary research was already in place before 2020, the full-scale studies might be conducted in 2022-2024.

Special Funding Program is required to be developed as soon as possible to ensure access to capital and loan provision. We suggest that the local Funding Programme is to be created, funded by international donors, and managed by the Cabinet of Ministers of Ukraine.

Given that currently in Ukraine, there is no legislation allowing direct funding activities by international and foreign organizations, a special State Enterprise has to be created, adopted by the Law of Ukraine, e.g. Law of Ukraine On Funding of Climate-Smart Irrigation. It might take several years to develop the Law, and then other several years to adopt it. This way, we add another five years until the project beginning (should the Law be adopted earlier, the project could start earlier).

The Fund is a state institution - a legal entity under public law. The Fund acquires the rights of a legal entity from the date of its state registration in the manner prescribed by law. The founder of the Fund is the state represented by the Cabinet of Ministers of Ukraine; the Fund is formed by the decision of the Cabinet of Ministers of Ukraine. The Fund may receive from governments, agencies, and institutions of foreign countries, as well as from international financial organizations (hereinafter - donors) financial contributions and assistance in the form of targeted grants or otherwise on the basis of the relevant agreement. The Fund provides independent and transparent separate accounting of such contributions and assistance in accordance with the legislation of Ukraine. The participation of international donors could guarantee the availability of funds per sei, coupled with more efficient control of money allocation and expenditure.

The Fund has the right in the manner prescribed by law to enter into agreements, acquire property and personal non-property rights. The Fund may, under the law, be a member of associations of legal entities, act as a participant (founder) of other legal entities, if necessary or appropriate to achieve the purpose of the Fund.

The objective of the Fund is the provision of funds to purchase and operate the equipment for CSI, so that CSI could spread on 0.5 million ha by 2038.

Annual targets to reach are described in Table 2.10 below.

The Fund forms a permanent internal audit unit, which is part of the internal control system.

The annual budget of the Fund is formed at the expense of the State Budget of Ukraine and funds received by the Fund as grants or otherwise attracted from any other sources not prohibited by law. The indicative calculation of costs for Fund operation and maintenance is provided in Table 2.2.1.

Table 2.2.1 The indicative expenditures for 10 years of Fund operation in Ukraine

	Number and units	**Expenditures per month**	**Expenditures per year, USD**	**Expenditures for Program duration, USD**
Number of staff units of the Fund[20]	10 persons	Wage/month/person - USD1500, USD	180000	1800000
Rent of office	50 m2	USD 670/month	8040	80400
Purchase of PCs, printers/scanners, router	10 PCs, 1 router, 4 printers	1 PC – USD 1000; 1 router - USD 500; 1 printer - USD 555	12000	24000
Purchase of licensed antivirus software	10 PC	USD 37/year per 2 PC	185	1850
Stationery, maintenance of equipment		USD 300	300	3000
Awareness rising events	2/year	-	9075	90750
Grand Total				**2000000**

Sources of formation of funds of the Fund can be monetary of the founder; funds raised on a gratuitous and non-refundable basis, including from donors; funds provided by the law on the State Budget of Ukraine for the relevant year for the implementation of the Fund's programs; other sources and incomes not prohibited by the legislation of Ukraine.

The Fund considers the applications and decides on the provision of loans. Loans are provided and distributed by Ukrainian banks that have to be chosen and qualified to participate in the Program. Banks define the schemes of appropriate revenues receiving. To estimate the revenues, agri producers might need to present their expected plans regarding types of crops for the upcoming 8 years (or other period of loan they apply for). Wide inclusion of women into the projects is one of the important considerations for the loan provision.

For particular Program design, representatives from the Ministry of Finance of Ukraine, the Ministry of Justice of Ukraine, together with representatives of donor organizations and specialists in public finance, should be involved.

Import tax exemptions should be enacted for the period of the first five years of the program's operation to ensure cheaper equipment in the Ukrainian market. Further exemptions do not seem to be reasonable, as domestic producers may want to take part in a competition, seeing the marketplace for their goods, and this is up to the market to decide.

The Adoption of Law on WUAs had to be commenced in 2019-2020, according to the provisions of Strategy for Irrigation by 2030. Unfortunately, it did not happen in 2020.

[20] Legal ground - CMU (2014) Decree of CMU #85 dated 5 April 2014

2.1.2.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

The major necessary action is required to adopt the Law on Water users' associations, aiming at increased institutional capacity, which, in particular, should provide the latter with real rights and possibilities of gaining irrigation machinery and infrastructure.

The estimations of costs of actions and activities

In order to assess the cost, the focus on our ambition was made, in particular in the area that is capable of hosting CSI. We estimate that CSI could be realistically adopted in 500 thousand ha by 2038.

For further calculations, the following assumptions were used:

- The cost of climate-smart smart irrigation is USD 4251/ha (II report). In order to simplify calculations, we assume USD 4200/ha, allowing the economy of scale and acknowledging partial presence of some elements of CSI, possessed by farmers and agri holdings.
- Exchange rate is 1 USD = 29 UAH.
- We assume the spread of CSI exponentially rather than by equal installations annually (Fig 2.2), because CSI depends not only on financial parameters, but also on the physical renovation of irrigating infrastructure and on reasonable offtake of Strategy for Irrigation and Drainage by 2030.

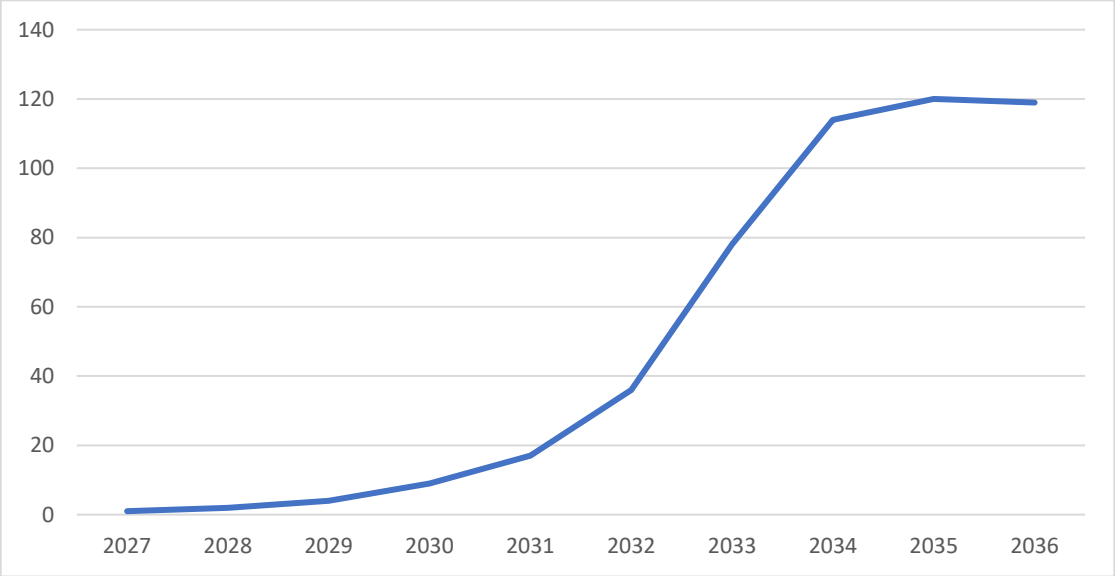

Figure 2.2. The assumed spread of CSI by years in 2027-2036, *thousand ha*

- In order to implement the CSI and to reach the goal established, we suggest that the commercial banks could cooperate with the donors in Ukraine through the above mentioned Funding Program. Banks may impose their requirements to distinguish WUAs eligible for loans.
- We consider the *classic (differentiated) payment scheme of loan* (i.e. not the annuity loan), where interest is charged on the balance of the loan body. Accordingly, in the beginning of the maturity, the amount of the annual payment will be significantly higher than in the last periods. With an annuity loan, the amount of payment will be the same throughout the entire loan repayment period, but during the first several months interest prevails in the payment, whereas in the last months the body of the loan prevails. However, annuity loans turn to be more expensive even with the same interest rate.
- The share of own capital is 40% and the remainder is the borrowed capital. This assumption is rather optimistic, as usually the higher cost of capital the country has (Fig.2.3.), the lower has to be the share of borrowed capital (Fig.2.4.)

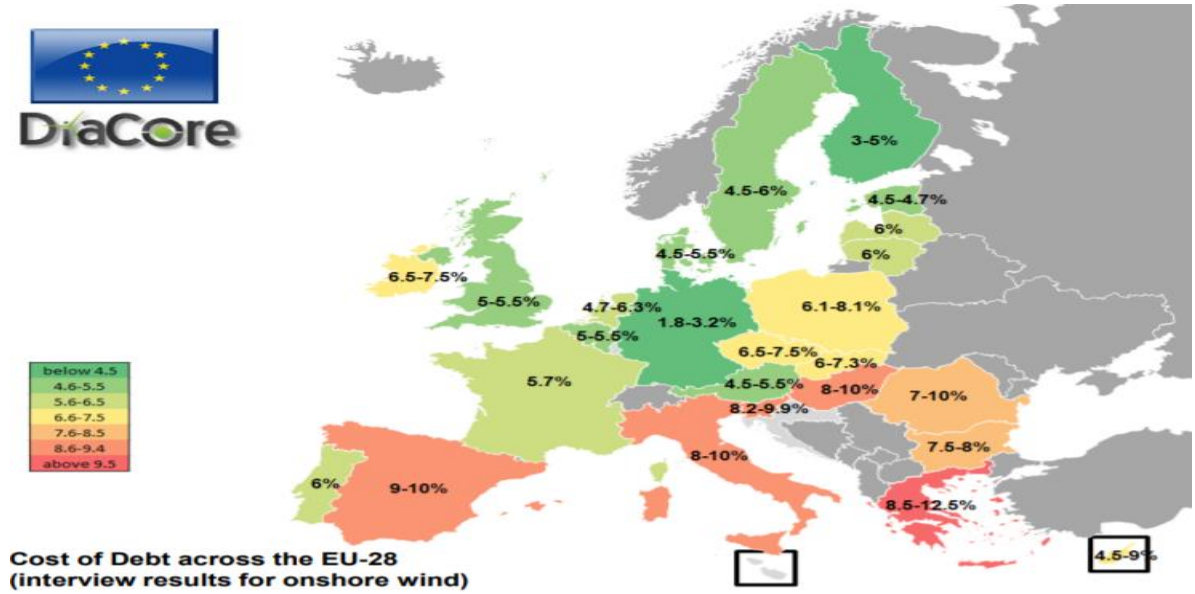

Figure 2.3. Cost of debt in the EU-28 (2016)

Source: DiaCore (2016) Policy Dialogue on the Assessment and Convergence of RES Policy in EU Member States Final Report Project.

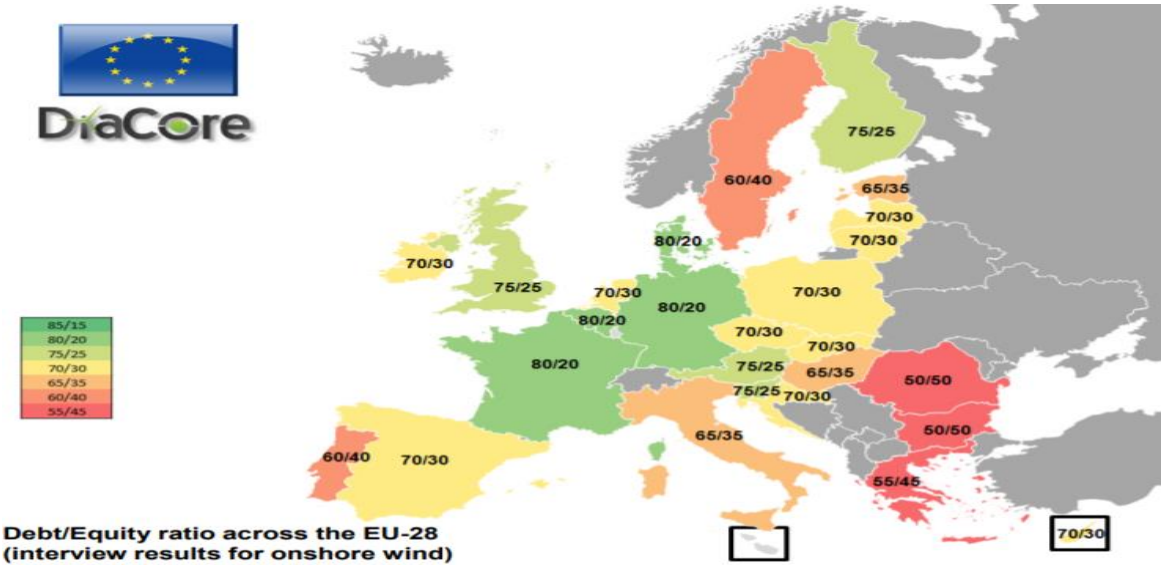

Figure 2.4 Debt/Equity ratios across the EU-28 (2016)

Source: DiaCore (2016) Policy Dialogue on the Assessment and Convergence of RES Policy in EU Member States Final Report Project.

Ukrainian banks tend to provide only relatively small short loans. The interest rate depends on the loan history of the borrower, the volume of the loan, share of own/borrowed capital, cost of collateralized property. Sometimes the collateral could be even a guarantee of future harvest. The maximal loan provided in Ukraine is that provided by Alpha Bank (one of top 5 the largest Russian banks), reaching UAH 7.5 million (USD 265 thousand). However, this is rather the exception and loans are usually smaller.

Import tax exemptions do not require funds from state budget or donors' expenditures. Next steps should include adoption of Law of Ukraine "On water Users Associations", Development of mechanisms for state support for the acquisition of irrigation machinery and elements of CSI system by Water Users Associations.

Our assessment of funds required to implement the CSI technology, reaches USD more than USD 2.1 billion. More detailed calculations are presented in subsection 2.2.2 Specific Project Ideas.

2.1.2.6 Management Planning

Risks and Contingency Planning

The potential risks could be of several types: cost, scheduling and performance.

Scheduling risks could be applicable to all of the activities, in particular the two activities related to studies.

Overcoming financial barriers has the largest number of risks: investments into CSI may occur slower than expected. Costs may appear to be higher than initially expected due to rapidly changing market conditions and in some cases, unexpected transaction costs. Despite raising awareness, companies' benefit for the use of technology might not be as high as it was anticipated. The adoption of import tax exemption may not occur due to permanent budget's constraints and high budget deficit in 2021, aggravated by COVID-19 economic slowdown.

As it was stated above, CSI relies on the implementation of Strategy of Irrigation and Drainage by 2030, in particular in the restoration of watering infrastructure per sei. In order to implement the Strategy, Governmental Guarantees have to be provided (Article 6 of Law of Ukraine "On State Budget") for internal loans aiming at the restoration of melioration. However, there is no guarantee that they will be provided in 2021 or in the next years due to extensive State Budget deficit (nearly 8% of GDP in 2021).

The Adoption of Law of Ukraine "On water Users Associations" might also be postponed due to insufficient lobby.

Awareness rising and knowledge sharing might face the cost risk due to inability to assess the budget of activities. The budget strongly depends on the types of methods employed (e.g., virtual vs offline; number of participants in trainings, duration of trainings etc.).

Next Steps

The immediate requirement includes in order to to proceed, but not limited to, the adoption of the Law of Ukraine "On water Users Associations" and creation of enabling environment for transfer of property rights for irrigation equipment and infrastructure to Water Users Associations.

Critical point to succeed is the recognition of importance of technology and shown commitment and interest from the Ministry in the charge of irrigation (as of June 2021, it is the Ministry of Agrarian Policy and Food of Ukraine) to implement the technology. The fact is given that the technology of CSI requires more than a decade for implementation, the long-term institutional memory is needed as well.

2.1.2.7 TAP overview table

Sector	Water							
Sub-sector	Irrigation							
Technology	Climate-Smart Irrigation							
Ambition	The ambition was defined for CSI technology for TAP implementation: the technology has the potential to be implemented in **0.5 million ha by 2037**.							
Benefits	Adaptation Benefits of the technology include, but not limited to: - the prevention of crop loss due to over watering or under watering; - the decreased amount of nutrients reaching water bodies; - the maximal use of soil moisture; - the indirect conservation of biodiversity through cleaner water; - the enhanced management of water under the climate change balancing the availability of water supply and irrigation demand. - reduced and optimized water consumption. Mitigation benefit includes the reduction of CO_2 emissions into the atmosphere as a result of lower electricity consumption, as less water is required to be transported for irrigation. Economic and financial benefits are following: - the potential creation of new jobs both for women and men to produce equipment and software; - the potential activation of banking system that would provide loan for equipment.							
Action	**Activities to be implemented**	**The sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Indicators for the Monitoring of implementation**	**Budget per activity**
Action 1. In-depth Research	1.1. The assessment of water available for irrigation in the medium and long-run	The Ministry of Environmental Protection and Natural Resources of Ukraine	**Institute for Water Problems and Melioration Problems, NAASU** Ukrainian Hydrometeorological Institute, National Academy of Sciences of Ukraine, State Service of Emergencies of Ukraine	2022-2023	Scheduling risk Cost risk	Performed assessment	Conducted study on water availability for irrigation in the medium and long-run	USD 100 thousand

	1.2. The adjustment of imported equipment to local conditions (Study to develop adjustment factors for local crops and weather conditions)	International financial institutions providing financing for climate change adaptation activities (Global Environmental Facility)	Institute for Water Problems and Melioration, the National Academy of Agrarian Sciences of Ukraine The Institute of Irrigated Agriculture, National Academy of Agrarian Sciences of Ukraine	2022-2023	Scheduling risk	A set of domestic coefficients for local crops developed	Conducted study resulted in developed adjustment factors for crops grown in Ukraine and local weather conditions	USD 500 thousand
<u>Action 2.</u> Overcoming of financial barriers	2.1. Adoption of the Law enabling creation of specialized State Enterprise that would be able to access funding from international financial organisations with the purpose of sustainable financing of agriculture sector climate-resilient and adaptation interventions	Government of Ukraine	**Supreme Council of Ukraine**	2021-2025	Scheduling risk		Law adopted	No additional financing is required

	2.2. The development of special funding program, aiming at provision of long-term soft loans.	International financial institutions providing financing for climate change adaptation activities (Global Environmental Facility)	**The Ministry of Finance of Ukraine** Farming groups	2026-2037	Cost risk Scheduling risk Performance risk	Developed special Funding Program, aiming at provision of long-term soft loans, including SMEs from rural area	CSI implemented on 70% of area of ambition (0.35 mln ha)	USD 1353 million.
	2.3. The adoption of import tax exemption for imported equipment for CSI	-	State Fiscal Service of Ukraine	2022-2026	Performance risk	Adopted and enacted import tax exemption for the imported equipment for CSI		No additional financing is required
<u>Action 3.</u> Enabling economic and legislative stimuli	3.1. The Adoption of Law of Ukraine "On water Users Associations"	-	Supreme Council of Ukraine	2022	Performance risk Scheduling risk	Adopted Law of Ukraine "On water Users Associations"	Adopted Law of Ukraine "On water Users Associations"	No additional financing is required
	3.2. The transition of irrigation machinery and elements of CSI system from State Agency for Water Resources to Water Users Associations.	-	**The Ministry of AgroIndustrial Complex of Ukraine**, Ministry of Finance of Ukraine Water Users Associations	2022-2025	Performance risk		70% of pumping stations are transferred Water Users Associations.	Property rights transfer is associated with juridical procedures and respective costs. The amount of the costs is not known at the moment, as no mechanism of transfer is yet developed
	3.3. The Extension of the existing National Standard DSTU 7735:2015 to include provisions on CSI	State budget of Ukraine	The Ministry of AgroIndustrial Complex of Ukraine	2021	Performance risk	Updated National Standard DSTU 7735:2015	Updated National Standard DSTU 7735:2015	No additional financing is required

	3.4. The amendment of the existing State Building Standards of Ukraine. System for ensuring the reliability and safety of construction sites. General Principles of Security, Reliability and Constructive Safety of Buildings, Buildings Structures and Foundations DBN B.1.2-14-2009 to simplify the complexity of irrigation systems.	State budget of Ukraine	Ministry for the Communities and Territories Development of Ukraine	2021	Performance risk	Amended Building Standard of Ukraine DBN B.1.2-14-2009	Amended Building Standard of Ukraine DBN B.1.2-14-2009	No additional financing is required
Action 4. Awareness raising and knowledge sharing	4.1. The spread of information about CSI	Grants and technical aid of international organizations (such as USAID), Regional budgets, funds of business entities	The National Association of Agricultural Advisory Services of Ukraine	2022-2032	Performance risk	CSI is known and recognized irrigation technology	CSI is known and recognized irrigation technology	USD 100/person
	4.2. The enhancement of networking of CSI value chain actors involving rural area SMEs	Grants and technical aid of international organizations (such as USAID), Regional budgets, funds of business entities	The National Association of Agricultural Advisory Services of Ukraine	2022-2032	Performance risk	The Enhanced networking of CSI value chain actors, involving rural area SMEs	The Enhancement of networking of CSI value chain actors	USD 2000/organization

2.1.3 Action Plan for Technology B2: Drought risk assessment and mapping

2.1.3.1 Introduction

Drought risk assessment and mapping technology have been chosen by Ukrainian experts as the winning technology in the first stage of TNA Project in Ukraine in 2019.

Drought's risk assessment and mapping are a very important technology for Ukraine, because the climate of its territory is under the influence of atmospheric large-scale circulatory systems, which lead to long periods with shortage in precipitation, resulting in drought. The increased air temperature and uneven distribution of rainfall, which do not provide an effective accumulation of moisture in the soil caused the increased incidence and intensity of drought. Many researchers have noted that since 2000, there has been a tendency to increase the frequency, intensity and prevalence of seasonal drought. Although drought studies are conducted in Ukraine, they are non-systematic in nature, do not have a clear and functional technological basis and do not prevent the risks and loss of drought in the water and agriculture sectors.

The description of Drought risk assessment and mapping is a key element of drought management, as it helps to identify most of areas at the risk of drought, allowing communities to plan, as well as to prepare for and mitigate possible impacts. Drought's risk is calculated as the probability of negative impact caused by interactions between hazard (the probability of future drought events occurring on the basis of past, current and projected drought conditions), exposure (scale of assets and population in the area) and vulnerability (the probability of assets and population being affected by drought in the area).

This technology has sufficient adaptation and economic benefits.

Adaptation Benefits of the technology:

- technology provides special tools for forecasting drought hazards, preventing and managing risks, which is the basis for developing adaptation plans for communities and sectors of the economy; agriculture, the water sector, and local communities will benefit the most from the use of technology;
- helps to identify the response measures, e.g. water-retaining agricultural practices, water storage, fixing leaks in municipal water supplies, promotion of water-saving techniques in households;
- increases the adaptive capacity in the social sphere;
- increases the adaptive capacity of weather related sectors of economics;
- improves drought mitigation and management in high-risk areas and in consideration of factors that may exacerbate impacts;
- improves water management in drought risk conditions by balancing the availability of water supply between different water users
- - protects vulnerable ecosystems against the effects of drought in high-risk areas where drought impacts are exacerbated by human activity;
- contributes to reduce land degradation and desertification;
- increases the resilience of communities to climate change.
- reduces social vulnerability.

Economic and financial benefits are following:

- the application of drought risk assessment and mapping technology on the basis of modernized drought monitoring system would reduce sufficient crop loss in agriculture;
- resilience of ecosystems is enhanced to promote sustainable economic growth and peoples' livelihoods.
- the potential creation of new jobs to assessment, forecasting, mapping of droughts and development of adaptation plans for communities and sectors of the economy.

Gender Perspective: Drought Risk Assessment and Mapping technology is gender-neutral. Men and women are equally beneficiaries of this technology, whose beneficiaries are men and women equally. At

the same time, the implementation of technology will create additional jobs for women with education in meteorology, hydrology, GIS, etc.

With the help of the functioning of technology, public and private economic entities can timely and fully take into account the risks of drought in all their investments and make their business climate resilient.

The introduction of technology provides vulnerable communities with specific tools for drought's risk prevention and risk management. This increases the adaptive capacity in the social sphere and the resilience of communities to climate change.

Experts estimate the effect of the application of drought risk assessment technology and mapping in Ukraine on the basis of modernized drought monitoring system for preventing crop loss during drought from 950 to 1400 million US dollars annually (Evaluating, 2007). This means that every year Ukraine will additionally benefit from the implementation of this technology only in the agricultural sector at 2.1 -3.1% of GDP.

2.1.3.2 Ambition for the TAP

Climate warming, which is manifested in rising maximum temperatures and the number of hot days, increases the risks in those sectors of the economy that are most dependent on the effects of the weather. The most vulnerable sector of Ukraine's economy is agriculture. The main agricultural capacity of the country is placed in two agroclimatic zones (Steppe and Forest-Steppe) with a level of significant risk due to the fast-changing climate conditions. On average, 70 percent of the country's arable land belongs to these zones. This fact is evidence of significant dependence on the future of agricultural production and national food security from the character of climate changes. According to experts, annual crop loss can be from 10 to 70% due to adverse weather conditions in Ukraine and the main cause of this loss is drought. More than 30% of the areas of the best land has a constant shortage of moisture. In the years of severe drought, the negative deviation of the crop's yield from the trend line is up to 500 kg / ha in Ukraine as a whole, in the steppe regions - up to 1000-1500 kg / ha, there are cases of complete loss of the crop.

Studies conducted for the territory of Ukraine about arid phenomena shows that the maximum number of droughts has been observed in the southern and southwestern regions of Ukraine (Fig.2.5) and a tendency has been observed to increase the recurrence, intensity and prevalence of seasonal drought after 2000. Some of severe droughts have been observed in the last decade (2007, 2010, 2015, 2020) and affected 50–80 % of the country territory (TNA Ukraine, 2019).

Figure.2.5. Partizanskoye reservoir, shallow due to drought in the Crimea. Photo: TASS.

Sourse: https://novayagazeta.ru/articles/2020/10/15/87538-poluostrov-s-peresohshim-gorlom

On the basis of this, we propose in the first stage of technology's implementation to focus efforts in the southern region of Ukraine - the Steppe zone (40% of the county territory or 241,5 thousand square

kilometers), then spread it to the forest-steppe (33% of the country territory or 199,1 thousand square kilometers) and the third stage to the whole country.

In combination with other adaptation technologies, such as climate-smart irrigation (CSI), this could have a significant economic effect not only in agriculture but also in other sectors of Ukraine's economy.

2.1.3.3 Actions and Activities selected for inclusion in the TAP

The summary of barriers and measures to overcome barriers

There are economic, financial barriers, as well as barriers of other nature, described in detail in Adaptation Barrier Analysis and Enabling Framework Report (2020).

The introduction of drought risk assessment and mapping technology is extremely important in Ukraine, but there are a number of barriers identified by the project experts on the way to its implementation. Among them, there are two groups of *very important barriers*:

- The lack of awareness about benefits of technology;
- Inefficient insurance system: the ignorance of benefits of technology
- and *important barriers*:
- High financial costs
- The lack of long-term satellite, hydrometeorological data sets
- The lack of state support of hydrometeorological monitoring
- Imperfect legislative and regulatory framework for technology's implementation
- The lack of experts for modelling and forecasting of floods.

Identified barriers and overcoming measures for drought's risk assessment and mapping technology are presented in the table 2.3.

Table 2.3. Identified barriers and overcoming measures for drought risk assessment and mapping technology

Barriers	Measures
The lack of state support of hydrometeorological monitoring	Increase in the state support of hydrometeorological monitoring, search for investment, financial credits, funding for improving of hydrometeorological service. The implementation of the WMO service delivery strategy. On the basis of the improved quality of services, to implement commercial activities that will generate income, additional to the state provided funding.
The lack of long-term satellite, meteorological and hydrological data sets	Joining the NMHS of Ukraine to the EUMETNET. Creation of satellite, meteorological and hydrological data base
The lack of experts for drought assessment and mapping	The education of experts for modelling and forecasting of floods. The preparation of individual training plans on the basis of recommendations of the WMO Technical Commissions. The Collaboration with EFAS, Delft company (NL) and other for the training of personal. SESU needs to reform job payment system (increasing of monthly payment) to involve skilled people to monitoring department.
High financial costs	The implementation of the WMO service delivery strategy. Search for financial support from donors and funds
Expensive hardware components of technology	Search for collaboration with developers and providers of technical aid possibilities
Expensive licenses for software components, detailed topography maps	Search for collaboration with developers and providers of software components, GIS-technologies, detailed topography maps Purchase annual licenses, creating conditions for sharing of software, maps.
Imperfect legislative and regulatory framework for technology implementation	The development of legislative and regulatory framework for the technology's implementation. The Adoption of the Law

	"Sustainable development strategy of Ukraine by 2030". The Coordination Council on Land Degradation and Desertification should include in the NAP a list of measures for the implementation of drought hazard assessment and mapping technology. The creation of the legal framework for the implementation of satellite monitoring technologies.
The lack of awareness about benefits of technology	Wide awareness campaigns carried out by the authorities, the media and NGOs.
Inefficient insurance system: ignorance of the benefits of technology	Increasing the efficiency of insurance system. Powerful awareness campaign for stakeholders and insurance companies should be undertaken to clarify the benefits of using the technology and to develop regulatory mechanisms for the use of technology. The implementation of bonus-malus-system of insurance.

Actions selected for inclusion in the TAP

Economic and financial action. The main barriers on the way to technology's implementation *are economic and financial barrier*s that are associated with a requirement to modernize the system of hydro-meteorological monitoring. The lack of government funding of NMHS and the difficult economic situation in the country ask for finding non-standard ways to overcome this barrier.

One of the simplest actions is the implementation of the WMO service delivery strategy (WMO, 2014) by NMHSs of Ukraine as a member of the World Meteorological Organization, so it can be a very real mechanism for overcoming financial and economic barriers. The strategy explains the importance of service delivery; defines the four stages of a continuous, cyclic process for developing and delivering services and elements necessary for moving towards a more service-oriented culture; and describes practices to strengthen service delivery. The goal of the Strategy is to help NMHSs to raise standards of service delivery in the provision of products and services to users and customers.

On the basis of improved quality of services, to implement commercial activities that will generate income, additional to the state provided funding.

However, this measure will not be enough to overcome a financial barrier. In order to implement the technology, Ukraine must search for its own budgetary resources and seek support from international financial funds.

EBRD experts have observed (Evaluating, 2007) that the modernization of hydrometeorological monitoring system of Ukraine requires attracting investments of USD 82 million, which will pay off in 2 years, and after 7 years their efficiency exceeds 300%.

The index of effectiveness of the investments needed for the technical modernization and development of the National Hydrometeorological Service of Ukraine ranges from 1: 4.1 to 1: 10.8: each dollar that will be invested in monitoring upgrades can benefit from $ 4 to $ 11 at the expense of the warning losses from natural meteorological phenomena. The modernization of monitoring and use of modern technologies for drought and flood risk assessment and mapping will allow to get considerable economic effect in different sectors of the economy, which depend on the weather.

There are currently no clear instructions in the "Barrier Guidebook" (2016), nor in "The Economics of Adaptation. Concepts, Methods and Examples" for the economic calculations of non-marketing technologies, so the cost of implementing it in Ukraine can be fulfilled only approximately.

For example, the application of drought's risk assessment and mapping technology on the basis of modernized monitoring system would reduce crop losses in droughts annually by $ 950 million to $ 1400 million (Evaluating,2007). This means that every year Ukraine will additionally benefit from the implementation of this technology in the agricultural sector at 2.1 -3.1% of GDP.

Non-financial action. Full access to EUMETNET space monitoring databases. EUMETNET offers a framework for EUMETNET Member NMHSs to collaborate on activities in the field of Observing Systems. Ukraine is the Associate member of EU and can join the organization and gain an access to space monitoring information. It will be an effective measure that will help to overcome operational quality and efficiency's gaps/ barriers. This will bring the whole work and system to new standards and will broaden

an access to new resources and collaboration. Firstly, the rapid acquisition of environmental monitoring data on the of satellite technologies will allow the rapid assessment of soil moisture, the moisture content in vegetation and soil in large areas and therefore there will be a warning in advance for the need of irrigation or other measures in order to prevent drought. Secondly, for drought-affected areas on the basis of satellite data, it is possible to quickly map the area of crop loss and to estimate the damage caused by the drought as accurately as possible, as well as the amount of assistance needed to farmers.

Overcoming of the legal barrier. It is necessary to create a regulatory framework for the implementation of technology. Legislative changes are required to create a favorable climate for overcoming financial and bureaucratic obstacles to the implementation of appropriate technology, and oblige stakeholders and insurance companies to use technology in order to avoid economic losses from doing business and maximizing profits.

The Coordination Council on Land Degradation and Desertification should include in the NAP a list of measures for the implementation of drought hazard assessment and mapping technology, its dissemination and exploitation of results and the creation of a regulatory framework to overcome financial and bureaucratic obstacles to its implementation.

Overcoming this barrier could be facilitated by the adoption of the Law "Sustainable development strategy of Ukraine by 2030", whose project was developed in 2018. This law provides for the creation of systems of balanced production of food and the introduction of methods of agriculture that allow to increase the sustainability and productivity and increase production's volumes, promote the conservation of ecosystems, strengthen the ability to adapt to climate change, extreme weather events, drought, flood and gradually improve the quality of land and soil.

The implementation of drought hazard assessment and mapping technology in Ukraine needs to create a legal framework for the implementation of satellite monitoring technologies.

Disseminating information about the benefits of technology will also contribute to its dissemination and efficiency. Removing the barrier requires awareness campaigns carried out by authorities, the media and NGOs. In order to remove the barrier, it is necessary to intensify the campaign to highlight the activities of the hydro-meteorological service, types of forecasting and warning opportunities of the phenomena, the benefits of using early forecast, government, business and the media.

A shortage of qualified personnel can be corrected by the ***training of employees in the middle system of vocational education and higher education*** is observed. The provision of experts in the field should be made by the higher school, retraining and advanced training of specialized organization or investors. The training of such specialists can be organized in Ukrainian universities, where there are a sufficient number of highly qualified teachers from different fields of knowledge, a material and technical base for training.

On the basis of existing competencies of NMHS staff members, areas requiring additional training shall be identified and individual training plans shall be compiled. It is proposed that plans follow recommendations for the competence's development provided by the WMO Technical Commissions. The learning success shall be evaluated according to the WMO competency assessment.

SESU needs to reform job payment system (increasing of monthly payment) to involve skilled people to monitoring department.

Increasing of efficiency of insurance system. Following the modernization of the hydrometeorological monitoring service and the implementation of the flood risk assessment and mapping technology, a powerful awareness campaign should be undertaken for stakeholders and insurance companies in order to clarify the benefits of using the technology and to develop regulatory mechanisms for the use of technology by stakeholders and insurance companies.

Insurance companies should be able to adequately assess their own benefits from using drought's hazard assessment and mapping technology for the development and implementation of modern insurance approaches on the base of climatic indexes. For example, the current crop insurance system can be used for drought risks in Austria (Agricultural,2017).

This system is characterized by the dependence of insurance rate on the crops' sensitivity to insurable risks (drought damage) and the local hazard probability (e.g. the chance of drought) and exposure. Tariffs are calculated separately for each municipality. In subsequent years, premiums are determined by a bonus-

malus-system on the basis of the loss ratio of the preceding 10 years of insurance. This means if compensation was paid in the previous period of insurance, the premium may increase up to 20% of the basic premium. If the loss ratio falls below the actual premium level, the premium is lowered automatically. The lowest premium level (60% of the basic premium) can be reached after a minimum of three years of insurance. Certain on-farm risk's reduction measures are considered in the premium calculation. The same reference location that serves as a reference for hail risk is used for the drought's index. For the premiums of drought index, the bonus-malus-system is used to calculate premiums independently from other insured risks.

Activities identified for the implementation of selected actions

Before implementing the technology, it is necessary to ***conduct climate impact assessment in the water sector of Ukraine on a modern scientific and methodological basis. This will give the impact with climatic risks, vulnerabilities and identification of adaptation options.***

A shortage of qualified personnel for the implementation of technology can be corrected by training employees in the middle system of vocational education and higher education is observed. The provision of experts in the field should be made by the higher school, retraining and the advanced training of specialized organization or investors. The training of such specialists can be organized in Ukrainian universities, where there are a sufficient number of highly qualified teachers from different fields of knowledge and a material and technical base for training. On the basis of existing competencies of NMHS staff members, areas requiring additional training shall be identified and individual training plans shall be compiled. It is proposed that plans follow recommendations for competence development provided by the WMO Technical Commissions. The learning success shall be evaluated according to the WMO competency assessment.

The development of special funding program to implement the technology, particularly to the establishment of Drought Monitoring and Water Scarcity Center, to conduct Research and Training and to purchase the necessary equipment.

Reforming the remuneration system to motivate highly qualified specialists to work in monitoring units. SESU is required to reform the payment system of job (increase in monthly payment) to involve skilled specialists with the skills of IT and GIS technologies, processing of big data, modeling, mapping.

Such a centre can be established jointly by the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR) and the State Emergency Service of Ukraine (SESU) with the partial involvement of the state budget and international environmental investments.

Objectives of the center establishment: combining advanced technologies and highly qualified and well-motivated specialists with IT and GIS technology skills, big data processing, modeling, forecasting, mapping within the Center. They can ensure the success of technology implementation and operation in Ukraine. The Center may regularly provide public and private stakeholders with different information on the dangers of drought.

The development of effective insurance legislation that would take into account the benefits of using technology. It is possible to use an analogue: the insurance system for drought risk in Austria. It is also necessary to create a legal framework for the use of satellite information for drought monitoring in Ukraine.

Wide awareness campaigns are required to be carried out by authorities, the media and NGOs. Ukrainian stakeholders don't have enought information about the benefits of technology. The lack of information about the benefits of technology among insurance companies is the reason of inefficient insurance system in Ukraine and the ignorance of the benefits of technology. Following the modernization of the hydrometeorological monitoring service and the implementation of the drought's risk assessment and mapping technology, a powerful awareness campaign for stakeholders and insurance companies should be undertaken to clarify the benefits of using the technology and to develop regulatory mechanisms for the use of technology by stakeholders and insurance companies.

Actions to be implemented as Project Ideas

The main project idea for drought's risk assessment and mapping technology is an establishment of the Drought's monitoring and water scarcity Centre. Such a Centre can be established jointly by the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR) and the State Emergency Service of Ukraine (SESU) with the partial involvement of the state budget and international environmental investments.

The combination of advanced technologies, high skilled and good motivated specialists with skills of IT and GIS technologies, processing of big data, modelling, mapping in the frame of the Drought's monitoring and water scarcity centre could ensure the success of the implementation and operation of the technology in Ukraine. The center could provide state and private stakeholders information on drought risks and water availability on a regular basis.

2.1.3.4 Stakeholders and Timeline for the implementation of TAP

Main stakeholders of technology implementation are:

- for organizational measures, solving funding issues: the Ministry of Finance of Ukraine, the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR), the State Emergency Service of Ukraine (SESU);
- for the development of scientific and methodological base of the Drought's monitoring and water scarcity centre: The Institute of Water problems and reclamation, Ukrainian hydrometeorological Institute;
- the preparation of experts in drought risk assessment and mapping: the Ministry of Education and Science of Ukraine, the Taras Shevchenko National University of Kyiv, Odesa state ecological university;
- the development of special funding program: the Institute of Economics of NASU, the Ministry of Finance of Ukraine;
- reform in the remuneration system the State Emergency Service of Ukraine (SESU): the Ministry of the Finance of Ukraine;
- - the development of effective insurance legislation: the Parliament of Ukraine, the National Association of Insurers of Ukraine (NAIU), Ukrainian Federation on Insurance, the National Association of Agricultural Advisory Services of Ukraine;
- to create a legal framework for the use of satellite information for drought monitoring in Ukraine: the Parliament of Ukraine, the State Space Agency of Ukraine, the Space research Institute of NASU;
- awareness campaigns: state authorities, National Ecological Centre, the National Association of Agricultural Advisory Services, media and other NGOs.

All the suggested activities can be done simultaneously, some of them are going to start as early as in 2022. Due to the fact that some preliminary research was already in place before 2020, the full-scale studies might be conducted in 2022-2024.

Preparations for the establishment of a Drought Monitoring and Water Scarcity Center should begin as soon as possible. The Ministry of Finance of Ukraine, the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR), and the State Emergency Service of Ukraine (SESU) must address the issues of organization and financing in the first place.

Training of specialists should begin simultaneously with the creation of the organizational structure of the center, the formation of its management and staff, addressing issues of logistics.

Immediately at the initiative of the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR), they should begin work with the Parliament of Ukraine on the legislation's development.

The overall list of stakeholders has been provided in Annex I.

2.1.3.5 The Estimation of Resources Needed for Action and Activities

The fact is given that financing public goods has its own traits, we consider appropriate non-concessional financing form and international financial institutions (IFIs). The latter provide loans to countries in transition on better than market terms[21]. Even though the particular rates for financing is unknown, let alone interest in IFIs, we consider several options (with different interest rates – 4%, 6% and 8%) of amount of finance needed for technology of Drought's risk assessment and mapping.

TAP overview table in section 2.1.4.7 indicates the following expenditures for the Technology:

- Research – USD 200,000;
- The training of high skilled experts for the implementation and functioning of technology - USD 500,000
- The implementation of the technology in arid zone of Ukraine - USD 5,000,000;
- Reform in the remuneration system of the State Emergency Service of Ukraine - USD 2,000,000/year
- The establishment of a Drought Monitoring and Water Scarcity Center - USD 3,000,000;
- The spread of information about technology - USD100,000;

Thus, overall cost of technology is USD 32.8 million.

Below, we calculate two options: the payment of interest in case of "conventional debt" and future cost of investment/loan. In order to do so, we assume that the money is lent in two installments: USD 15.95 million in 2022 (for time period 2022-2026), and USD 16.85 in 2027 (for time period 2027-2033), as indicated in Table 2.4.

Table 2.4. The disbursement of financing of Drought risk assessment and mapping in 2022-2033, USD million

	Research	**Training**	**Software/ Hardware**	**Remuneration SESU**	**Drought Monitoring and Water Scarcity Center**	**Awarenes s raising**	**Subtotals**
2022	0.1	0.3	4	2	1.5	0.05	7.95
2023				2			2
2024				2			2
2025				2			2
2026				2			2
2027	0.1	0.2	1	2	1.5	0.05	4.85
2028				2			2
2029				2			2
2030				2			2
2031				2			2
2032				2			2
2033				2			2

For conventional debt calculations, the following assumptions were made on annual payment of interest:

- from 2022 to 2026 inclusive – the payment of interest on the first installment (USD 15.95 million);

[21] https://www.cbd.int/financial/interdevinno/sweden-interdev.pdf

- from 2027 to 2036 inclusive – the payment of interest on both installments (USD 15.95 + USD 16.85 million);
- from 2037 to 2041 inclusive – the payment of interest only on the second installments (USD 16.85 million).

Table 2.5. summarizes results.

Table 2.5. The amount of money needed for conventional debt

	4%			6%			8%		
	Debt service	Repyament of the prinicpal	Total paymen t	Debt service	Repyamen t of the prinicpal	Total payment	Debt service	Repyament of the prinicpal	Total paymen t
2022	0.638		0.638	0.957		0.957	1.276		1.276
2023	0.638		0.638	0.957		0.957	1.276		1.276
2024	0.638		0.638	0.957		0.957	1.276		1.276
2025	0.638		0.638	0.957		0.957	1.276		1.276
2026	0.638		0.638	0.957		0.957	1.276		1.276
2027	1.312		1.312	1.968		1.968	2.624		2.624
2028	1.312		1.312	1.968		1.968	2.624		2.624
2029	1.312		1.312	1.968		1.968	2.624		2.624
2030	1.312		1.312	1.968		1.968	2.624		2.624
2031	1.312		1.312	1.968		1.968	2.624		2.624
2032	1.312		1.312	1.968		1.968	2.624		2.624
2033	1.312		1.312	1.968		1.968	2.624		2.624
2034	1.312		1.312	1.968		1.968	2.624		2.624
2035	1.312		1.312	1.968		1.968	2.624		2.624
2036	1.312	15.95	17.262	1.968	15.95	17.918	2.624	15.95	18.574
2037	0.674		0.674	1.011		1.011	1.348		1.348
2038	0.674		0.674	1.011		1.011	1.348		1.348
2039	0.674		0.674	1.011		1.011	1.348		1.348
2040	0.674		0.674	1.011		1.011	1.348		1.348
2041	0.674	16.85	17.524	1.011	16.85	17.861	1.348	16.85	18.198
Tota l	**19.68**	**32.8**	**52.48**	**29.52**	**32.8**	**62.32**	**39.36**	**32.8**	**72.16**

Table 2.5. indicates that USD 32.8 million needed for technology of Drought risk assessment and mapping. being attracted in 2022 until 2041, may turn into USD 52.48-72.16 depending on the interest rate.

In order to calculate the future cost of investment/loan, we assumed that the loan is to be provided for 19 years at different interest rates (4%, 6%, 8%). In order to do so, we calculate the future cost of investments for each installment by using the array function and then summarize them in Table 2.6.

Table 2.6. The future sum of loan under different interest rates, USD million

	Interest rates		
	4%	6%	8%

I installment	28.73	38.23	50.60
II installment	30.35	40.38	53.45
Total	59.07	78.61	104.05

Table 2.5. indicates that the future sum of loan/investments of USD 32.8 million provided for 19 years may turn into USD 59.07-104.05 million depending on the interest rate.

Having given the high efficiency of investing financial resources in the development of hydrometeorological monitoring, it is also possible to offer an alternative to the partial financing of technology from the state budget of Ukraine by redistributing certain budget items from the State Emergency Service of Ukraine.

As it is already mentioned above each dollar that will be invested in the drought monitoring's upgrades can benefit from $ 4 to $ 11 at the expense of the warning losses from natural meteorological phenomena (Evaluating, 2007). The modernization of monitoring and use of modern technologies for drought risk assessment and mapping will allow to get considerable economic effect in different sectors of the economy, which depend on the weather. For example, the application of drought's risk assessment and mapping technology on the basis of modernized monitoring system would reduce crop losses in droughts annually by $ 950 million to $ 1400 million (Evaluating,2007). This means that every year Ukraine will additionally benefit from the implementation of this technology in the agricultural sector at 2.1 -3.1% of GDP.

Part of the state budget financing can be used to create the center. The state budget of Ukraine provides in 2021 only 30 million USD for National Meteorological and Hydrological Service (NMHS), of which 78% are provided for a salary and only 357 thousand dollars (1.6%) are provided for the development of the monitoring system (Rozpodil,2021). At the same time, $ 464 million are allocated for civil protection of the population from the effects of droughts, fires caused by droughts etc. When planning the budget for the coming years, it may be worth using the part of the civil protection budget to support drought monitoring system in order to detect them early and prevent from many of the negative effects of droughts, including fires in arid regions of the country. The use of the drought's risk assessment and mapping technology could allow the State Emergency Service of Ukraine (SESU) to reduce the cost of dealing with the effects of drought and compensate for the redistribution of funds to finance the monitoring system.

The financing for the training of specialists can be carried out both by the state order and with the attractive means of private companies for the potential stakeholders of technology which activity depends on weather. The state budget of Ukraine provides in 2021 about 32 million USD for the preparation of civil defense specialists in the educational institutions of the SESU (Rozpodil, 2021). The partial redistribution of these funds could help to organize specialists to monitor and prevent from drought risks.

2.1.3.6 Management Planning

The potential risks could be of several types: cost, scheduling and performance.

Scheduling risks could be applicable to the research stage of TAP, because technology implementation needs a modern assessment of the vulnerability of the water sector to droughts and performing of vulnerable area's ranking.

Scheduling risk is very likely and expected for the drought expert's preparation due to the long period of approving process of educational program by the Ministry of Education and Science of Ukraine and National Agency for Higher Education Quality Assurance.

For the development of special funding program and establishment of a Drought Monitoring system and Water Scarcity Center, there are also such risks.

Cost risk is the greatest risk in implementing a TAP (IFIs). The organization of financial support from international financial institutions is a difficult process and depends on both parties: donor institutions and the recipient state. Investments into the implementation of technology may occur slower than expected. Costs may appear to be higher than initially expected due to rapidly changing market conditions and, in some cases, unexpected transaction costs.

The focus on the reformatting SESU state budget funding to partially support the technology's implementation process may not be due to opposition from officials who distribute and use funds to overcome the effects of drought and fire.

Financial risks may threaten the development of a special financing program and the establishment of a Drought Monitoring system and Water Scarcity Center. Non-reforming of the remuneration system of the State Emergency Service of Ukraine is also a financial risk due to lack of funding that can exacerbate the shortage of highly qualified personnel for the technology of the drought monitoring system and assessment.

Performance risk exists for the Development of special funding program, the Establishment of a Drought Monitoring and Water Scarcity Center, the development of effective insurance legislation, create a legal framework for the use of satellite information for drought monitoring system in Ukraine, with the spread of information about technology.

Next Steps

Simultaneously with the search for financial resources for the implementation of technology, it is necessary to create a regulatory framework for its implementation. Legislative changes are needed to create a favorable climate for overcoming financial and bureaucratic obstacles to the implementation of appropriate technology and oblige stakeholders and insurance companies to use technology in order to avoid economic losses from doing business and maximizing profits.

2.1.3.7 TAP overview table

Sector	Water							
Sub-sector								
Technology	Drought risk assessment and mapping							
Ambition	**The ambition of implementation of technology:** first stage - 40% of the county territory, steppe zone by 2027; second stage - 33% of the country territory, forest-steppe zone by 2030; whole country **by 2033**.							
Benefits	**Adaptation Benefits of the technology**: - technology provides special tools for forecasting drought hazards, preventing and managing risks, which is the basis for developing adaptation plans for communities and sectors of the economy; - helps to identify the response measures, e.g. water-retaining agricultural practices, water storage, fixing leaks in municipal water supplies, promotion of water-saving techniques in households; - increase the adaptive capacity in the social sphere, including that of vulnerable groups; - increase the adaptive capacity of weather related sectors of economics; - improves drought mitigation and management in high-risk areas and in consideration of factors that may exacerbate impacts; - improving water management in drought risk conditions by balancing the availability of water supply between different water users, particularly rural area women - protects vulnerable ecosystems against the effects of drought in high-risk areas where drought impacts are exacerbated by human activity; - contributes to reduce land degradation and desertification; - increase the resilience of communities to climate change, including those from remote areas . - reducing social vulnerability and promoting inclusive resilience **Economic and financial benefits are following:** - the application of drought risk assessment and mapping technology on the basis of modernized drought monitoring system would reduce sufficient crop loss in agriculture; - resilience of ecosystems is enhanced to promote sustainable economic growth and peoples' livelihoods. - the potential creation of new jobs for both women and men to assessment, forecasting, mapping of droughts and development of adaptation plans for communities and sectors of the economy.							
Action	**Activities to be implemented**	**The sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Indicators for the Monitoring of implementation**	**Budget per activity**
Action 1. Research of the vulnerability of	1.1. Research on a modern scientific and	The Ministry of Environmental Protection and	**Institute for Water Problems and Melioration**	2022-2023	Scheduling risk Cost risk	Performed assessment	Conducted study on water availability for irrigation in the medium	USD 200 000

the water sector to droughts	methodological basis of gender-sensitive vulnerability of the water sector to droughts and perform ranking of vulnerable areas in the time sequence of water stress for the phased implementation of adaptation measures.	Natural Resources of Ukraine	**Problems, NAASU** Ukrainian Hydrometeorological Institute, National Academy of Sciences of Ukraine, State Service of Emergencies of Ukraine				and long-run	
Action 2. Training of drought experts	2.1. The training of specialists to acquire high skills for implementation of technology, form which at least 51% are women	The Ministry of Environmental Protection and Natural Resources of Ukraine, the State Emergency Service of Ukraine (SESU), Ministry of Education and Science of Ukraine	State Emergency Service of Ukraine (SESU), Ministry of Education and Science of Ukraine, **Taras Shevchenko National University of Kyiv, Odesa state ecological university**	2022-2025	Scheduling risk due long period of approving process of educational program by the Ministry of Education and Science of Ukraine (about 1 year) Cost risk	Evaluating the prepared experts according to the WMO competency assessment	Number and quality of prepared experts (gender - disaggregated)	500 000 USD
Action 3. Financial measure	3.1. The development of special funding program	The Ministry of Finance of Ukraine;	The Ministry of Finance of Ukraine, **Ministry of Environmental Protection and Natural Resources of Ukraine**, State Emergency Service of Ukraine	2022-2024	Cost risk Scheduling risk Performance risk	Developed special Funding Program, aimed at provision of long-term soft loans.	The implementation of the technology in arid zone of Ukraine , addressing the needs of all members of society, including those of vulnerable groups.	USD 5 million

	3.2. Reform in theremuneration system the State Emergency Service of Ukraine (SESU), considering the needs of both women and men	The Ministry of the Finance of Ukraine;	The Ministry of the Finance of Ukraine, **State Emergency Service of Ukraine**	2022	Cost risk	Reforming in the remuneration system, enabling financial frame- work for motivation of high skilled experts	Number of high skilled experts (gender disaggregated) in Drought Monitoring and Water Scarcity Center	USD 2 million/year
Action 4. Organisation measure	4.1. The Establishment of a Drought Monitoring and Water Scarcity Center	The Ministry of Finance of Ukraine, the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR), and the State Emergency Service of Ukraine (SES)	**The Ministry of Environmental Protection and Natural Resources of Ukraine**, State Emergency Service of Ukraine	2022-2023	Cost risks Scheduling risk Performance risk	The establishment of a Drought Monitoring and Water Scarcity Center	The Functioning of Monitoring and Water Scarcity Center	USD 3 million
Action 5. Economic and Legislative Stimuli	5.1. The development of effective insurance legislation, addressing the needs of all members of rural communities	Insurance Associations	The National Association of Insurers of Ukraine (NAIU), Ukrainian Federation on Insurance, National National Association of Agricultural Advisory Services of Ukraine	2022	Performance risk	Effective insurance legislation	Effective insurance legislation that uses of the benefits of the drought risk assessment and mapping technology, available for all members of society, including vulnerable groups form rural area	USD 30 000
	5.2. Create a legal framework for the use of satellite information for drought monitoring in	The State Space Agency of Ukraine	Parlament of Ukraine, **State Space Agency of Ukraine,** Space research Institute of NASU	2022	Performance risk	Created legal framework for the use of satellite information	Legal using of satellite information for the drought risk assessment and mapping technology	USD 20 000

	Ukraine							
<u>Action 6.</u> Awareness rising and knowledge sharing	6.1 The spread of information about technology	Grants and technical aid of international organizations (such as USAID) available for both women and men. Regional budgets, funds of business entities	**National Ecological Centre**, National Association of Agricultural Advisory Services of Ukraine, Ukrainian Meteorological Society, Ukrainian Geographical Society	2022-2032	Performance risk		Technology is known and recognized drought assessment technology, for the benefits of all in need members of society.	100000 USD

2.1.4 Action Plan for Technology B3: Flood hazard assessment and mapping

2.1.4.1 Introduction

Flood hazard assessment and mapping technology have been chosen by Ukrainian experts as the winning technology in the first stage of TNA Project in Ukraine in 2019.

Climate change is manifested in a significant change in the hydrological regime of water bodies now and in future. The most dangerous manifestations of the change in the hydrological regime are catastrophic floods and flash floods. The regional manifestation of these phenomena is wide enough in Ukraine. This is primarily the Carpathian region Transcarpathia (Transcarpathian region), Prykarpattya (Lviv, Ivano-Frankivsk and Chernivtsi regions). The territory of the Carpathians (Tisza, Dniester (Fig.2.6) and Prut basins) is one of the most flood-prone regions in Europe. Floods in the Carpathians are natural phenomena common to this territory. They are determined here by the frequency, intensity of development and simultaneous spread on a large area (up to 10-30 thousand km^2), often with significant destructive consequences.

Figure 2.6. The consequences of the catastrophic flood in the Dniester River near the town of Halych on June 24, 2020. The solar power plant was shut down.

Source: https://www.youtube.com/watch?v=dIX5i8dPZYw

In the last 20 years, in Ukraine, significant floods that have led to emergencies have been observed in 1995, 1998, 2001, 2008, 2010, 2017, 2020.

Only from 2000 year more than 280 emergency flood events were in Ukraine: loss from flood – 6 203 750 ₴ or 228 079 €; expenses for liquidation flood events with adverse consequences – 65 419 925 ₴ or 2 405 144 € (Danko at al., 2019). Losses from the 2020 flood are the largest and amount to 5 billion (Naibilsh masshtabni pavodky v istorii Ukrainy, 2020) The recurrence of high floods in the Transcarpathian region and their magnitude will increase by the end of this century (Didovets at al., 2019). One of the modern technologies of adaptation to extreme manifestations of climate change in the water sector is the technology of flood hazard assessment and mapping. Its use can help to prevent and reduce losses in the Ukrainian economy.

This technology has sufficient environmental and socio-economic benefits.

Climate change mitigation/adaptation benefits of technology: helps to increase readiness to floods. Reduces the vulnerability of climate during timely preparation of adaptation measures and the mitigation of possible impacts.

Benefits to economic / social and environmental development:

- the potential of decreasing losses and damage caused by flood;
- increase in preparedness to floods;
- decrease in costs needed for dealing with their consequences;
- creates preconditions for the development of insurance business;
- increase in preparedness to floods leads to smaller negative environmental impact, which is especially important in case of availability of landfills, nuclear power plants etc;
- -the protection of population and companies through improved planning and increased preparedness.

The creation of a visual product that helps to understand one of the displays of climate change.

Assuming that flood damage in Ukraine during 1995-2010 amounted to $ 7.5 billion, 1% reduction in flood damage, which could be due to the introduction of Flood's Risk Assessment and Mapping, could help to save $ 75 million for the year in which the flood will occur. (TNA UA REPORT, 2020).

2.1.4.2 Ambition for the TAP

The impact of harmful effects of flood is observed in Ukraine in the area of 165000 km2 (Comprehensive program, 2006). This is almost 30% of the country. Although during rain and melting snow, an increase of water flow of rivers and the harmful effects of water are observed in all river basins of Ukraine.

Losses from flooding of settlements were estimated at $ 1,000 per hectare (at 2005 prices). In terms of the maximum possible area of flooding (165,000 km2), this will amount to 16.5 billion dollars. The cost of flood control measures, taking into account the capabilities of the state budget of Ukraine, was estimated at $ 415 million (Comprehensive program, 2006). The implementation of this program in full could provide annual savings for the state budget of $ 80 million.

Surface (river) flooding is prevailing type of flooding in Ukraine. Flood-prone regions of Ukraine are located in the catchments of different Carpathian inflows in the Dniester (8.7% of the country territory), in the area of some Danube tributaries (5,3%) as well tributaries of the Prypyat (20%), Desna (15%), catchment of West Bug (2,1%).

However, the most dangerous flood regions are the river basins of Transcarpathia (about 32.0 thousand km2) and Precarpathian (52.5 thousand km2). For example, the damage caused by the last catastrophic flood in the Dniester basin in June 2020 is estimated at UAH 4 billion. ($ 142.9 million). Therefore, the implementation of technology should primarily take place in these regions. In the case of effective use of this technology, in combination with other flood control measures, flood losses could be reduced by at least 30-50%. And moreover, the efficiency of the technology in 1% could save for the state budget of Ukraine (in case of flood 2020 in the Dniester basin) 1, 4 million US dollars, which is more than enough for the annual maintenance of our proposed Center for Flood Monitoring and Prevention.

2.1.4.3 Actions and Activities selected for inclusion in the TAP

The summary of barriers and measures to overcome barriers

There are economic, financial barriers, as well as barriers of other nature, described in detail in Adaptation Barrier Analysis and Enabling Framework Report (2020).

Since 2000, more than 280 emergency floods have occurred in Ukraine. Due to climate change, the frequency and severity of floods are increasing. The implementation of the technology for flood risk assessment and mapping is very important for Ukraine. Its implementation can have significant socio-economic benefits, if a number of barriers are to be overcome.

Very important barriers for implementation according to project experts are:

- The lack of awareness about the benefits of technology;
- The lack of long-term satellite, meteorological and hydrological data sets;
- Inefficient insurance system: ignorance of the benefits of technology.

Important barriers are:

- The lack of state support of hydrometeorological monitoring; measuring equipment, gauges and data transferring and collecting instruments have deficient technology;
- High financial costs;
- The lack of experts for modelling and forecasting of floods;
- Expensive hardware components of technology.

Identified barriers and overcoming measures for flood hazard assessment and mapping technology are presented in the Table 2.7.

Table 2.7. Identified barriers and overcoming measures for flood hazard assessment and mapping technology

Barriers	**Measures**
The lack of state support for hydrometeorological monitoring; measuring equipment, gauges and data transferring and collecting instruments have deficient technology	Increase in the state support of hydrometeorological monitoring, search for investment, financial credits, funding for improving of hydrometeorological service. The implementation of the WMO service delivery strategy. On the basis of the improved quality of services, to implement commercial activities that will generate income, additional to the state provided funding.
The lack of long-term satellite, meteorological and hydrological data sets	Joining the NMHS of Ukraine to the EUMETNET. To strengthen Collaboration with EFAS. The creation of satellite, meteorological and hydrological data base
The lack of experts for modelling and forecasting of floods	The education of experts for modelling and forecasting of floods. The preparing of individual training plans on the basis of the recommendations of the WMO Technical Commissions. Collaboration with EFAS, Delft company (NL) and other to training of personal. SESU needs to reform the job payment system (increasing of monthly payment) to involve skilled people to monitoring department.
High financial costs	The implementation of the WMO service delivery strategy. Search for financial support from donors and funds
The expensive hardware components of technology	Search for technical aid possibilities
Expensive licenses for software components, detailed topographic maps	Collaboration with EFAS, Delft company (NL) to access to innovative technologies for flood assessment and mapping. NMHS of Ukraine can use opportunity to sign the license agreement with Delft company to use free some Delft products, especially Delft-FEWS operationally.

Imperfect legislative and regulatory framework for technology implementation	The development of legislative and regulatory framework for technology implementation: 1. The development of national regulatory framework for the creation of flood risk management plan (FRMP), and preliminary flood risks assessment. 2. The creation of legal framework for the implementation of satellite monitoring technologies.
The lack of awareness about benefits of technology	Wide awareness campaigns are carried out by the authorities, the media and NGOs.

Actions selected for inclusion in the TAP

Economic and financial action.

The economic and financial barriers are similar to the drought's risk assessment and mapping technology barriers in order to implement flood's hazard assessment and mapping technology described in detail in Section 2.1.3.3.

The main barriers on the way to technology implementation *are economic and financial barrier*s that are associated with the need to modernize the system of hydro-meteorological monitoring system. Most of river basins are equipped with insufficient gauging stations for rainfall, water level and streamflow observations. The measuring equipment, gauges and data transferring instruments have deficient technology. A significant drawback of the Hydrometeorological Monitoring Service in Ukraine is the practically lack of automated technical complexes for measuring meteorological and hydrological parameters necessary for flood's assessment and mapping. The level of use of remote means is extremely low for obtaining information, there are practically no modern Doppler radars, the insufficient level of use of information for meteorological satellites. Using remotely-sensed data for real-time flood forecast requires high-performance computing resources for data management and integration, model simulation and further processing which will, however, necessitate more investments in the implementation of this technology. For instance, the detection of flash floods remains a major challenge even though this kind of flood can be detected by using real-time rainfall's observation (e.g. meteorological radars) and real-time upstream water level information. The technology is not available everywhere, not even in few developed countries. Another common technical issue is the performance of models used for flood forecast. In operational flood forecast and warning, modeling related challenges involve in improving the accuracy of forecasts by accounting for uncertainties in input data, modeling approaches, model simplifications and the output's quantification. These factors cause the lag of Ukraine's hydrometeorological service from the services of the leading countries in the world and deteriorate the quality of the observation data in terms of the implementation of flood risk assessment and mapping this phenomenon.

The lack of government funding of NMHS and the difficult economic situation in the country requires to find non-standard ways to overcome this barrier.

One of the simplest actions is the implementation of the WMO service delivery strategy (WMO, 2014) by NMHSs of Ukraine as a member of the World Meteorological Organization, so it can be a very real mechanism for overcoming financial and economic barriers. The strategy explains the importance of service delivery; defines the four stages of a continuous cyclic process for developing and delivering services and the elements necessary step for moving towards a more service-oriented culture; and describes practices to strengthen service delivery. The goal of the Strategy is to help NMHSs to raise the standards of service delivery in the provision of products and services to users and customers.

On the basis of the improved quality of services, to implement commercial activities that will generate income, additional to the state for provided funding.

However, this measure will not be enough to overcome a financial barrier. To implement the technology, Ukraine must search for its own budgetary resources and seek support from international financial funds.

IBRD experts have established (Evaluating, 2007) that modernization of hydrometeorological monitoring of Ukraine requires attracting investments of USD 82 million, which will pay off in 2 years, and after 7 years their efficiency exceeds 300%.

The index of effectiveness of the investments needed for the technical modernization and development of the National Hydrometeorological Service of Ukraine ranges from 1: 4.1 to 1: 10.8: each dollar that will be invested in monitoring upgrades can benefit from $ 4 to $ 11 at the expense of the warning losses from natural meteorological phenomena. The modernization of monitoring and use of modern technologies for drought and flood risk assessment and mapping will allow to get considerable economic effect in different sectors of the economy, which depend on the weather.

Non-financial action.

The lack of long-term satellite, meteorological and hydrological data sets, spatial data for mapping. There is the inadequate and poor management of hydrological networks and/or temporary shut-down due to equipment damage, weather-related or financial issues impact subsequent challenges such as discrete and short records of data, poor data quality and modeling related uncertainty. Multi-decadal continuous data records are required for producing robust flood models, model forecasts and hazard map preparation. The availability and coverage of various ground are insufficient as well as remote sensing data such as satellite imagery and radar-based data. An access in real-time or near real-time is limited to satellite information. Delay in the receipt of information from satellite "Sentinel" reaches 5 days, and from satellite "Landsat" reaches 14-16 days. There is inadequate hydrological network's coverage for monitoring of floods i.e., un-gauged or poorly gauged sites, adds to the inaccuracy of flood assessment. The acquisition of spatial data required for flood forecasting and risk mapping are problematic, such as land-use, population distribution, or soil moisture, as some of these data sets are not updated regularly enough to be compatible with flood forecaster's requirements. Spatial data products, although accessible freely and available in near real-time, are under-utilised by technology; ground observations remain the common practice to detect floods. Using remotely-sensed data for real-time flood forecast requires high-performance computing resources for data management and integration, model simulation and further processing and mapping.

Very useful action for the successful implementation of technology is full access to EUMETNET space monitoring databases of Ukrainian NMHSs. EUMETNET offers a framework for EUMETNET Member NMHSs to collaborate on activities in the field of Observing Systems. Ukraine is the Associate member of EU and can join the organization and gain an access to space monitoring information. It will be an effective measure that will help to overcome operational quality and efficiency gaps/ barriers. This will bring the whole work and system to new standards and will broaden an access to new resources and collaboration.

To increase the cooperation of NMHS of Ukraine with the European Flood Awareness System (EFAS). This will help to overcome the barrier of receiving satellite, meteorological and hydrological data and lack of flood forecasting personnel. NMHS of Ukraine can use an opportunity to sign the license agreement with Delft company to use free some Delft products, especially Delft-FEWS operationally.

Overcoming the legal barrier. It is necessary to create a regulatory framework for the implementation of technology. Legislative changes are needed to create a favorable climate for overcoming financial and bureaucratic obstacles to the implementation of appropriate technology and oblige stakeholders and insurance companies to use technology to avoid economic losses from doing business and maximizing profits. An important legislative barrier to technology implementation is the lack of sufficient regulatory framework. The implementation of Directive 2007/60 / EC (Flood Directive) in Ukraine is a part of a global reform of the implementation for integrated water resource management on the basis of the basin principle. In implementation process, there were changes in Ukrainian Legislations (changes of Water Code of Ukraine); the identification of the appropriate competent authority (the Ministry of Interior of Ukraine, The State Emergency Service of Ukraine); developed normative acts (the Methods of preliminary flood's risks assessment (PFRA). Next steps of implementation are the creation of methods

for the development of flood risk maps and flood hazard maps, template of flood's risk management plan (FRMP), preliminary flood's risks assessment (for 9 River basin districts of Ukraine (RBD).

There are also legislative barriers to the implementation of satellite monitoring technologies, which are an integral part of flood hazard assessment technology due to the lack of a legal framework in Ukraine for such work (Shelestov at al., 2017).

An important non-financial barrier is human potential. 74% of the flood forecasting personnel confirms that their centers do not have the experts and staff capable to integrate data, perform forecasts and disseminate information (Perera,2019). The successful and long-term operation of the technology requires the presence of a number of highly qualified specialists with specialization in meteorology, hydrology, monitoring, GIS technologies, mapping, IT technologies that could work with large databases, models and modern equipment.

A shortage of qualified personnel can be corrected by training employees in the middle system of vocational education and higher education is observed. The provision of experts in the field should be made by the higher school, retraining and advanced training of specialized organization or investors. The training of such specialists can be organized in Ukrainian universities, where there are a sufficient number of highly qualified teachers from different fields of knowledge and a material and technical base for training.

On the basis of existing competencies of NMHS staff members, areas requiring an additional training shall be identified and individual training plans shall be compiled. It is proposed that plans follow recommendations for competence development provided by the WMO Technical Commissions. The learning success shall be evaluated according to the WMO competency assessment.

To develop of new training programs for training and retraining of personal. The design, review and updating of the training programs to provide staff at different levels with the advanced technology are required to meet the challenges of hydro-meteorological data collection and transmission, flood forecasting, sustainable technology development and flood mapping are also very important.

SESU needs to **reform job payment system** (increasing of monthly payment) to involve skilled people to monitor department.

The lack of awareness about benefits of technology, it is a barrier that will prevent from the use of technology to the benefit of the various weather-dependent industries and its dissemination. There is the lack of new communication channels for better connection with end users and public sector. In order to remove the barrier, it is necessary to intensify the campaign to highlight activities of the hydro-meteorological service, types of forecasting and warning opportunities of the phenomena, the benefits of using early forecast, government, business and the media.

Increase in the efficiency of insurance system. Following the modernization of the hydrometeorological monitoring service and the implementation of the flood risk assessment and mapping technology, a powerful awareness campaign should be carried out for stakeholders and insurance companies in order to clarify the benefits of using the technology and to develop regulatory mechanisms for the use of technology by stakeholders and insurance companies.

There is the ignorance of the benefits of technology in Ukraine, the insurance business still does not take advantage of the use of modern technologies for flood's hazard assessment. The insurance procedure is optional. The population is not motivated for compulsory insurance, since the state compensates for the flood damage from the state budget. Those flood victims who received compensation from the insurance company are not eligible to receive assistance from the state.

Flood insurance is a type of property insurance that covers a dwelling for loss sustained by water damage specifically due to flooding caused by heavy or prolonged rain, melting snow, coastal storm surges, blockage of drainage systems by storm or levee dam failure. In many places, flood is considered as a very major phenomenon and the damage or destruction it causes are uncovered if you do not get supplemental insurance. In developed countries, for example in the USA, the federal National Flood

Insurance Program (NFIP) offers flood insurance to homeowners in participating communities, along with those who are determined to be in the NFIP-designated floodplains, though policies are offered through private insurers, the government sets rates. The pricing of flood insurance policy is based on the NFIP-designated flood zone in which the property is located. Flood hazard zoning is usually based on flood's risk assessment and mapping technology. This means that the technology of flood risk assessment is not only directly linked to the risk assessment and zoning, but also it is directly used by the insurance business to evaluate and recover damages. In Ukraine, the insurance business still does not take advantage of the use of modern technologies for risk assessment. The insurance procedure is optional. The population is not motivated for compulsory insurance, since the state compensates for the flood damage from the state budget. Those flood victims who received compensation from the insurance company are not eligible to receive assistance from the state. The League of Insurance Organizations of Ukraine proposes to amend the Law of Ukraine "On Insurance" and to introduce a mandatory flood insurance system that will take into account risk zoning, as it is used in the world practice of insurance (*Pusch, 2004*). An improvement in the insurance system will facilitate the introduction and dissemination of flood's risk assessment and mapping technology in Ukraine.

Activities identified for the implementation of selected actions

Before implementing the technology, it is necessary to ***conduct research on a modern scientific and methodological basis on the vulnerability of the water sector to floods*** and to perform the ranking of vulnerable areas and sectors of economics.

A shortage of qualified personnel for the implementation of technology can be corrected by the training of employees in the middle system of vocational education and higher education is observed. The provision of experts in the field should be made by the higher school, retraining and advanced training of specialized organization or investors. The training of such specialists can be organized in Ukrainian universities, where there are a sufficient number of highly qualified teachers from different fields of knowledge and there is a material and technical base for training. On the basis of existing competencies of NMHS staff members, areas requiring additional training shall be identified and individual training plans shall be compiled. Training on hydrologic data collection, transmission, achieving and retrieval techniques, methods of communication interface techniques among meteorological inputs, hydrological models, advantages and weaknesses of radar applications in flood assessment and mapping technology, training on the analysis of the catchment characteristics of a specific river basin and the rainfall-runoff response of the basin to precipitation inputs and flood forecast are necessary for the effective operation of the technology.
It is proposed that plans follow recommendations for competence development provided by the WMO Technical Commissions. The learning success shall be evaluated according to the WMO competency assessment.
The development of special funding program to implement the technology, particularly to the establishment of Floods Monitoring System and Forecast Center, in order to conduct Research and Training and purchase the necessary equipment. The donor of the funding program could be one or several International Financial Organizations that provide financial aid for climate change adaptation activities: Global Environment Facility (GEF), European Bank for Reconstruction and Development (EBRD) etc.

Reform in the remuneration system to motivate highly qualified specialists to work in monitoring units. SESU is required to reform the job's payment system (increase in monthly payment) to involve skilled specialists with skills of IT and GIS technologies, processing of big data, modeling, mapping.

The Establishment of the Floods monitoring system and forecast center.

The development of effective insurance legislation that would take into account the benefits of using technology. It is possible to use an analogue: the floods hazard insurance system in USA - National Flood Insurance Program (NFIP).

***The development of a national regulatory framework for the establishment of a flood risk management plan and preliminary flood risk assessment*.** It is also necessary to create a legal framework for the use of satellite information for drought monitoring system in Ukraine.

Wide awareness campaigns carried out by the authorities, the media and NGOs are required. Ukrainian stakeholders don't have enought information about the benefits of technology. The lack of information about the benefits of technology among insurance companies is the reason of inefficient insurance system in Ukraine and the reason of ignorance for the benefits of technology. Following the modernization of the hydrometeorological monitoring service and the implementation of the drought risk assessment and mapping technology, a powerful awareness campaign for stakeholders and insurance companies should be undertaken to clarify the benefits of using the technology and to develop regulatory mechanisms for the use of technology by stakeholders and insurance companies.

Actions to be implemented as Project Ideas

The main project idea is an establishment of the Floods monitoring system and forecast centre *for* Flood hazard assessment and mapping technology. Such a Centre can be established jointly by the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR) and the State Emergency Service of Ukraine (SESU) with the partial involvement of the state budget and international environmental investments.

The combination of advanced technologies and high skilled and good motivated specialists with skills of IT and GIS technologies, processing of big data, modelling, mapping in the frame of the Floods monitoring and forecast centre could ensure the success of the implementation and operation of the technology in Ukraine. The center could provide the information of state and private stakeholders on flood's hazard and flood's forecast on a regular basis.

As it has been mentioned above each dollar that will be invested in the flood monitoring upgrades can benefit from $ 4 to $ 11 at the expense of the warning losses from natural meteorological phenomena (Evaluating, 2007). The modernization of monitoring and use of modern technologies for flood's hazard assessment and mapping will allow to get the considerable economic effect in the different sectors of the economy.

2.1.4.4 Stakeholders and Timeline for the implementation of TAP

The main stakeholders of technology implementation are:

- for organizational measures, solving funding issues: the Ministry of Finance of Ukraine, the Ministry of Environmental Protection and Natural Resources of Ukraine(MEPNR), the State Emergency Service of Ukraine (SESU);
- for the development of scientific and methodological base of the Flood monitoring and forecast centre: the Institute of Water problems and reclamation, Ukrainian hydrometeorological Institute;
- the preparation of experts in flood hazard assessment and mapping: the Ministry of Education and Science of Ukraine, the Taras Shevchenko National University of Kyiv, Odesa state ecological university;
- the development of special funding program: the Institute of economics of NASU, the Ministry of Finance of Ukraine;
- reform in the remuneration system the State Emergency Service of Ukraine (SESU): the Ministry of the Finance of Ukraine;
- the development of effective insurance legislation: the Parliament of Ukraine, the National Association of Insurers of Ukraine (NAIU), Ukrainian Federation on Insurance, the National Association of Agricultural Advisory Services of Ukraine;

- to create a legal framework for the use of satellite information for floods monitoring system in Ukraine: Parliament of Ukraine, State Space Agency of Ukraine, Space research Institute of NASU;
- awareness campaigns: state authorities, National Ecological Centre, the National Association of Agricultural Advisory Services, media and other NGOs.

All the suggested activities can be done simultaneously, some of them are going to start as early as in 2022. Due to the fact that some preliminary researches were already in place before 2020, the full-scale studies might be conducted in 2022-2024.

Preparations for the establishment of a Flood Monitoring system and Forecast Center should begin as soon as possible. The Ministry of Finance of Ukraine, the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR) and the State Emergency Service of Ukraine (SES) must address the issues of organization and financing in the first place.

The training of specialists should begin simultaneously with the creation of the organizational structure of the center, the formation of its management and staff, addressing issues of logistics.

Immediately at the initiative of the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR), the work should be started with the Parliament of Ukraine on the legislation development.

The overall list of stakeholders has been provided in Annex I.

2.1.4.5 The Estimation of Resources Needed for Action and Activities

Similarly, in the case of Drought risk assessment and mapping, we consider financing this technology by IFIs. The fact is given that figures for the implementation of the technology are absolutely the same, as we use them for further calculations.
TAP overview table in section 2.1.4.7 indicates the following expenditures for the Technology:

- Research – USD 200,000.
- The training of high skilled experts for the implementation and functioning of technology - USD 500,000.
- The implementation of the technology in the arid zone of Ukraine - USD 5,000,000.
- Reform in the remuneration system of the State Emergency Service of Ukraine - USD 2,000,000/year
- The establishment of a Flood Monitoring System and Forecast Center - USD 3,000,000.
- The spread of information about technology – USD 100,000.

Thus, overall cost of technology is USD 32.8 million.

Below, we calculate two options: the payment of interest in case of “conventional debt” and future cost of investment/loan. In order to do so, we assume that the money is lent in two installments: USD 15.95 million in 2022 (for time period 2022-2026), and USD 16.85 in 2027 (for time period 2027-2033), as they are indicated in Table 2.8.

Table 2.8. The disbursement of financing for Flood risk assessment and mapping in 2022-2033, *USD million*

	Research	**Training**	**Software/ Hardware**	**Remuneration SESU**	**Floods Monitoring and Forecast Center**	**Awareness raising**	**Subtotals**
2022	0.1	0.3	4	2	1.5	0.05	7.95
2023				2			2
2024				2			2
2025				2			2
2026				2			2
2027	0.1	0.2	1	2	1.5	0.05	4.85
2028				2			2
2029				2			2
2030				2			2
2031				2			2
2032				2			2
2033				2			2

For conventional debt calculations, the following assumptions were made on the annual payment of interest:

- from 2022 to 2026 inclusive – the payment of interest on the first installment (USD 15.95 million);
- from 2027 to 2036 inclusive – the payment of interest on both installments (USD 15.95 + USD 16.85 million);
- from 2037 to 2041 inclusive – the payment of interest only on the second installments (USD 16.85 million).

Table 2.9. summarizes results.

Table 2.9. The amount of money needed for conventional debt

	4%			6%			8%		
	Debt service	The repyament of the prinicpal	Total payment	Debt service	The repyament of the prinicpal	Total payment	Debt service	The repyament of the prinicpal	Total payment
2022	0.638		0.638	0.957		0.957	1.276		1.276
2023	0.638		0.638	0.957		0.957	1.276		1.276
2024	0.638		0.638	0.957		0.957	1.276		1.276
2025	0.638		0.638	0.957		0.957	1.276		1.276
2026	0.638		0.638	0.957		0.957	1.276		1.276
2027	1.312		1.312	1.968		1.968	2.624		2.624
2028	1.312		1.312	1.968		1.968	2.624		2.624
2029	1.312		1.312	1.968		1.968	2.624		2.624
2030	1.312		1.312	1.968		1.968	2.624		2.624

2031	1.312		1.312	1.968		1.968	2.624		2.624
2032	1.312		1.312	1.968		1.968	2.624		2.624
2033	1.312		1.312	1.968		1.968	2.624		2.624
2034	1.312		1.312	1.968		1.968	2.624		2.624
2035	1.312		1.312	1.968		1.968	2.624		2.624
2036	1.312	15.95	17.262	1.968	15.95	17.918	2.624	15.95	18.574
2037	0.674		0.674	1.011		1.011	1.348		1.348
2038	0.674		0.674	1.011		1.011	1.348		1.348
2039	0.674		0.674	1.011		1.011	1.348		1.348
2040	0.674		0.674	1.011		1.011	1.348		1.348
2041	0.674	16.85	17.524	1.011	16.85	17.861	1.348	16.85	18.198
Total	19.68	32.8	**52.48**	29.52	32.8	**62.32**	39.36	32.8	**72.16**

Table 2.9. indicates that USD 32.8 million is needed for the technology of Flood risk assessment and mapping, being attracted from 2022 to 2041, may turn into USD 52.48-72.16 depending on the interest rate.

In order to calculate the ***future cost of investment/loan***, we assumed that the loan was to be provided for 19 years at different interest rates (4%, 6%, 8%). In order to do so, we calculate the future cost of investments for each installment using the array function, and then summarize them in Table 2.9.

Table 2.10. The future sum of loan under different interest rates, *USD million*

	Interest rates		
	4%	6%	8%
I installment	28.73	38.23	50.60
II installment	30.35	40.38	53.45
Total	59.07	78.61	104.05

Table 2.9. indicates that the future sum of loan/investments of USD 32.8 million provided for 19 years may turn into USD 59.07-104.05 million depending on the interest rate.

A part of financing of the state budget can be used to create the center. The state budget of Ukraine provides in 2021 only USD 30 million for National Meteorological and Hydrological Service (NMHS), of which 78% are provided for salary and only USD 357 thousand (1.6%) are provided for the development of the monitoring system (Rozpodil,2021). At the same time, USD 464 million are allocated for the civil protection of the population from the effects of floods and other natural phenomena. When planning the budget for the coming years, it may be worth using part of the civil protection budget to support flood monitoring system in order to detect them early and prevent many of the negative effects of floods. The use of the flood hazard assessment and mapping technology could allow the State Emergency Service of Ukraine (SESU) to reduce the cost of dealing with the effects of floods and compensate for the redistribution of funds in order to finance the monitoring system. It is assumed that flood damage in Ukraine during 1995-2010 amounted to $ 7.5 billion, 1% reduction in flood damage, which could be due to the introduction of Flood's Risk Assessment and Mapping, could help save USD 75 million for the year in which the flood will occur (TNA Ukraine 2019).

The financing of training of specialists for Floods monitoring system and forecast centre can be carried out both by the state order and with the attraction of means of private companies for potential technology stakeholders which activity depends on flood hazard. The state budget of Ukraine provides in 2021 about USD 32 million for the preparation of civil defense specialists in the educational institutions of

the SESU (Rozpodil, 2021). The partial redistribution of these funds could help to organize specialists in order to monitor and prevent from flood's hazard.

2.1.4.6 Management Planning

The potential risks could be of several types: cost, scheduling and performance.

Scheduling risks could be applicable to the research stage of TAP, because the technology's implementation needs a modern assessment of the vulnerability of the water sector to floods and performing the ranking of vulnerable areas.

Scheduling risk is very likely and expected for the flood's expert preparation due the long period of approving process of educational program by the Ministry of Education and Science of Ukraine and National Agency for Higher Education Quality Assurance.

For the development of special funding program and establishment of a Floods Monitoring and Forecast Center, there are also such risks.

Cost risk is the greatest risk in implementing a TAP. The organization of financial support from international financial institutions is a difficult process and depends on both parties: donor institutions and the recipient state. Investments into the implementation of technology may occur slower than expected. The costs may appear to be higher than initially expected due to rapidly changing market conditions and, in some cases, unexpected transaction costs.

The focus on the reformatting of SESU state budget's funding to partially support the technology implementation process may not be because of opposition from officials who distribute and use funds to overcome the effects of flood and fire.

Financial risks may threaten the development of a special financing program and the establishment of a Flood Monitoring System and Forecast Center. Non-reform in the remuneration system of the State Emergency Service of Ukraine due to the lack of funding is also a financial risk that can exacerbate the shortage of highly qualified personnel for the technology of the flood monitoring and assessment.

Performance risk exists for the development of special funding program, the establishment of a Drought Monitoring System and Water Scarcity Center, the development of effective insurance legislation create a legal framework for the use of satellite information for the flood monitoring system in Ukraine and for the spread of information about technology

Next Steps

First of all, it is necessary to eliminate legislative obstacles by the development of effective insurance legislation that would take into account the benefits of using technology. The pricing of flood insurance policy has to be based on the "technology"-designated flood zone in which the property is located. This means that the technology of flood risk assessment is not only directly linked to the risk assessment and zoning, but also directly used by the insurance business to evaluate and recover damages. In Ukraine, the insurance business still does not take advantage of the use of modern technologies for risk assessment. The insurance procedure is optional. The population is not motivated for compulsory insurance, since the state compensates for the flood damage from the state budget. Those flood victims who received compensation from the insurance company are not eligible to receive assistance from the state. The League of Insurance Organizations of Ukraine must initiate to accept the Law of Ukraine "On Insurance" and to introduce a mandatory flood insurance system that will take into account risk zoning, as it is used in the world practice of insurance. Improvement in the insurance system will facilitate the introduction and dissemination of flood risk assessment and mapping technology in Ukraine.

2.1.4.7 TAP overview table

Sector	Water
Sub-sector	
Technology	Floods hazard assessment and mapping
Ambition	**The implementation of technology:** first stage - 5,3% of the county territory, rivers of Danube catchment by 2027; second stage – 8,7% of the country territory, rivers of Dnister catchment by 2030; whole country **by 2033**.
Benefits	This technology has sufficient adaptation and economic benefits. **Adaptation Benefits** of the technology: - technology provides special tools for assessment and forecasting risk of floods, preventing and managing risks, which is the basis for developing adaptation plans for communities and sectors of the economy; - helps to identify response measures for adaptation sectors of economics and communities, including those addressing vulnerable groups needs;; - increases the adaptive capacity in the social sphere, including that of vulnerable groups;; - increases the resilience and adaptive capacity of flood related sectors of economics, including communities form remote areas; -improvement of land use management plans will be facilitated by agricultural mitigation, with strong empowerment of women; - the introduction of zoning will help limit the construction of new buildings in areas prone to flooding and prevent flood risks of exposed communities; - development of non-structural measures, such as early warning, dry and wet proofing, and relocation available for all members of society; - mitigation in insured and uninsured private households due to changes of flood insurance, addressing the needs of all users; - increase the resilience of communities to climate change, including those of remote areas and low -income households; - reducing social vulnerability and promoting inclusive resilience The introduction of technology provides vulnerable communities with specific tools for flood hazard's forecast and prevention and risk management. This increases the adaptive capacity in the social sphere and the resilience of communities to climate change, including that of low-income, remote areas - Helps to increase of readiness of communities to floods, addressing the needs of both women and men - Reduces the vulnerability of climate during the timely preparation of gender – responsive adaptation measures and the mitigation of possible impacts. -The protection of population and companies through the improved planning and increased preparedness. **Economic and financial benefits are following:** With the help of the functioning of technology, public and private economic entities can timely and fully consider the risks of drought in all their investments and make their business climate resilient. - The creation of potential of decreasing losses and damage caused by flood of flood- prone areas; - Decreasing costs needed for dealing with their consequences; - To create preconditions for the development of insurance business available for all members of society ; - Increased preparedness to floods leads to smaller negative environmental impact, which is especially important in case of availability of landfills, nuclear power plants etc;

	- The resilience of ecosystems is enhanced to promote the sustainable economic growth and peoples' livelihoods. - The application of flood risk assessment and mapping technology on the basis of modernized floods monitoring system would reduce losses of agricultural land and limit construction of new buildings in flood-prone areas; - Hydro-meteorological information and early warning systems can save hundreds of lives of both women and men and large financial resources (from millions to billions of dollars annually).							
Action	**Activities to be implemented**	**The sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Indicators for the monitoring of implementation**	**Budget per activity**
Action 1. In-depth research	1.1 Research on a modern scientific and methodological basis of gender-sensitive vulnerability of the water sector to floods and to perform the ranking of vulnerable areas for the phased implementation of adaptation measures.	The Ministry of Environmental Protection and Natural Resources of Ukraine	**Institute for Water Problems and Melioration Problems, NAASU** Ukrainian Hydrometeorological Institute, the National Academy of Sciences of Ukraine, State Service of Emergencies of Ukraine	2022-2023	Scheduling risk Cost risk	Performed assessment	Conducted study on water availability for irrigation in the medium and long-run	USD 200 000
Action 2. Training	1.2 The training of high skilled experts for the implementation and functioning of technology form which at least 51% are women	The Ministry of Environmental Protection and Natural Resources of Ukraine, the State Emergency Service of Ukraine (SESU), the Ministry of Education and Science of Ukraine	The State Emergency Service of Ukraine (SESU), the Ministry of Education and Science of Ukraine, **Taras Shevchenko National University of Kyiv, Odesa state ecological university**	2022-2025	Scheduling risk due the long period of approving process of educational program by the Ministry of Education and Science of Ukraine (about 1 year) Cost risk	The evaluation of the prepared experts according to the WMO competency assessment	The number and quality of prepared experts (gender disaggregated)	500 000 USD
Action 3. Financial measure	The development of special funding program	The Ministry of Finance of Ukraine;	The Ministry of Finance of Ukraine, **Ministry of Environmental**	2022- 2024	Cost risk Scheduling risk Performance	Developed special Funding Program,	The implementation of the technology in flood prone zone of Ukraine, addressing the needs of	USD 5 million (for the fund)

			Protection and Natural Resources of Ukraine, State Emergency Service of Ukraine		risk	aiming at the provision of long-term soft loans.	all members of society, including those of vulnerable groups.	
	Reform in the remuneration system of the State Emergency Service of Ukraine (SESU considering the needs of both women and men	The Ministry of the Finance of Ukraine;	The Ministry of the Finance of Ukraine, **State Emergency Service of Ukraine**	2022	Cost risk	Reform in the remuneration system, enabling financial frame- work for motivation of high skilled experts	The number of high skilled experts in Floods Monitoring and Forecast Center	USD 2 million/year
Action 4. Organisation measure	The establishment of a Flood Monitoring and Forecast Center	The Ministry of Finance of Ukraine, the Ministry of Environmental Protection and Natural Resources of Ukraine(MEPNR), and the State Emergency Service of Ukraine (SES)	**The Ministry of Environmental Protection and Natural Resources of Ukraine**, State Emergency Service of Ukraine	2022-2023	Cost risks Scheduling risk Performance risk	The establishment of a Floods Monitoring and Forecast Center	The functioning of Floods Monitoring and Forecast Center	USD 3 million
Action 5. Economic and Legislative Stimuli	The development of effective insurance legislation addressing the needs of all members of rural communities	Insurance Associations	The National Association of Insurers of Ukraine (NAIU), Ukrainian Federation on Isuranse, the National National Association of Agricultural Advisory Services of Ukraine	2022	Performance risk	Effective insurance legislation	Effective insurance legislation that uses the benefits of the floods hazard assessment and mapping technology available for all members of society, including vulnerable groups form rural area	No funding

	To create a legal framework for the use of satellite information for drought monitoring in Ukraine:	The State Space Agency of Ukraine	Parlament of Ukraine, **State Space Agency of Ukraine,** Space research Institute of NASU	2022	Performance risk	Created legal framework for the use of satellite information	The legal use of satellite information for the flood hazard assessment and mapping technology	No funding
Action 6. Awareness risin and knowledg sharing	The spread of information about technology	Grants and technical aid of international organizations (such as USAID), available for both women and men Regional budgets, funds of business entities	**National Ecological Centre**, The National Association of Agricultural Advisory Services of Ukraine, Ukrainian Meteorological Society, Ukrainian Geographical Society	2022-2032	Performance risk		Technology is known and recognized floods hazard assessment and mapping technology, for the benefits of all in need members of society.	100000 USD

2.2 Project Ideas for Sector B

2.2.1 The brief summary of the Project Ideas for Sector B

The main project idea for Climate-Smart Irrigation lies in the field of creation of conditions for an access to financing, in particular the creation of special funding program. The major need of this particular measure is caused by the fact that the technology of Climate-Smart Irrigation requires significant financing. The financial aspect should be elaborated and the technology has high prospects for transfer, diffusion and deployment.

The main project idea for Flood hazard assessment and mapping technology is an establishment of the Flood monitoring system and forecast Centre. Such a Centre can be established jointly by the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR) and the State Emergency Service of Ukraine (SESU) with partial involvement of the state budget and international environmental investments.

The main project idea for Drought risk assessment and mapping technology is an establishment of the Droughts monitoring system and water scarcity Centre. Such a Centre can be established jointly by the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR) and the State Emergency Service of Ukraine (SESU) with the partial involvement of the state budget and international environmental investments.

The combination of advanced technologies and high skilled and good motivated specialists with skills of IT and GIS technologies, processing of big data, modelling, mapping in the frame of both Centres could ensure the success of the implementation and operation of the mentioned above technology in Ukraine. Both centres could provide state and private stakeholders information on flood hazard and flood forecast on a regular basis.

2.2.2 Specific Project Ideas

The creation of a special funding program for Climate-Smart Irrigation was selected as a project idea. However, in 2021, the function of irrigation was transferred from the Ministry of Environmental Protection and Natural Resources of Ukraine to the Ministry of Agrarian Policy and Food and Decree of CMU dated 24 May#539 “Some issues of distribution of certain powers of central executive bodies in the field of land reclamation” was adopted. Nonetheless, this project idea could become a part of a technologically oriented climate adaptation investment portfolio.

Short institutional memory does not allow the wide-scale implementation of technology at the moment. However, this project idea should be implemented, the project would require the following financing. The interest rate varies from 15% to 25% in UAH depending on conditions. For the purpose of further calculation, we assume that the regular interest rate is 22% in UAH per annum, which translates into 8.9% in USD.

Background information	The water sector and agriculture are being severely affected by displays of climate change. The dynamics of water use show the growing demand for water coupled with growing water scarcity. Agriculture is one of the most vulnerable sectors in Ukraine in terms of climate change displays. The ability of Ukraine’s agriculture in the coming decades is seriously compromised by droughts, the frequency of which is expected to persist. Ukraine has lower availability of water resources in comparison to the European countries; water stress is already felt in most of southern regions and is expected to persist even in the remainder of the country in the nearest future. Climate-Smart Irrigation is one of the technologies that is capable of providing large-scale irrigation for major cereals and other crops, to which drip irrigation is not applicable. This technology is relatively more expensive than conventional irrigation, mainly due to the use of modern, highly technological equipment. Therefore,

	overcoming of the financial barrier by means of the creation of a special funding program for Climate-Smart Irrigation is suggested as a Project Idea.
Objectives and outputs	The objective of the Funding Program (the Fund) is the provision of long-term soft loans to purchase and operate the equipment for Climate-Smart Irrigation. Should the Fund operate and allocate funding in the amount required, Climate-Smart Irrigation could spread on 0.5 million ha by 2037.
Link to country development priorities	The creation of the Funding Program is fully in line with Strategy for Irrigation and Drainage by 2030, as well as the Sustainable Development Goals of Ukraine for the period up to 2030
Scope, activities and actions	A primary climatic zone for the technology implementation in Ukraine is Steppe, especially Kherson, Odesa, and Mykolaiv regions. Kherson region is the aridest area, and it has Kakhovsky Irrigation Channel – a major irrigation channel in Southern Ukraine. In the decades to come, Steppe will extend to Odesa, Kirovograd, Cherkasy, Poltava. Kharkiv, Luhansk, Donetsk, Dnipro, Mykolaiv, Kherson, Zaporizhzhya regions, and the Crimean Peninsula. Action: Overcoming of financial barriers *Activity* The development of special funding program, aimed at the provision of long-term soft loans. The funding is to be provided by international donors. Later, the funding is required to be distributed by commercial banks operating in Ukraine. Loans should be provided for eight years with an interest rate of 18% in UAH, which translates into 7.28% in USD, whereas the remainder 4% in UAH (22% - 18%) should become irrecoverable debt, covered by the Fund. In Ukraine, there are examples of such Funds in the realm of renewable energy. The interest rate of 7.28% in USD was chosen.
Timeline	2027-2036, total of 10 years
Budget	• USD 2 million – Program operation and Maintenance • USD 1351million, of which irrecoverable debt – USD 91.2 million (Tables 2.11, 2.12, 2.13 below).
Sources of funding	International programs of technical support and development; State budget of Ukraine Staff permanent: 1 Program manager; 6 experts; 1 internal auditor, 1 communication specialist; 1 assistant.
Measurement/Evaluation	The number of loans provided, units; area involved with CSI, ha.
Potential risks	(i) inability to attract funds; (ii) Delays caused by tendering procedures that are mandatory for equipment purchase (ProZorro); (iii) cease of funding.
Project beneficiaries	Agri producers and exporters; IT companies (here, women can benefit the most due to possibilities of data collection and analysis)
Responsibilities and coordination	The project would be launched under the support of the international program of development. Should the State Enterprise be formed, the Project operation would be coordinated by the Cabinet of Ministers of Ukraine.

Table 2.11 The assessment of borrowed capital to implement CSI on 500 thousand ha in Ukraine by 2037

Year	Area of CSI, thousand ha	Expenses for CSI, USD million	Borrowed capital needed, USD million
2027	1	4,2	2,5
2028	2	8,4	5,0
2029	4	16,8	10,1
2030	9	37,8	22,7
2031	17	71,4	42,8
2032	36	151,2	90,7
2033	78	327,6	196,6
2034	114	478,8	287,3

2035	120	504	302,4
2036	119	499,8	299,9
Total	**500**	**2100**	**1260,0**

Source: own calculations

Assuming that the loans are taken for 8 years, we can state that the difference between the two different types of interest rates (7.28% and 8.89% in USD), i.e. irrecoverable debt, would reach USD 91.3 during the entire time of program duration (Table 2.12).

Table 2.12 Irrecoverable debt during program duration

Year	Interest rate 7.28%	Interest rate 8.89%
1	183 456	224 028
2	527 436	644 081
3	1 192 464	1 456 182
4	2 683 044	3 276 410
5	5 434 884	6 636 830
6	11 282 544	13 777 722
7	24 009 804	29 319 665
8	41 552 784	50 742 342
9	57 582 252	70 316 789
10	70 699 356	86 334 791
11	59 302 152	72 417 051
12	47 996 676	58 611 326
13	36 897 588	45 057 632
14	26 188 344	31 979 997
15	16 304 652	19 910 489
16	8 209 656	10 025 253
17	2 728 908	3 332 417
Total, USD	**412 776 000**	**504 063 000**
	Irrecoverable debt, USD	91 287 000

Source: own calculations

Revenue flow sufficient to pay back the loans is shown in Table 2.11.3. To assess the potential revenues, the data from report TNA (2020), Adaptation was used. According to the Report, 1 ha of wheat resulted in USD 594 of net income, 1 ha of barley – USD 510, 1 ha of corn – USD 746, 1 ha of soy - USD 863, and 1 ha of sunflower – USD 825. It is important to note that these figures were obtained already using the technology of Climate-Smart Irrigation. Based on the data of State Statistics Service of Ukraine on the planted area of annual crops in Ukraine in 2020 (SSSU 2021), we calculated the percentage of the above-mentioned five crops. For simplification, we assume that such a structure will remain in future (however, it is not the case in real life, but the real structure of planted areas is unknown, as well as the future prices of agri commodities). Based on the structure of planted area used, 1 “mixed” ha of agricultural crops gives USD 705 of net income (so, 1 thousand ha would bring USD 705 thousand of net income, respectively).

Table 2.13 The hypothetical revenue flows

Years	Net income	Interest rate 7.28%
1	705 000	206 544
2	2 115 000	642 564
3	4 935 000	1 537 536
4	11 280 000	3 556 956
5	23 265 000	7 435 116
6	48 645 000	15 627 456
7	103 635 000	33 320 196
8	184 005 000	60 237 216
9	268 605 000	91 322 748
10	352 500 000	125 245 644
11	352 500 000	137 902 848
12	352 500 000	152 043 324
13	352 500 000	168 497 412
14	352 500 000	190 546 656
15	352 500 000	225 000 348
16	352 500 000	269 005 344
17	352 500 000	312 286 092
	3 467 190 000	**1 794 414 000**

Source: own calculations

Tables 2.11 - 2.13 are indicative, showing the following:

- The cost of CSI to be implemented on 0.5 million ha in Ukraine by 2036 reaches USD 2.1 billion. This amount of money is difficult to attract, as the country has high investment risk coupled with high weather and climatic agricultural risks;
- More than half of that money is to be borrowed;
- Even use of hard loans seems doubtful in 2021, as it has been mentioned, that banks tend to provide the maximal loan of USD 0.26 million per entity.
- The Fund should be created providing softer loans than Ukrainian market can offer and at the rates considered, the irrecoverable debt will reach only USD 91.2 million;
- The hypothetical revenue flow is sufficient to pay the loan and to recover the share investments put into Climate-Smart Irrigation as equity.

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Annex 1.

List of stakeholders involved and their contacts

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Ministry for Development of Economy , Trade and Agriculture of Ukraine Directorate of Agro-Industrial Development	https://www.me.gov.ua/	Vedmid Larysa	l.vedmid@me.gov.ua	+38(067) 502-43-23
Ministry for Development of Economy , Trade and Agriculture of Ukraine Directorate of Agro-Industrial Development	https://www.me.gov.ua/	Mishchenko Liubov	lyubov.chernenko@gmail.com	+38(098) 599-68-98
Ministry for Development of Economy , Trade and Agriculture of Ukraine Directorate of Pricing Policy and Development of the Real Sector of the Economy	https://www.me.gov.ua/	Viktoria Kovalenko	kovian7@gmail.com	+38(067) 214-23-04
Ministry for Development of Economy , Trade and Agriculture of Ukraine Directorate of Pricing Policy and Development of the Real Sector of the Economy	https://www.me.gov.ua/	Olena Khomych	olenakhomych@me.gov.ua	+38(095) 394-87-77
State Agency of Fisheries of Ukraine	https://darg.gov.ua/	Polina Ivashchenko	polina.ivashchenko @gmail.com; inter@darg.gov.ua	+38 (044) 484-63-31 +38(066) 573-42-77

The State Service of Ukraine for Geodesy, Cartography and Cadastre (StateGeoCadastre)	https://land.gov.ua/	Olha Savchuk	savchuk@land.gov.ua	+38(044) 299-35-14
State Statistics Service of Ukraine Department of ecological accounts and environmental statistics division of agriculture and environmental statistics	www.ukrstat.gov.ua	Oksana Yuriivna Boretska	O.Boretska@ukrstat.gov.ua	+38(044) 287-12-22
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Annex 2.

Cereal and Legumes Output Decline caused by drought 2020 by the most affected oblasts in Ukraine

Crop Name	Oblast	Output, 000 Ton				% Decline over 2017-19
		2020	2019	2018	2017	
Wheat	Lviv	800.95	863.46	776.09	781.44	0.75%
	Ivano-Frankivsk	290.21	268.94	323.03	291.02	1.40%
	Chernivtsi	153.75	203.52	182.39	202.69	21.64%
	Ternopil	1049.33	1172.42	1037.15	1100.24	4.89%
	Khmelnitsky	1091.60	1439.09	1243.56	1316.02	18.10%
	Vinnytsa	1387.24	1830.79	1673.76	1738.10	20.62%
	Odessa	1007.29	2011.60	2354.09	2284.32	***54.56%***
Barley	Lviv	180.93	255.83	232.00	255.73	27.00%
	Ivano-Frankivsk	126.37	125.24	114.96	122.47	-4.53%
	Chernivtsi	70.77	73.79	65.49	77.54	2.08%
	Ternopil	443.72	538.35	494.17	532.64	14.95%
	Khmelnitsky	324.72	438.39	412.96	455.97	25.48%
	Vinnytsa	363.07	486.21	394.70	469.02	19.31%
	Odessa	541.24	1017.39	1134.70	1268.22	**52.53%**
	Vinnytsa	2.50	2.25	2.56	4.27	17.40%
	Odessa	2.09	1.70	1.97	8.10	**46.73%**
Maize	Lviv	38.16	458.90	358.21	271.03	**89.48%**
	Ivano-Frankivsk	96.32	312.81	327.31	291.93	69.00%
	Chernivtsi	131.08	359.49	330.48	312.41	60.77%
	Ternopil	111.04	929.91	1005.53	861.05	**88.09%**
	Khmelnitsky	161.01	1858.26	2101.61	1516.12	**91.18%**
	Vinnytsa	164.50	3574.90	3751.38	2554.53	**95.01%**
	Odessa	193.98	613.47	717.70	512.46	68.44%
Sunflower	Lviv	28.63	72.65	79.79	73.68	**62.02%**
	Ivano-Frankivsk	15.33	61.13	57.62	76.88	**76.49%**
	Chernivtsi	34.71	34.30	52.35	43.56	20.03%
	Ternopil	120.42	215.62	190.57	234.16	43.58%
	Khmelnitsky	294.71	513.39	484.12	438.67	38.44%
	Vinnytsa	574.76	846.05	808.08	725.85	27.55%
	Odessa	336.74	693.36	886.28	903.87	**59.32%**
Pulses	Lviv	5.76	12.09	23.04	38.04	**76.38%**
	Ivano-Frankivsk	11.73	12.49	19.04	20.35	32.17%
	Chernivtsi	2.65	2.54	4.33	6.13	38.85%
	Ternopil	31.59	33.71	67.18	94.77	51.56%
	Khmelnitsky	23.11	24.70	54.33	59.81	50.06%
	Vinnytsa	20.22	23.14	70.05	95.71	**67.89%**
	Odessa	25.49	56.81	69.2	130.52	**70.19%**

Source: FAO, 2021

Annex 3

State support programs available for adaptation agriculture technologies, 2021

State support program, 2021	Budget, mln UAH	Applicability			Type of Support	Comments
		DI CA	AG	BG		
Partial compensation of agricultural machinery and equipment of domestic production	1 000	A	N/A	A	up to 50% cost compensation on the agro machinery and equipment including irrigation (after purchasing)	The most popular and well work support program
Financial support for measures in agriculture sector by reducing the cost of loans ("Cheap loans")	1 200	A	A	A	Farmer should pay only 5% of interest rate, the difference would be cover from the program. Limit of compensation is 5 mln UAH for crop farming and 15 min UAH for livestock farming.	Insufficient banks capacity caused the fundamental access issues to the financial resource that the farmers face.
Financial support for the development of viticulture, horticulture and hop growing	450	N/A	A	N/A	80% cost compensation on planting material for fruit trees, berry plants, grapes and hops (after planting)	
		N/A	A	N/A	30% cost compensation on the work to install drip irrigation systems and the purchase of materials necessary for such work (after the complete completion of installation work)	
		N/A	A	N/A	Partial cost reimbursement for purchasing equipment for processing home-grown fruits, berries and grapes into juices, wine materials and other	
		N/A	A	N/A	50% cost compensation on new construction and reconstruction of refrigerators and shops	
		N/A	A	N/A	30% cost compensation on the machinery both domestically produced and imported (after purchasing)	
Financial support for farms and agricultural cooperatives	60	N/A	N/A	A	5 thousand hryvnias per one hectare, but not more than 100 thousand per farm.	Available only for small farm start-ups. Farmers have a low interest to program.
	10	A	A	N/A	Cost compensation on the machinery and equipment for agricultural cooperatives	Available only for cooperatives
	10	A	A	A	Cost partial reimbursement for extension services provided	Low quality of advisory services
State support for irrigation	100	A	N/A	N/A	Cost compensation on Drip irrigation; Purchase of machinery; Construction/repair of facilities (pumping, water-generating structures); Construction/repair of internal systems	