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MINISTRY OF NATURE PROTECTION

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION

TECHNOLOGY ACTION PLAN (TAP)

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TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION

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FOREWORD

The impact of Armenia on global climate system is not significant, our share in global emissions is only 0.014%. Highlighting the need of countries to combine their efforts in combating climate change, Armenia as a developing country shares the commitment to limiting greenhouse gas emissions. The quantitative indicators of these contributions are summarized in the Intended Nationally Determined Contributions (INDC) of Armenia, which, in the result of extensive consultations, have been approved by both the Government of the Republic of Armenia and the civil society and have been presented to the attention of Parties of the UN Framework Convention on Climate Change (UNFCCC). This document actually represents the official long-term concept of our country aimed at the implementation of our commitments under UNFCCC, and where along with the mentioned climate change mitigation measures those of adaptation with the component on the transfer and development of the technologies are included.

We consider the on-going UNEP/DTU TNA as priority project to launch the mentioned technology mechanism, which will outline the path that will promote continuous selection and implementation of modern and accessible technologies in Armenia, on the examples of several selected mitigation and adaptation projects. In this sense, TNA project is aimed at strengthening the capacities on the development and transfer of technologies with positive and promising results for this phase.

First Deputy Minister of
Nature Protection of RA  **Simon PAPYAN**

List of abbreviations and acronyms

AMD	Armenian drams
AUA	American University of Armenia
CJSC	Closed Joint-Stock Company
DTU	Technical University of Denmark
EU	European University
GEF	Global Environmental Facility
GMO	Genetically Modified Object
INDC	Intended Nationally Determined Contributions
LSG	Logical Problem Analysis
LSGB	Local Self-Governance Body
MEDI	Ministry of Economic Development and Investments of RA
MNP	Ministry of Nature Protection of RA
MoA	Ministry of Agriculture of RA
MoF	Ministry of Finances of RA
MoH	Ministry of Health of RA
MSE	Ministry of Science and Education of RA
MTAD	Ministry of Territorial Administration and Development of RA
NGO	Non-Governmental Organization
PSRC	Public Services Regulatory Commission of RA
RA	Republic of Armenia
REC	Regional Environmental Center
SCWE	State Committee of Water Economy
SNCO	State Non-Commercial Organization
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UDP	UNEP DTU Partnership
UN	United Nations
UNEP	United National Environment Programme
UNFCCC	UN Framework Convention on Climate Change
USD	United States Dollars
WWTP	Wastewater Treatment Plant

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Report III

Technology Action Plan (TAP) Report

Executive Summary

Technology Action Plan (TAP) report concludes the Technology Needs Assessment process in the Republic of Armenia, summarizing the key needs in agriculture and water sectors, related to climate change adaptation. Based on the results of technology needs assessment and barrier analysis phases of the respective project, the current report presents the potential ways of making possible the transfer and diffusion of prioritized technologies, which include the following:

Agriculture	Water
• Windbreaks as climate change adaptation tool	• Establishment of recirculating water system for fisheries
• Local melioration and low-volume drip irrigation for newly planted orchards	• Installation of compact wastewater treatment plants and application of natural and hybrid treatment systems
• Diversification of agriculture	• Diffusion and expansion of drip irrigation system

The implementation of the Project has been supervised by the working group of Interagency Council for coordination of requirements and provisions of UN Framework Convention on Climate Change established by Decree N 955-A of Prime Minister of RA dated October 2, 2012[1]. Representatives of respective ministries and state agencies, appointed by the order of Minister of Nature Protection of RA are involved in the working group. This gives a good opportunity for multi-stakeholder decision-making process, as well as awareness raising on technology needs assessment at different levels. The Project implementation has been administered by "Environmental Project Implementation Unit" State Agency of the Ministry of Nature Protection of RA, and UNFCCC National Focal Point. Mr. Aram Gabrielyan, has been acting as National Coordinator.

Technology needs assessment project has been based on ecosystem approach, requiring prioritization of balanced actions. The approach is promoted by RA Government, particularly in Intended Nationally Determined Contributions of Armenia[2], which states that "*adaptation strategy and contributions are based on the requirement of the UNFCCC Article 2 "Objective", which stipulates to restrain climate change within timeframe sufficient to allow ecosystems to adapt naturally to climate change*". Ecosystem approach to adaptation is one of the key pillars of adaptation strategy of Armenia and is in line with country's environmental policy, thereby ensuring compliance with respective international conventions and treaties, and establishing basis for inter-sectorial/cross-sector cooperation and facilitating cross-border cooperation.

Consultations with key stakeholders, including representatives of public institutions, such as the Ministries of Nature Protection, Agriculture, and Economy, academia and scientific institutions, businesses, international organizations, NGOs, etc. have been an integral part of project implementation. Technology action plans have been developed in consultations with sectorial technology working groups representing relevant stakeholders. Participatory approach has been applied by national consultants to make the results more comprehensible and acceptable for beneficiaries and interested parties.

[1] https://www.e-gov.am/decrees/item/11373/
[2] http://www4.unfccc.int/submissions/INDC/Published%20Documents/Armenia/1/INDC-Armenia.pdf

Technology action plans have been developed for each of prioritized technologies of agriculture and water sectors aiming to overcome the barriers to transfer and diffusion of these, identified during the Barrier Analysis and Enabling Framework phase of the Project. Key barriers to prioritized technologies are presented below.

Technology	Barrier name	Barrier category
Windbreaks	Large number of potential beneficiaries	Market conditions
	Small land parcels	Market conditions
	Limited knowledge on benefits of the technology	Information and awareness
Local melioration	Imperfection of legislation on melioration of unusable lands and absence of motivation mechanisms	Legal and regulatory
	High cost	Economic and financial
	Insufficient level of development of irrigation water infrastructure	Technical
Agriculture diversification	Limited research on agriculture diversification	Information and awareness
	Lack of guidelines on agricultural systems and agricultural rules	Information and awareness
	Insufficient level of development of logistic mechanisms and processing facilities	Institutional and organizational capacity
Recirculating water system for fisheries	Corruption and conflict of interests	Legal and regulatory
	Low fee for the used water	Legal and regulatory
	Disregard of water resources' protection by decision-makers	Legal and regulatory
	Restricted information on technology at all levels	Information and awareness
Compact wastewater treatment plants and natural and hybrid treatment systems	Lack of political decisions	Legal and regulatory
	Unrealistic norms and rules	Legal and regulatory
	Lack of promotional economic mechanisms	Legal and regulatory
Drip irrigation	Absence of local standards of irrigation water quality	Legal and regulatory
	High cost of technology introduction	Economic and Financial
	Lack of access to information for farmers and low level of training	Information and awareness

Measures to overcome the barriers have been identified for each technology and respective action plans have been drafted by the project team. The action plans have then been discussed with

stakeholders, particularly during the meeting held on December 19, 2016. Based on comments of participants of the meeting, amendments have been made to the technology action plans, following which the final versions of these have been approved by the working group of Interagency Council for coordination of requirements and provisions of UN Framework Convention on Climate Change, during its regular meeting held on January 31, 2017.

The action plans for each technology include the descriptions of respective sector and sub-sector, the ambition related to implementation of the technology, the list of actions, as well as the activities to be implemented under each action. For each activity, details on the sources of funding of its implementation responsible bodies, the implementation timeframe, relevant risks, success criteria, indicators for monitoring of implementation and finally the budgets are presented.

Key elements of technology action plans are summarized in the table below.

Technology	Action	Activities to be implemented
Windbreaks as climate change adaptation measure	1. Windbreak studying	Activity 1.1. Studying of international and national practices
	2. Legal regulation for windbreak establishment	Activity 2.1. Development of Strategy "On development of windbreaks in administrative territories of communities" and submit to RA Government approval.
		Activity 2.2. Public hearings on draft strategy.
		Activity 2.3. Submission of draft strategy for the approval of RA Government.
	3. Selection of communities for the implementation of pilot projects and clarification of relationships with stakeholders	Activity 3.1. Studying of natural and economic conditions of the community territory.
		Activity 3.2. Discussion of the project's expedience/commitment with community council and population.
		Activity 3.3. Coordination of terms of participation of the community in the project.
	4. Development of model design for windbreaks establishment	Activity 4.1. Evaluation of field assessments and results.
		Activity 4.2. Development of pilot project design.
		Activity 4.3. Environmental assessment of the design.
		Activity 4.4. Acceptance of the design by the client.
	5. Implementation of pilots in at least 3 communities	Activity 5.1. Adaptation of model design in accordance with conditions of pilot project communities.
		Activity 5.2. Development of bill of quantities of the project.
		Activity 5.3. Implementation of soil and tree planting works.
		Activity 5.4. Organization of maintenance and security of the plantations.
	6. Spreading information on the technology in rural communities	Activity 6.1. Organization of workshops as per main phases of project implementation.
		Activity 6.2. Spreading of leaflets and videos.
Local melioration and low-volume drip irrigation for newly planted orchards	1. Studying of international best practice and development of economic mechanisms for application of the technology.	Activity 1.1. Selection of countries.
		Activity 1.2. Selection of exemplary technologies.
	2. Development of technology	Activity 2.1. Feasibility study of the technology.

Technology	Action	Activities to be implemented
	introduction package with feasibility and environmental substantiations.	Activity 2.2. Professional and environmental expertise.
	3. Development of mechanisms and criteria for selection of pilot areas.	Activity 3.1. Mechanisms of selection and clarification of the status of land plots requiring melioration from the land fund of the community.
		Activity 3.2. Adoption of mechanisms of selection of pilot territories.
	4. Spreading of information on the results of pilot project	Activity 4.1. Organization of field days and presentation of information on project progress to the beneficiaries, as per project implementation stages.
		Activity 4.2. Publication and distribution of advisory leaflets about the project.
		Activity 4.3. Regular coverage in the media.
	5. Organization of experimental training days for beneficiaries.	Activity 5.1. Discussion of economic issues of selection of fruit varieties for pilot areas.
		Activity 5.2. Analysis of obtained results and development of recommendations.
		Activity 5.3. Clarification of orders of state support to dissemination of experience.
Diversification of agriculture	1. Feasibility study of effectiveness of agricultural production diversification	Activity 1.1. Selection of agricultural production diversification option under climate change
	2. Assessment of agricultural production market	Activity 2.1. Analysis of market capacity and geography.
		Activity 2.2. Assessment of the state of market infrastructure.
		Activity 2.3. Analysis of costs and prices.
	3. Clarification of financial and economic mechanisms	Activity 3.1. Development of economic mechanisms for introduction and development of the project.
		Activity 3.2. State support for provision of grants and low interest credits.
		Activity 3.3. Development of terms for co-financing by co-partners.
	4. Development of criteria for selection of territories	Activity 4.1. Selection of land plots located at the elevation of up to 600 meters above sea level out of the community land.
		Activity 4.2. Selection of adequate crops and varieties for natural conditions.
	5. Organization of propagation of seedlings and development of irrigation network reconstruction project	Activity 5.1. Selection of irrigated lands and modernization of the network.
		Activity 5.2. Establishing of nursery.
	6. Development and implementation of orchard planting and crop sowing plan.	Activity 6.1. Orchard planting.
		Activity 6.2. Sowing of sunflower, corn and sorghum.
Creation of recirculating water system for fisheries	1. Development of financial mechanisms	Activity 1.1. Studying of international practice on introduction and development of the system and development of economic mechanisms
		Activity 1.2. State support in terms of provision of grants and low interest loans.

Technology	Action	Activities to be implemented
	2. Increased efficiency of water use in fisheries	Activity 2.1. Development of water use standards for fisheries and legislative fixing of these
		Activity 2.2. Monitoring and revision of conditions of water use permissions provided to fisheries
		Activity 2.3. Improved supervision of observance of water use permissions' terms
		Activity 2.4. Development of new mechanisms for calculation of tariff for water used in fisheries.
	3. Development of enabling framework for the technology introduction	Activity 3.1. Development of a package of technology introduction proposals with technical, economic and environmental substantiations
		Activity 3.2. Implementation of pilot projects in 2-3 fisheries
		Activity 3.3. Monitoring and analysis of the technology introduced in pilot areas
	4. Development of technology introduction process	Activity 4.1. Spreading of information about the technology among the fisheries, presentation of the results of pilot projects
		Activity 4.2. Organization of trainings for fisheries
Installation of compact treatment plants and application of natural and hybrid treatment systems	1. Revision of Water Code and other legal documents with regards to wastewater removal and treatment / Development of new law and sub-legislative package on water removal	Activity 1.1. Analysis of the existing legislative field, development and adoption of new legislative package
		Activity 1.2. Revision of approaches on establishing of environmental pines and penalties for the purpose of obliging business to conduct wastewater treatment.
		Activity 1.3. Revision of treatment level depending on the purpose of reuse of wastewater (determination of TLOs)
	2. Development of financial mechanisms	Activity 2.1. Studying of international experience supporting construction of WWTPs by the businesses and development of new economic mechanisms.
		Activity 2.2. Adoption of wastewater treatment phased approach.
		Activity 2.3. State support through provision of grants and establishing and development of community funds.
		Activity 2.4. Establishing and development of community funds.
	3. Support to introduction of new effective technologies	Activity 3.1. Development of package of proposals for technology selection with feasibility and environmental substantiations.
		Activity 3.2. Construction of demo/pilot WWTPs using different technologies.
		Activity 3.3. Monitoring and analysis of work of constructed WWTPs
	4. Training of human resources and awareness raising	Activity 4.1. Training of specialists in design, construction and operation of WWTPs.
		Activity 4.2. Development of new attitude towards wastewater treatment and reuse among the population.
		Activity 4.3. Spreading of the idea of treated

Technology	Action	Activities to be implemented
		wastewater as a water resource within the society.
Spreading and expansion of drip irrigation system	1. Development and introduction of local standards of irrigation water	Activity 1.1. Studying of international standards of irrigation water.
		Activity 1.2. Development of national standards of irrigation water and fixing by law.
		Activity 1.3. Development of a system of supervision of irrigation water quality.
	2. Development of financial and economic mechanisms for introduction of the system	Activity 2.1. Studying of international experience on introduction and development of the system and development of economic mechanisms.
		Activity 2.2. State support for provision of grants and low interest credits.
	3. Development of enabling environment for introduction of the technology	Activity 3.1. Development of a package of proposals of technology introduction for farmers with feasibility and environmental studies.
		Activity 3.2. Implementation of pilot projects for different crops in at least 5 farms.
		Activity 3.3. Monitoring and analysis of introduction of the technology in pilot areas.
	4. Development of the process of technology introduction	Activity 4.1. Spreading of information on the technology among the farmers.
		Activity 4.2. Spreading of information on the results of pilot project.
		Activity 4.3. Organization of training courses for farmers.
		Activity 4.4. Promotion of local production of equipment for the technology.

Chapter 1.Agriculture Sector

1.1. Actions at the sectoral level

1.1.1. Agriculture overview

Agricultural lands occupy about 2.1 million ha, or 72% of the territory of the country, including 448.4 thousand ha of arable lands (21.9%), 33.4 thousand ha of perennial plantings (1.6%), 121.6 ha of hayfields (5.9%), 1,056.3 thousand ha of pastures (51.5%), and 392.7 thousand ha of other lands (19.1%).

The economic crisis of the beginning of 1990s had negative impacts/affected on Armenia's agriculture. As a result of land privatization former large farms were turned into around 340 thousand small farms, the average size of which is around 1.4 ha. This in turn has led to a decrease in the effectiveness of land management and production infrastructure. Following the transition to the market economy the sector has been experiencing a decline, including 30% reduction in crop yield, reduction in livestock numbers, halving of irrigated lands, as well as threefold reduction in the use of chemical fertilizers (See Table 1 for details).

Table 1. Numbers of livestock and poultry, thousand heads[3]

Livestock/poultry	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
Cattle	690.0	507.5	478.7	573.3	570.6	571.4	599.2	661.0	677.6	688.6
Sheep and goats	1,291	603.2	548.6	603.3	511.0	592.5.	590.2	674.7	717.6	745.8
Pigs	329.3	79.6	70.6	137.5	192.6	114.8	108.1	145.0	139.8	142.4
Horses	-	-	11.5	10.8	10.1	12.1	9.9	10.8	11.7	11.4
Poultry	11245	3100	4255.1	4861.7	4134.6	3462.4	4023.5	4050.0	4101.2	4145.5

Further decline in agricultural productions has been prevented and stability has been ensured thanks to the implementation of a number of projects by the Government and international organizations. As a result, the agricultural production has started growing, reaching average annual growth rate of7.7% in 2000-2006, which later decreasing to 2.2% (See details in Table 2).

Table 2. Production of main types of agricultural output, thousand tons[4]

Agricultural output	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
Grain	271.0	262.7	224.8	396.2	326.4	440.7	456.1	548.8	590.6	637.9
Potatoes	212.5	427.7	290.3	564.2	482.0	557.3	647.2	660.5	733.2	764.5
Vegetables	389.7	450.9	375.7	663.8	707.6	787.1	849.0	876.0	954.6	1031.5
Watermelons	31.4	54.0	52.8	117.8	132.5	180.9	205.1	208.1	245.8	286.8
Fruit and berries	155.5	146.1	128.5	315.6	128.5	239.4	331.7	338.1	291.0	386.5
Grapes	143.6	154.9	115.8	164.4	222.9	229.6	241.4	240.8	261.3	309.2
Meat (slaughter weight)	145.0	82.4	49.3	56.0	69.5	71.7	73.9	83.4	93.1	100.4
Milk	432.0	428.3	452.1	594.6	600.9	601.5	618.2	657.0	700.4	728.6
Eggs (million pieces)	606	518	385.4	518.2	702.2	633.6	658.1	615.2	641.8	659.8

In recent years, the average GDP share of agriculture in Armenia has been around 18%, while the share in labor market is much higher, reaching 44% of total workforce.

The sector is among the riskiest ones due to a number of reasons, including the climate change, which leads to increased air temperature and reduction of precipitations. Extreme atmospheric phenomena, common in Armenia, such as hails, early frosts, droughts, flooding, etc., arebecoming

[3]Armenia National Statistical Service (1990, 1995, 2001, 2006, 2013, 2016)
[4]Armenian National Statistical Service (1990, 1995, 2001, 2006, 2013, 2016)

more frequent as a result of changing climate, turning agriculture into one of the most vulnerable sectors.

1.1.2. Main documents regulating agriculture sector in Armenia

2010-2020 Sustainable Rural and Agricultural Development Strategy of the Republic of Armenia. The document reflects the importance of addressing of risks related to natural disasters and implementation of adaptation measures, namely, introduction of agricultural insurance. Another important direction is the implementation of mud-flow management and land erosion control. Other activities aimed at risk management include piloting of anti-hail systems, introduction of water efficiency technologies, regulation of irrigation water use in drought and water scarcity conditions, etc.

The Law of the Republic of Armenia on Agricultural Cooperatives adopted on December 21, 2015, regulates relationship related to establishing, membership, conduct of activities, implementation, cessation of activity, reorganization, and liquidation of agricultural cooperatives and unions of these and establishes the rights, duties and responsibilities of members of these, as well as the directions of state support of agricultural cooperatives.

The Law is designed to eliminate barriers limiting sustainable development preventing effective development of agriculture, such as small size of farms and land fragmentation emerged as a result of land privatization in the beginning of 1990s. Cooperative development can promote better coordination of activities among farmers, thus potentially helping climate change adaptation efforts.

1.1.3. Preliminary targets for technology transfer and diffusion in agriculture

The technologies prioritized for the agriculture within the framework of technology needs assessment include (i) windbreaks as climate change adaptation technology, (ii) local melioration and low-volume drip irrigation for newly planted orchards, as well as (iii) diversification of agriculture. The targets for transfer and diffusion of those technologies are linked to the vision of the Government of the Republic of Armenia for the development of agriculture, presented in 2010-2020 Strategy of Sustainable Development of Armenia's Agriculture[5]. These include the following:

- Development integrated family farming with agricultural organizations, cooperatives and market infrastructure, through application of intensive technologies,
- Provision of sustainable food security of population and meeting the demand for agricultural raw materials agro-processing sector through realistic combination of the interests of national food security and the principles of comparative advantages of external trade,
- Increasing of gross product in the agriculture mostly via labor productivity growth, reduction in the number of agricultural employees and use of part of excess workforce via agricultural service and trainings in non-agricultural activity sector,
- Processing of the significant part of produced agricultural goods in the workshops developed in rural communities as a result of development of small and medium enterprises,
- Prevalence of agricultural production with high added in crop production and cattle breeding,

[5] 2010-2020 Strategy of Sustainable Development of Armenia's Agriculture

- High level of food security of the population, self-sufficiency of the most important foods, reduction of rural poverty and emigration.

All of the prioritized technologies to some extent contribute to this vision, particularly by providing opportunities for increased incomes, intensification of agricultural activities, better cooperation among farmers, increased crops, etc.

1.2. Action plan – Windbreaks as climate change adaptation measure

1.2.1. Overview of Windbreaks as climate change adaptation measure

Windbreaks have long been used for land melioration purposes around the world and the technology is not new to Armenia either. During the soviet period, many of the agricultural lands, especially those used for grain production, were surrounded by small forests used as windbreaks. Studies have shown that by reducing the speed of wind, keeping the snow in the fields, increasing soil humidity, improving the microclimate, and protecting sowing from drought windbreaks help increasing the yield by 10-25%[6]. In addition to their direct function, these have also been used for local recreation purposes, and sometimes as a source of firewood.

Given that the climate change risks for Armenia also include intensiveness and frequency of strong winds, the technology is becoming very important for the country, where most of the existing windbreaks have been destroyed during the energy crisis of early 1990s. Windbreaks are established by planting of 3-4 lines of trees with total width of up to 15 meters. Depending on tree species a planting scheme with 2.5-4-meter space between the lines and 2-3 meters between the plants can be used.

Depending on the features of the terrain each windbreak can stretch 200-600 meters along the width and 1,000-1,200 meters along the length of fields. 10-15 meters wide spaces are left for farm machinery and vehicles.

If after harvesting the area is used for grazing of cattle, then the width of the spaces reach up to 20-25 meters. Preference is given to tree species with dense foliage (poplar, beech, elm, apple, plum, pear, sweet cherry, etc.). Planting scheme is used which makes wind penetration more difficult.

Since historically most of the windbreaks in Armenia have been planted on the territories of collective farms by the state, the technology can be considered as other non-market good, though in case of large-scale application of the technology farmers may also be required to invest into planting of windbreaks.

Windbreaks technology will mostly involve organizational issues, taking into consideration that the average size of Armenian farms is less than 1 ha, thus diffusion of this technology will require a lot of organizational efforts to ensure cooperation between a large numbers of farmers.

Based on the Second Edition of UDP Guidebook on Overcoming Barriers to the Transfer and Diffusion of Climate Technologies, the technology is mostly defined non-market, under the category of publicly provided goods. Windbreaks will be providing services to a large group of beneficiaries, while being owned either by state or farm cooperatives.

[6] 2015 annual report of "Gyumri selection station" CJSC of the Ministry of Agriculture of RA

Despite the relatively low cost of the technology implementation, it is still quite expensive for individual farmers, thus there will be a need for cooperation between them in order to finance planting of windbreaks, or there will be a need for government intervention, which may be a more realistic approach, given the difficulties related to cooperation in Armenia, as well as the significant impact the technology can have on agriculture.

1.2.2. Enabling framework –Windbreaks as climate change adaptation measure

The enabling framework for windbreaks technology is presented below.

Table 3. Enabling framework for Windbreaks as climate change adaptation tool

N	Enabling framework	Comments
1.	Legislation	Adoption of the RA Law on Agriculture will create a framework for the development of a legal basis to introduce necessary technologies, including windbreaks.
2.	Technical standards	Development of technical standards for windbreaks establishment will ensure proper quality of technology introduction, while at the same time potentially serving as a capacity building tool.
3.	Financial policy	Development of financial incentives for windbreaks establishment can become a triggering mechanism at the early stages of technology diffusion, since most of the farmers are currently not interested in long-term investments, despite the awareness of the benefits of windbreaks.
4.	Illegal logging	Since most of the windbreaks planted during the Soviet period have been destroyed as a result of illegal logging, it is important to increase the effectiveness of combating by better security measures, as well as providing alternative sources of energy and income, including agroforestry.
5.	Land cadaster	The mapping of agricultural lands requiring windbreak establishment will be an important preparatory activity for implementation of the technology.
6.	Forest management plans	In compliance with the Armenian legislation the definition of forest includes a surface of at least 1,000 m^2 and minimal width of 10 m, thus many windbreaks may potentially be considered forests, implying development of respective management plans. It is important to ensure that the windbreaks are included into them for protection and proper management purposes.
7.	National forest program	National forest program is the main document regulating forest policy in Armenia and inclusion of provisions on windbreaks in it will increase the attention towards the technology, thus potentially becoming a capacity building tool.
8.	Sectoral strategy	Windbreaks establishment is not included in respective strategies and doing so is important both for awareness raising and implementation of respective activities by republican and regional agricultural support centers.

1.2.3. Barriers – Windbreaks as climate change adaptation measure

i. Economic and financial barriers

The cost of this project is not significant, so it is not really a barrier to technology diffusion. Planting of 2,160 ha of windbreaks and the maintenance of these during the first year will cost AMD 3,240 million, and the annual cost of maintenance for the following years will be AMD 460 million. Thus, planting of windbreaks can be financed by 230 thousand beneficiaries. Each beneficiary will need to invest AMD 14,000 for the planting and AMD 2,000 annually for the maintenance during the following years.

Other issues, such as technical resources and seedlings are quite accessible and do not constitute major barriers either. There are many nurseries that can provide high quality seedlings for planting of windbreaks.

ii. Non-financial barriers

Non-financial barriers are more significant and include the following:

- *Limited knowledge on the benefits of the technology* – since most of the windbreaks have been felled more than 20 years ago, many farmers do not understand the importance of these or give low priority to the technology. Planting of windbreaks is an additional work for farmers with unknown results.
- *Lack of legal acts regulating the technology* – there are no documents that regulate or recommend the technology to the farmers or present its benefits, such as increased yield, etc. Agricultural support marz centers of the Ministry of Agriculture do not have any instructions on the introduction of windbreaks.
- *Large number of potential beneficiaries* – while the potential area of windbreaks all over the country is only around 2,160 ha, the number of potential beneficiaries is 230 thousand. In order to plant windbreaks in all potential locations it will be necessary to come to an agreement with all of these farmers, which will be rather difficult, if not impossible.
- *Lack of studies on the technology in Armenia* - during past 25 years there have virtually not been conducted any studies in this field and no advisory services have been provided to beneficiaries.
- *Small land parcels* – after the land privatization in the beginning of 1990s the average arable land parcel in Armenia is less than a hectare, thus the income of an individual farmer is also quite low. This is another factor leading to lack of interest in investing into new technologies. Moreover, due to small size of parcels, many of them are not used by the owners.

Limited understanding of climate change impacts – since most farmers have a limited understanding of climate change and its potential impact on their activities, they also do not attach importance to the adaptation measures.

1.2.4. Proposed action plan – Windbreaks as climate change adaptation measure

The action plan proposed for introduction of Windbreaks as climate change adaptation measure technology is presented in Table 4 below.

Table 4. Action plan for windbreaks technology

Sector	**Agriculture**
Sub-sector	**Windbreaks**
Technology	**The technology implies development of artificial windbreaks along the agricultural fields, with 3-year long first phase. Taking into consideration that for each 100 ha of agricultural land there is required 2.4 ha windbreak, for 14,475 ha arable land of proposed 15 communities there will be required 347.4 ha of windbreak in Akhuryan (1,845 ha), Arevik (938 ha), Azatan (2,492 ha), Aygabats (1,045 ha), Akhurik (563 ha), Arapi (783 ha), Karnut (672 ha), Kamo (906 ha), Jajur (364 ha), Hatsik (656 ha), Voskehask (1,154 ha), Mayisyan (635 ha), Shirak (909 ha), Gharibjanyan (431 ha) and Beniamin (417 ha) communities of Shirak region of Armenia.**
Intention	**It is planned to conduct pilot projects in 15 communities with over 31 thousand beneficiaries, with aim of creating preconditions for technology diffusion in the whole country.**
Benefits	**Windbreaks help to increase the grain yield by 10-25%, and the yield of potatoes and vegetables by 8-12%. Taking into consideration that according to the data of recent 5 years there is cultivated 12,000 of arable lands of selected communities, of which 70% are used for the production of grains, 6.5% - for potato, 2.5% for vegetables and 21% for forage, calculations show that windbreaks establishmentwill enable generation of additional annual gross output of AMD 716 million and AMD 430 million income. Since theestablishment of 1 ha of windbreak costs in average AMD 1.5 million, then 345 ha will require AMD 517.5 million. It appears that, within 3 year, when windbreaks have sufficient height and contribute to yield increasing the costs will be compensated starting from 4th year.**

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
1. Studying of windbreaks	Activity 1.1. Studying of international and national practices	International grant and state budget	MoA, MNP	1 year	Risk 1. Limited data on national experience	Criterion 1. Development of a road map for windbreak establishment	Indicator 1. Approval of professional and civil society	12,000
2. Legal regulation for windbreakestablishment	Activity 2.1. Development of Strategy on the development of windbreaks in administrative territories of communities.	State budget	MoA, MNP	1 year	Risk 1. No precedent in the last 25 years. Risk 2. Low level of awareness.	Criterion 1. Approval by stakeholders. Criterion 2. Readiness of LSGBs to implement. Criterion 3. Inclusion of strategy implementation activities in RA annual report on the implementation of European landscape convention.	Indicator 1. Conformity with the international best practice. Indicator 2. Stakeholders poll results.	2,800

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
	Activity 2.2. Public hearings of the draft strategy.	State budget	MoA, MNP	1 year	Risk 1. Absence of precedent. Risk 2. Low level of importance awareness.	Criterion 1. Approval by stakeholders. Criterion 2. Readiness of LSGBs to implement. Criterion 3. Inclusion of strategy implementation activities in RA annual report on the implementation of European landscape convention.	Indicator 1. Conformity with international best practice. Indicator 2. Stakeholders poll results.	1,200
	Activity 2.3. Submission of the draft strategy to the RA Government approval.	State budget	MoA, MNP	1 year	Risk 1. Absence of precedent. Risk 2. Low level of importance awareness.	Criterion 1. Approval by stakeholders. Criterion 2. Readiness of LSGBs to implement. Criterion 3. Inclusion of strategy implementation activities in RA annual report on the implementation of European landscape convention.	Indicator 1. Conformity with international best practice. Indicator 2. Stakeholders poll results.	3,000
3. Selection of communities for the implementation of pilot projects and specification of relationship with stakeholders	Activity 3.1. Studying of natural and economic conditions of the community territory.	International grant and state budget	MoA, MTAD, LSGBs	1 year	Risk 1. Underestimation of the importance of windbreaks. Risk 2. Discontent for the provision of land for the project. Risk 3. Lack of experience and willingness to implement joint project within the community.	Criterion 1. Effective campaign and professional consulting. Criterion 2. Willingness to cooperate.	Indicator 1. Development of a protocol on the cooperation and implementation of provided terms.	2,400

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
	Activity 3.2. Discussion of the project's expedience with community council and population.	International grant and state budget	MoA, MTAD, LSGBs	1 year	Risk 1. Underestimation of the importance of windbreaks. Risk 2. Discontent with provision of land for the project. Risk 3. Lack of experience and willingness to implement joint project within the community.	Criterion 1. Effective campaign and professional consulting. Criterion 2. Willingness to cooperate.	Indicator 1. Development of a protocol on the cooperation and implementation of provided terms.	600
	Activity 3.3. Coordination of the terms of community participation in the project.	International grant and state budget	MoA, MTAD, LSGBs	1 year	Risk 1. Underestimation of the importance of windbreaks. Risk 2. Discontent with provision of land for the project. Risk 3. Lack of experience and willingness to implement joint project within the community.	Criterion 1. Effective campaign and professional consulting. Criterion 2. Willingness to cooperate.	Indicator 1. Development of a protocol on the cooperation and implementation of provided terms.	600
4. Development of model design for windbreak establishment	Activity 4.1. Field studies and evaluation of results.	State budget	MoA	1 year	Risk 1. Diversity of natural and economic conditions. Risk 2. Fragmentation and small surface of agricultural land plots.	Criterion 1. Compliance with terms of reference of the client.	Indicator 1.Implementation deadlines and requirements of the client are met.	12,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
	Activity 4.2. Drafting of a pilot project.	State budget	MoA	1 year	Risk 1. Diversity of natural and economic conditions. Risk 2. Fragmentation and small surface of agricultural land plots.	Criterion 1. Compliance with the terms of reference of the client.	Indicator 1. Observation of the implementation deadline and requirements of the client.	8,000
	Activity 4.3. Environmental assessment of the draft project.	State budget	MoA	1 year	Risk 1. Diversity of natural and economic conditions. Risk 2. Fragmentation and small surface of agricultural land plots.	Criterion 1. Compliance with terms of reference of the client.	Indicator 1. Observation of the implementation deadline and requirements of the client.	2,000
	Activity 4.4. Acceptance of the draft project by the client.	State budget	MoA	1 year	Risk 1. Diversity of natural and economic conditions. Risk 2. Fragmentation and small surface of agricultural land plots.	Criterion 1. Compliance with terms of reference of the client.	Indicator 1. Observation of the implementation deadline and requirements of the client.	2,000
5. Implementation of pilots in at least 3 communities	Activity 5.1. Localization of the draft model project in accordance with the conditions of pilot project communities.	International and private grants	MoA	2 years	Risk 1. Uncertainty related to the provision of funds. Risk 2. Difficulty of obtaining consent and co-financing with farmers.	Criterion 1. Windbreaks establishment in selected communities.	Indicator 1. Windbreaks planted in at least three of shortlisted 15 communities. Indicator 2. Monitoring reports on the planting of windbreaks in pilot communities are developed.	12,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
	Activity 5.2. Drafting of cost estimate of the project.	International and private grants	MoA	2 years	Risk 1. Uncertainty related to provision of funds. Risk 2. Difficulty of obtaining consent and co-financing with farmers.	Criterion 1. Windbreaks establishment in selected communities.	Indicator 1. Availability of monitoring indicators conducted in at least 3 communities. Indicator 2. Availability of data analysis.	15,000
	Activity 5.3. Implementation of soil and tree planting works.	International and private grants	MoA	2 years	Risk 1. Uncertainty related to provision of funds. Risk 2. Difficulty of obtaining consent and co-financing with farmers.	Criterion 1. Windbreaks establishment in selected communities.	Indicator 1. Windbreaks planted in at least 3 of 15 shortlisted communities.	210,000
	Activity 5.4. Organization of thecare and maintenance of plantations.	International and private grants	MoA	2 years	Risk 1. Uncertainty related to provision of funds. Risk 2. Difficulty of obtaining consent and co-financing with farmers.	Criterion 1. Windbreaks establishment in selected communities.	Indicator 1. Monitoring reports on the care and maintenance of windbreaks in pilot communities are developed.	148000
6. Diffusion of information on the technology in rural communities	Activity 6.1. Organization of workshops at the main stages of the project implementation.	International grant, state budget	MoA	2 years	Risk 1. Low level interest in communities. Risk 2. Low level of professionalism of campaigners. Risk 3. Poor quality information materials.	Criterion 1. Interested and active farmers. Criterion 2. Availability of information materials. Criterion 3. Farmers' behavioral change	Indicator 1. Monitoring on the technology introduction progress twice a year. Indicator 2. Analysis of monitoring results and submission of recommendations.	3,500
	Activity 6.2. Distribution of leaflets and educational films.	International grant, state budget	MoA	2 years	Risk 1. Low level interest in communities. Risk 2. Low level of professionalism of	Criterion 1. Interested and active farmers. Criterion 2. Availability of information materials. Criterion 3. Farmers'	Indicator 1. Report on the monitoring of the technology introduction progress twice a year. Indicator 2. Analysis of	3,500

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
					campaigners. Risk 3. Poor quality information materials.	behavioral change.	monitoring results and submission of recommendations.	

1.3. Action plan – Local melioration and low-volume drip irrigation for newly planted orchards

1.3.1. Overview of Local melioration and low-volume drip irrigation for newly planted orchards

The Republic of Armenia has around 12 thousand ha of unused land in dry subtropical and continental climatic zones. The reasons are the lack of irrigation water and thin humus layer, and those issues will become even more acute, as climate change in Armenia will mostly lead to reduced precipitation and increase of average temperature. In fact, these processes are already more acute in Armenia, than in most of the world, with the reduction of precipitations by about 10% over the last decades and increasing of air temperature by over 1.10 C.

Nevertheless, the suggested technology of Local melioration and low-volume drip irrigation for newly planted orchards makes the agriculture possible even in deserts. The technology includes local melioration accessible only across the roots of the tree (Water is applied close to plants so that only part of the soil in which the roots grow is wetted), and planting of orchards with thermophilic fruit trees using drip irrigation. In Armenia, such territories exist in Ararat, Armavir, Aragatsotn, Kotayk, Tavush and Syunik marzes, the use of which can ensure adaptation to climate change and will have economic, social and environmental significance.

Other important components of this technology include removing of stones, sand, soil without humus from the tree trunk zone and melioration with carried fertile soil, conduction of watering and nourishing of seedlings or group of seedlings through drip irrigation system with pipes attached to small tanks in the territories with dry subtropical and severe continental climate.

Depending on the melioration needs of the location, distance of water sources and fruit type, the cost of planting of 1 ha of orchard and installation of drip irrigation system with small tanks will be about AMD 2.5-3 million. Maintenance of one hectare of apricot and peach orchard requires AMD 400 thousand per year. After the maintenance, AMD 40 thousand is needed for harvesting of 1 ton. This cost increases proportionally depending on the harvest of given years. Profit from realization of harvest of one-hectare apricot orchard is AMD 7 million (in case of harvest of 30 tons). The average income is around AMD 5 million.

While it is foreseen that the technology may initially be attractive for large farms and the state, it can be used by smaller farms as well. Given that there are around 12 thousand ha of land in dry subtropical and continental climatic zones in need of melioration, and the average land plot is around 1 ha per family in Armenia, the technology will have approximately 12 thousand users, which is a significant number for Armenia. Taking this into consideration, the technology can be categorized as a consumer good.

1.3.2. Enabling framework –Local melioration and low-volume drip irrigation for newly planted orchards

The enabling framework for local melioration of low-volume drip irrigation technology is presented below.

Table 5. Enabling framework for Local melioration and low-volume drip irrigation for newly planted orchards

N	Enabling framework	Comments
1.	Legislation	The adoption of RA Law on Agriculture will create a framework for the development of legal basis for the introduction of necessary technologies, including those of local melioration and low-volume drip irrigation for newly planted orchards.
2.	Technical standards	The development of technical standards for local melioration and low-volume drip irrigation will ensure proper quality of technology introduction, while at the same time potentially serving as a capacity building tool.
3.	Financial policy	Soft loans for the introduction of advanced agricultural technologies, such as drip irrigation, will create enabling framework and incentives for farmers.
4.	Irrigation water standards	The development of irrigation water quality standards is necessary to ensure farmers with proper quality irrigation water supply not requiring excessive investments for the purchase of filters, as well as maintenance costs.
5.	Melioration programs	The development of respective programs by the Government will become an important impetus on the importance of the technology both for farmers and larger investors
6.	Land cadaster	The mapping of respective lands, assessment of the quality of soils, climatic conditions and other characteristics will make the decision-making easier for farmers and investors.
7.	Sector strategy	While drip irrigation is included in development documents, reclamation is not sufficiently covered. This will become an important step for awareness raising and implementation of respective activities by regional and republican agricultural support centers.

1.3.3.Barriers – Local reclamation and low-volume drip irrigation for newly planted orchards

i. Economic and financial barriers

High cost – the average cost for the local reclamation/melioration of 1 ha and planting of orchard is about AMD 2.5-3.0 million, which is a considerable sum for the majority of farmers due to their low solvency. Since most of the lands requiring reclamation is located in areas prone to hails it will be necessary to install anti-hail nets to protect the newly planted orchards from hail. While anti-hail nets have already been tested in Armenia and proved their usefulness both from financial and technological perspectives, installation of these will require additional investments, which may be unaffordable for most of the farmers in Armenia.

ii. Non-financial barriers

Insufficient level of irrigation water infrastructure– most of the land requiring reclamation/melioration is located in areas where irrigation water infrastructure needs rehabilitation, as since the beginning of 1990s no agricultural activities have been conducted. In addition, these are also relatively dry areas and water may need to be brought from a remote area.

Limited *technological capacities for the reclamation of rocky soils* – while Armenia is rich in rocky soils, there is actually no experience in local melioration provided by the given technology. A major melioration project has recently been implemented by Tierras de Armenia in Armavir marz, where vineyards have been planted. But this is the only example of rocky soil reclamation during recent years.

Imperfection of legislation on the reclamation of unused lands and absence of motivation mechanisms – given the abundance of unused lands throughout the country, it may be a challenge to find investors interested in melioration of rocky soils, if no incentives are provided by the state, which currently has no clear legislation on subject matter.

Consolidating land owners is an issue – while during the Soviet period all farmers were united in different forms of collective farms, following land privatization of early 1990s most farmers became landowners and despite numerous efforts, uniting them around common issues has proved to be extremely difficult.

Lack of productive and economic potential assessment of unused lands in the Republic of Armenia – there is no cadaster map presenting the unusable lands, and subsequently an assessment of potential benefits of using such land in case land reclamation is not carried out.

Lack of scientific and educational/consulting activities on the technology – owners of land plots requiring reclamation need consulting to know whether it is worth making investments into melioration of these.

1.3.4. Proposed action plan – Local reclamation/melioration and low-volume drip irrigation for newly planted orchards

The action plan proposed for introduction of Local melioration and low-volume drip irrigation for newly planted orchards technology is presented in Table 6 below.

Table 6. Action plan for local melioration technology

Sector	**Agriculture**
Sub-sector	**Local reclamation and low-volume drip irrigation fore newly planted orchards**
Technology	**Planting of thermophilic fruit orchards on semi-desert and rocky and sandy soils of Ararat Valley and foothill zone, which are not currently used for agricultural purposes due to low fertility and insufficient humidity, returning these to productive turnover by applying local reclamation applied only in the contour accessible tree root and low-capacity drip irrigation.**
Ambition	**Local melioration of 12,000 ha of semi-desert and rocky and sandy soils of Ararat Valley and foothill zone for cultivation of thermophilic fruit crops. In case of application of the recommended technology low-growth intensive orchards can be planted, applying jet or low-capacity drip irrigation system, using water absorbents and anti-hail nets. In case of proper implementation of the technology there will be sustainable yield within 3-4 years, which will compensate the main costs in 2 years.**
Benefits	**Benefits of the technology include 2.5-3-fold reduction of irrigation costs, 60-80% increasing of yield, 45-50% profitability of fruit production, expansion of irrigated lads, water saving, increasing of incomes of population.**

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
1. Studying of international best practice and development of economic mechanisms on the application of the technology.	Activity 1.1. Selection of countries for experience analysis in local melioration and conduction of study tours.	International grant, state budget	MoA	1 year	Risk 1. Selection of countries with experience that is completely different from that of Armenia. Risk 2. Selection of high cost technologies.	Criterion 1. Selected country is mostly similar to Armenia. Criterion 2. Selected technology is accessible in Armenia.	Indicator 1. Positive feedback of beneficiaries and the professionals of the field.	2,000
	Activity 1.2. Selection of most appropriate model technologies applied in visited countries.	International grant, state budget	MoA	1 year	Risk 1. Selection of countries with experience that is completely different from that of Armenia. Risk 2. Selection of highly costly technologies.	Criterion 1. Selected country is mostly similar to Armenia. Criterion 2. Selected technology is accessible in Armenia.	Indicator 1. Positive feedback of beneficiaries and the professionals of the field.	3,000
2. Development of a package of	Activity 2.1. Feasibility study of the technology.	International grant, state	MoA	1 year	Risk 1. Difficulty in finding financial	Criterion 1.Thoroughness and investment	Indicator 1. Meeting the client's needs.	22,000

technology introduction with feasibility and environmental substantiations.		budget			means. Risk 2. Lack of professional experience.	attractiveness of the project. Criterion 2. Positive conclusion of the expertise.	Indicator 2. Compliance with international standards.	
	Activity 2.2. Conducting professional and environmental expertise of the technology.	International grant, state budget	MoA	1 year	Risk 1. Difficulty in finding financial means. Risk 2. Lack of professional experience.	Criterion 1. Thoroughness and investment attractiveness of the project. Criterion 2. Positive conclusion of the expertise.	Indicator 1. Meeting the client's needs. Indicator 2. Compliance with international standards.	8,000
3. Development of mechanisms and criteria for the selection of pilot areas.	Activity 3.1. Mechanisms for the selection of land plots requiring reclamation from the community land fund and clarification of the status. Համայնքների հողային ֆոնդից մելիորացվող հատվածների ընտրության և կարգավիճակի հստակեցման կառուցակարգեր	State	MoA, territorial administration and LSG bodies	1 year	Risk 1. Difficulty of access to irrigation water. Risk 2. Lack of special reclamation equipment/melioration machinery. Risk 3. There are no proper conditions for the use of the machinery.	Criterion 1. Cooperation between project implementer and land owner. Criterion 2. Possibility of ensuring conditions for the cultivation of thermophilic crops.	Indicator 1. Cadaster assessment and registration. Indicator 2. Registration of the right of ownership or lease.	15,000
	Activity 3.2. Adoption of mechanisms for selection of pilot territories.	State	MoA, territorial administration and LSG bodies	1 year	Risk 1. Difficulty of access to irrigation water. Risk 2. Lack of special melioration machinery. Risk 3. Absence of conditions for use of machinery.	Criterion 1. Cooperation between project implementer and land owner. Criterion 2. Possibility of ensuring conditions for production of thermophilic crops.	Indicator 1. Cadaster assessment and registration. Indicator 2. Registration of ownership right of lease.	5,000
4. Distribution of information on the results of the pilot project	Activity 4.1. Organization of field days and presentation of information on project progress to the beneficiaries, as per	International grant, state budget	MoA, territorial administration and LSG bodies	3 year	Risk 1. Lack of interest towards lands requiring reclamation due to the availability of uncultivated arable lands in Armenia.	Criterion 1. Interest/co-financing of beneficiaries. Criterion 2. Implementation of similar projects initiated by communities and farmers.	Indicator 1. Monitoring of presentation of project outcome and coverage of the progress.	8,000

	project implementation stages.				Risk 2. Presentation of project results at required professional level.			
	Activity 4.2. Publication and distribution of advisory leaflets on the project.	International grant, state budget	MoA, territorial administration and LSG bodies	3 year	Risk 1. Lack of interest towards lands requiring melioration due to availability of uncultivated arable lands in Armenia. Risk 2. Presentation of project results at required professional level.	Criterion 1. Interest/co-financing of beneficiaries. Criterion 2. Implementation of similar projects initiated by communities and farmers.	Indicator 1. Monitoring of the coverage of project outcomes and progress.	3,000
	Activity 4.3. Regular media coverage	International grant, state budget	MoA, territorial administration and LSG bodies	3 year	Risk 1. Lack of interest towards lands requiring reclamation due to the availability of uncultivated arable lands in Armenia. Risk 2. Presentation of project results at required professional level.	Criterion 1. Interest/co-financing of beneficiaries. Criterion 2. Implementation of similar projects initiated by communities and farmers.	Indicator 1. Monitoring on the coverage of project outcomes and progress.	8,000
5. Organization of experimental training days for beneficiaries.	Activity 5.1. Discussion on economic issues of selection of fruit varieties in pilot areas.	International and private grants, state budget	MoA, territorial administration and LSG bodies	3 years	Risk 1. Formal selection of participants. Risk 2. Random selection of external experts.	Criterion 1. Participants show enhanced interest in discussions. Criterion 2. Practical recommendations on improvement of the projects. Criterion 3. New applications from participants	Indicator 1. Monitoring on participation and the training process.	12,000

	Activity 5.2. Analysis of obtained results and development of recommendations.	International and private grants, state budget	MoA, territorial administration and LSG bodies	3 years	Risk 1. Formal selection of participants. Risk 2. Random selection of external experts.	Criterion 1. Participants show enhanced interest in discussions. Criterion 2. Practical recommendations on the improvement of the projects. Criterion 3. New applications from participants	Indicator 1. Monitoring on the participation and the training process.	4,000
	Activity 5.3. Specification of state support regulations on the dissemination of practices.	International and private grants, state budget	MoA, territorial administration and LSG bodies	3 years	Risk 1. Formal selection of participants. Risk 2. Random selection of external experts.	Criterion 1. . Participants show enhanced interest in discussions Criterion 2. Practical recommendations on the improvement of the projects. Criterion 3. New applications from participants.	Indicator 1. Monitoring on participation and the training process.	4,000

1.4. Action plan – Diversification of agriculture

1.4.1. An overview of Agricultural Diversification

While most of the territory of the Republic of Armenia is located more than 1,000 meters above sea level, there are certain areas located at elevations up to 600 m, which are more exposed to climate change risks. Here average air temperature increase and lack of irrigation water due to reduction of precipitation may become a serious threat.

Given the above-mentioned thermophilic crop area expansion and water-saving irrigation technology development may be a good adaptation measure. The technology of Agricultural Diversification/diversified agriculture technology suggest adaptation to climate change and mitigation of socio-economic consequences via diversification of agricultural production in lower communities of Meghri region of Syunik marz and Noyemberyan region of Tavushmarz of RA.

The technology involves diversification of agricultural activities of the farmers from respective communities by increasing the area of intensive orchards of persimmon, pomegranate, olive, fig and other subtropical fruits, as well as by using anti-hail nets and local drip and jet irrigation low cost and water saving systems. Zorakan and Haghtanak communities of Noyemberyan region of Tavush marz are viewed as project sites.

Similar project can also be implemented in Bagratashen, Deghdzavan, Debedavan, Ptghavan, Voskevan, Koti, Barekamavan communities of the same region, as well as Meghri, Agarak, Alvank, Shvanidzor, Nrnadzor, Lehvaz, Vardanidzor and other communities of Meghri region of RA.

In terms of its category and market character, the technology of agricultural diversification has two dimensions. On one hand, it can be described as consumer good, since the potential consumers include all farmers living at the elevations of up to 600 m, while at the initial stage the required seedlings will mostly be imported, thus requiring a relatively complicated supply chain. On the other hand, the soft part of the technology implies provision of consulting services usually provided by respective state agencies. Thus, the technology has certain characteristics of other non-market good as well.

1.4.2. Enabling framework –Diversification of agriculture

The enabling framework for technology of agricultural diversification is presented below.

Table 7. Enabling framework for Diversification of agriculture

N	Enabling framework	Comments
1.	Legislation	The adoption of RA Law on Agriculture will create a framework for development of legal basis for introduction of necessary technologies, including diversified agriculture.
2.	Technical standards	The Development of technical standards for diversified agriculture will ensure introduction of proper quality technology, while at the same time potentially serving as a capacity building tool.
3.	Financial policy	Soft loans and more favorable insurance schemes for introduction of advanced agricultural technologies, such as diversified agriculture, will create a favorable environment and incentives for farmers.
4.	Irrigation water standards	The development irrigation water quality standards is necessary to ensure farmers with proper quality irrigation water supply not requiring excessive investments into filters of drip irrigation systems, as well as maintenance costs.
5.	Land cadaster	The development of an adequate database of lands will facilitate decision-making process for farmers and investors.
6.	Sector strategy	Paying more attention to agriculture diversification in agriculture strategic papers will become an important step for awareness raising and implementation of respective activities by regional and republican agricultural support centers.

1.4.3. Barriers – Diversified agriculture

i. Economic and financial barriers

Perceived high cost – planting of persimmon, pomegranate, olive, fig and other subtropical fruit varieties, introduction of intensive technologies, anti-hail nets, local drip or jet irrigation systems require significant investments, which are unbearable for farmers.

Insufficient level of development of logistic mechanisms and processing facilities – one of the main issues for farmers in Armenia is selling their products, and in case of non-traditional crops this can be even more problematic.

ii. Non-financial barriers

Limited number of local nurseries with sufficient capacity – local nurseries do not have enough experience in the cultivation of seedlings of required species, thus it may be difficult to obtain necessary seedlings at the moment. Also, most of them do not have sufficient capacities to conduct selection of varieties best adapted for Armenia.

Absence of RA Law on Agriculture – there is no regulation or promotion of introduction of new species and varieties, including GMOs.

Lack of guidelines on agricultural systems and agricultural rules – the introduction of new species will require new skills and knowledge, while none of these is available and there are no guidelines to help farmers interested in diversified agriculture.

Difficulty of consolidation/collaboration of different land owners – while during the Soviet period all farmers have been united in different forms of collective farms, following land privatization of early 1990s most farmers became landowners and despite numerous efforts, uniting them around common issues has proved to be extremely difficult.

Uncertainty over climate change patterns[7] – despite the increase of average air temperature, it is difficult to predict what exact temperature trends there will be in 15-20 years, thus the risk associated with introduction of new species remains high.

Lack of research on diversified agriculture – farmers introducing new species take risks, for studies conducted to assess their effectiveness in Armenia are limited.

[7]Gevorgyan A. Main types of synoptic processes and circulation types generating heavy precipitation events in Armenia //Meteorology and Atmospheric Physics.-2013

1.4.4. Proposed action plan – *Diversified agriculture*

The action plan proposed for introduction of diversified agriculture technology is presented in Table 8 below.

Table 8. Action plan for diversified agriculture technology

Sector	**Agriculture**
Sub-sector	**Diversified agriculture production in lower zones of Armenia for the purpose of climate change adaptation**
Technology	**The impacts of climate change are most visible in lower zones of Armenia, in communities located at an altitude of up to 600 meters above the sea level. Specifically, the increasing of air temperature and lack of sources of irrigation water increase the risks related to production of traditional crops. Thus, climate risks need to be made more manageable via thermophilic crop area expansion and introduction of water-saving irrigation technologies.**
Ambition	**The project implies climate change adaptation and mitigation of socio-economic situation via diversification of agricultural production in low-lying communities of Meghri region of Syunikmarz and Noyemberyanregion of Tavushmarz of Armenia. Zorakan and Haghtanak communities of Noyemberyan region of Tavush marz have been considered as pilot project sites. Similar project will be implemented in Bagratashen, Deghdzavan, Debedavan, Ptghavan, Voskevan, Koti and Barekamavan communities of the same region, based on the results of piloting Zorakan and Haghtanak communities.**
Benefits	**Benefits of the technology include effective utilization of production potential and means of production and reduced seasonality thanks to diversification of agricultural production, 2.5-3-fold growth of income received from a unit of land in comparison with grains.**

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
1.Feasibility study on the effectiveness of a diversified agriculture **production**	Activity 1.1.Selection of agricultural production diversification option under climate change	Grant	MoA, Tavush regional administration, LSGBs	1 year	Risk 1.The power of tradition. Risk 2. Absence of precedent. Risk 3.Labor-intensivenew option	Criterion 1. Participation of co-partners. Criterion 2. Income stabilization. Criterion 3. Increased employment. Criterion 4.Land useeffectiveness.	Indicator 1. Measurability of outcomes of project phases. Indicator 2. Monitoring plan for the assessment of technology introduction efficiency.	3,000
2. Assessment of the agricultural productsand their market	Activity 2.1. Market capacity and geographical analysis.	Grant	MoA, Tavush regional administration , LSGBs	1 year	Risk 1. Difficulties inaccessing foreign markets. Risk 2. Imperfection of logistic system. Risk 3. Difficulty in introducing a new product into the	Criterion 1. Increased gross output and net income as per unit of land. Criterion 2. Increased profitability of production. Criterion 3. Increased opportunities for selling of fresh and processed	Indicator 1. Expertise on the reliability of study results.	3,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
					market	produce.		
	Activity 2.2. Assessment of fresh and processed produce market infrastructure.	Grant	MoA, Tavush regional administration, LSGBs	1 year	Risk 1. Difficulties in accessing foreign markets. Risk 2. Imperfection of logistic system. Risk 3. Difficulty in introducing a new product into the market	Criterion 1. Increased gross output and net income as per unit of land. Criterion 2. Increased profitability of production. Criterion 3. Increased opportunities for the selling of fresh and processed produce.	Indicator 1. Expertise on the reliability of study results.	2,500
	Activity 2.3. Analysis of costs and prices.	Grant	MoA, Tavushregional administration, LSGBs	1 year	Risk 1. Difficulties accessing foreign markets. Risk 2. Imperfection of logistic system. Risk 3. Difficulty in introducing a new product into the marketplace.	Criterion 1. Increased gross output and net income as per unit of land. Criterion 2. Increased profitability of production. Criterion 3. Increased opportunities for the selling of fresh and processed produce.	Indicator 1. Expertise on the reliability of study results.	3,500
3. Specification of financial and economic mechanisms	Activity 3.1. Development of economic mechanisms for project introduction and development.	State, international grants	MoA, Tavush regional administration, LSGBs	5 years	Risk 1. Difficulties in localizing international practice. Risk 2. Difficulty in finding financial means. Risk 3. Lack of interest at state level. Risk 4. Corruption.	Criterion 1. Technological card and business plan. Criterion 2. Existence of clear economic structures and systems. Criterion 3. Cooperation agreement between copartners.	Indicator 1. Number of available technological cards and business plans.	5,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
	Activity 3.2. State support for the provision of grants and low interest credits.	State, international grants	MoA, Tavush regional administration, LSGBs	5 years	Risk 1. Difficulties in localizing international practice. Risk 2. Difficulty of finding financial means. Risk 3. Lack of interest at state level. Risk 4. Corruption.	Criterion 1.Technological card and business plan. Criterion 2. Clear economic structures and systems. Criterion 3. Cooperation agreement between copartners.	Indicator 1. Monitoring on the coordinated activities of farmers and project managers.	50,000
	Activity 3.3. Development of co-financing terms for partners.	State, international grants	MoA, Tavush regional administration, LSGBs	5 years	Risk 1. Difficulties in localizing international practice. Risk 2. Difficulty of finding financial means. Risk 3. Lack of interest at state level. Risk 4. Corruption.	Criterion 1. Technological card and business plan. Criterion 2. Clear economic structures and systems. Criterion 3. Cooperation agreement between copartners.	Indicator 1. Monitoring on the coordinated activities of farmers and project managers.	25,000
4. Development of criteria for the selection of sites	Activity 4.1. Selection of land plots located at an altitude of 600 meters above sea level out of the community land.	State, Private Interested land owners, State grant Private co-financing	MoA, LSGBs	1 year	Risk 1. Wrong registration of soil-climatic parameters. Risk 2.Incorrect methodology of optimal structure of arable lands.	Criterion 1. Effective design of arable land structure. Criterion 2. Locally adapted and prospective varieties.	Indicator 1. Cadaster evaluation and registration. Indicator 2. Expert assessment.	3,000
	Activity 4.2. Adopt crops and varieties to natural, economic conditions.	State, Private Interested land owners State grant	MoA and respective specialized institutions, LSGBs	1 year	Risk 1. Incorrect registration of soil-climatic parameters. Risk 2. Incorrect	Criterion 1. Effective design of structure of arable lands. Criterion 2. Locally adapted and prospective varieties.	Indicator 1. Number of preselected adequate crops and varieties. Indicator 2. Expert assessment.	2,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
		Private co-financing			methodology of optimal structure of arable lands.			
5. Organization of fruit tree seedlings produce and development of irrigation network reconstruction project	Activity 5.1. Selection of irrigated lands and network modernization.	State grant, Private co-financing	MoA	1 year	Risk 1. Difficulty in finding relevant professionals.	Criterion 1. Compliance with technological conditions/environment	Indicator 1.Compliance of implemented activities with respective technological conditions.	1,000/ha
	Activity 5.2. Nursery establishment.	State grant, Private co-financing	MoA	1 year	Risk 1. Difficulty in finding relevant professionals.	Criterion 1. Compliance with technological conditions/environment.	Indicator 1. Level of compliance of implemented activities to respective technological conditions.	1,200/ha
6. Development and implementation of orchard planting and crop sowing plan.	Activity 6.1. Orchard planting.	State grant, Private co-financing	MoA	2 years	Risk 1. Difficulty in finding relevant professionals.	Criterion 1. Compliance with technological conditions/environment.	Indicator 1. Level of compliance of implemented activities to respective technological conditions.	5,000/ha
	Activity 6.2. Sowing of sunflower, corn and sorghum.	State grant, Private co-financing	MoA	2 years	Risk 1. Difficulty in finding relevant professionals.	Criterion 1. Compliance with technological conditions/environment.	Indicator 1. Level of compliance of implemented activities to respective technological conditions.	600/ha

Chapter 2.Water Sector

2.1. Actions at the sectorial level

2.1.1. Overview of water sector

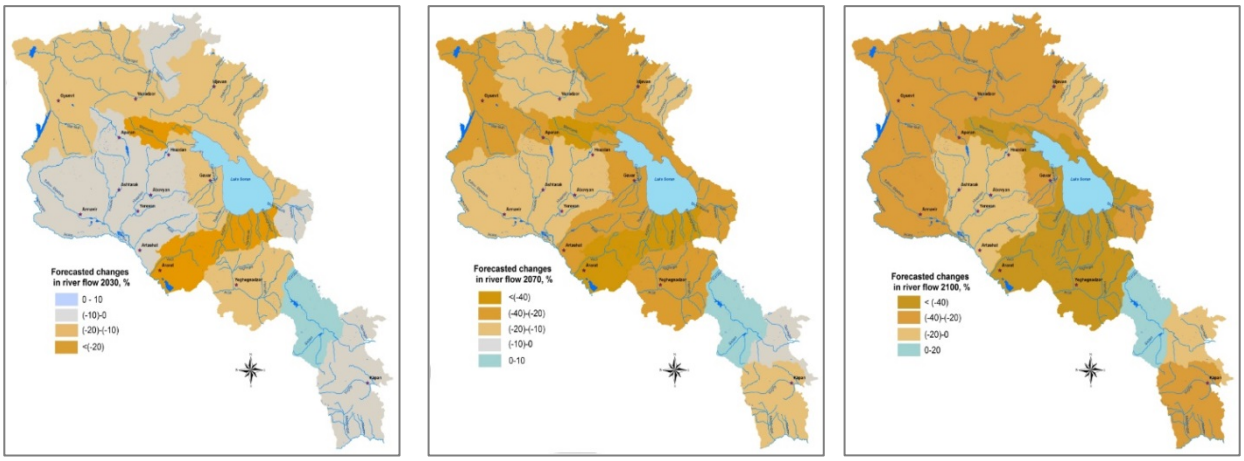
Water resources play a key role for the development of Armenia's economy, especially for sectors like agriculture, where about 80% of crops are irrigated, as well as and hydro energy, with 1,032 MW installed capacity, which makes around 30-40% of annual energy production. 96% of drinking water is received from ground water sources (2013). Thus, efficient management of water resources is essential in the socio-economic development of the country.

Total intake of water in 2013 has been 2,955 million m^3,of which 2,089.1 million m^3has been used. 88% of water has been used for irrigation, pisciculture and forestry needs, manufacturing has used 8% and 4% has been used for drinking and domestic needs. In 2014 and 2015, water intake has been 2,860.2 and 3,271.7 million m^3, respectively, of which 2,112.8 and 2,533.1 million m^3 have been used. At that, 86% of the water was used for irrigation, pisciculture and forestry needs in 2014, and 90% in 2015.[8]

Araks is the only large river of Armenia, but the river network in general is quite dense, with over 200 rivers that are longer than 10 km, and the total length of these is about 13 thousand km. Nevertheless, most of them dry in summertime and have no permanent flow.

Armenia has uneven spatial distribution of water, and has water scarcity issues in central part of the country, where the population is the densest. While Hrazdan River is the main source of water in this part of the country, it has significant annual flow fluctuations, reaching up to 50%. The projected changes in river flows in Armenia are shown below.

Projected changes in river flows in Armenia for 2030, 2070 and 2100.



2030 **2070** **2100**

Fisheries are one of the new directions of agriculture sector that are promoted by RA Government. Currently more than 300 fish farms operate in Armenia, most of which (76%) is located in Armavir and Ararat provinces. 70 fish farms exist nn remaining 8 provinces of RA (24% of fisheries), more than half of which is located in Gegharkunik, Lori and Shirak provinces. According to data provided by Ministry of Agriculture of the RA, currently there are 2,670 ha of water surface used for industrial fisheries. 60% of water used for industrial fisheries is groundwater, while 40% is surface. Currently

[8] Statistical yearbook of Armenia, 2016

there are more than 250 fisheries operating in Ararat artesian basin, which use groundwater of the Valley for their needs (450 wells are used).

The renewable groundwater reserves of the Valley are 1,226 million m3, while fisheries have been provided with 1,496 million m3water use permits. There are mostly conventional flow "flow through" fisheries, where water flows through fishery system and then is discarded into environment. While in case of "flow through" system the water supplies oxygen to fish and removes dissolved or suspended particles. As a result of exploitation of "flow through" system fisheries, annually 800 million m3 of water from Ararat artesian basin flows into Arax River, and then to neighboring countries. Transition to circulatory (semi-closed) and closed water supply systems will enable decreasing water consumption several times and using water resources more effectively (in case of circulatory system the volume of fresh water is about 30%, and in case of closed system – 3-5%).

Wastewater collection and treatment systems are available in all urban and about 20% of rural communities. Existing 20 WWTPs have been designed for mechanical and biological treatment of wastewater. Municipal sanitation systems are used for the collection of wastewater, which later goes to WWTPs, often by gravity flow. Nevertheless, despite the existence of collection systems, the wastewater is mostly directly discharged into rivers and other water bodies, due to the absence of necessary facilities for the collection and transfer of wastewater to WWTPs.

Most of wastewater treatment plants were constructed prior to 1990 and are outdated. Since then they have become inefficient and costly due to the increase of energy price.

2.1.2. Main documents regulating water sector in Armenia

The Law of the Republic of Armenia on National Water Programme of the Republic of Armenia. The Law regulates relationship related to National Water Programme, including the assessment of water resources, water demand and supply, main objectives and perspectives of water sector protection and development. The Law is designed to meet the demand for water via efficient management of usable water resources, environmental protection, regulation and use of water resources, etc.

The Law of the Republic of Armenia on Fundamentals of National Water Policy. The law is designed to ensure access to water resources for various purposes including social and economic development and environment protection, today and in the future.

Fundamentals of National Water Policy include the following directions: (1) sustainable management of water resources, (2) priorities of water resources use and protection, (3) accounting and assessment of water resources, (4) development of water resources demand and supply, and (5) relations regarding water basin management.

2.1.3. Preliminary targets for technology transfer and diffusion in water sector

The water sector technologies prioritized during the technology needs assessment phase of the Project included (i) design of recirculating water system for fisheries, (ii) installation of compact wastewater treatment plants and application of natural and hybrid treatment systems, and (iii) spreading and diffusion of drip irrigation system. Note that the second technology actually includes two technologies, but since these are interconnected and the drip irrigation technology is very important for Armenia due to agriculture's in its economy, it was decided to unite the two in the Barrier Analysis and Enabling Framework report.

The water sector of Armenia is regulated by two major documents, including RA Law on National Water Program and RA Law on Fundamentals of National Water Policy. The objectives of these documents include meeting of the needs of population and the economy through efficient use of water resources, ensuring environmental sustainability, regulation and use of strategic water reserves, protection of national water reserve, etc.

Technologies prioritized during the technology needs assessment phase are all in compliance with the above-mentioned objectives. Given climate change impact on water resources in Armenia, in particular the reduction of precipitations and surface evaporation growth, it is important to manage the existing water resources more efficiently, as well as to protect surface and ground water reserves from contamination.

The first technology is important both for the protection of ground and surface water reserves, as fisheries in Armenia, and especially in the important agricultural area of Ararat Valley, mostly depend on groundwater, while used water is then discharged into surface water bodies contaminating them. Ararat Valley groundwater basin is also important for the energy sector, as Armenian Nuclear Plant, located here, uses groundwater for its cooling system.

Next technology is related to wastewater treatment, which is a serious issue in Armenia, as majority of communities do not have any treatment systems and wastewater is directly discharged into rivers. This can become a serious healthcare and environmental issue, since increasing temperatures and evaporation in parallel with the reduction of precipitations can lead to water quality decline, if no steps are taken to prevent this happening.

Finally, the development of drip irrigation is necessary to ensure the efficient use of available ground and surface water resources, taking into account according to climate change projections for Armenia precipitations in July and August, when the demand for water is the highest, will reduce significantly.

2.2. Action plan – Design of recirculating water system for fisheries

2.2.1. Overview of recirculating water system for fisheries

Ararat Valley with its strategic importance for the country from the perspective of groundwater resources is currently overloaded with more than 250 fisheries, which use groundwater of the Valley to function (there are more than 450 wells). Renewable groundwater reserves of Ararat Valley are 1,226 million m^3, while fisheries have been provided with water use permits for the volume of 1,496 million m^3.

As a result, water resources of Ararat artesian basin are under threat of draining. In addition, 6,200 ha of agricultural land of 200 farms of Ararat and Armavir province remain without irrigation. If not cultivated, these will degrade and soil will lose the accumulated carbon in the future, thus it will be much more expensive to return these lands into agricultural turnover.

It is recommended to install closed or semi-closed water circulation systems in fisheries. Closed systems pump the whole volume of used water to the fisheries after treating it with mechanical and biological filters and enriching with oxygen. In this case, the demand for fresh water is 6-8%, to restore the water losses during the treatment process.

The process is the same in semi-closed circulation systems, but the level of water re-use is 70%, and 30% is replenished with fresh water.

The technology is categorized as a capital good, since it has a limited number of consumers, while requiring relatively high capital investments. Currently, there are no technology providers in Armenia, and the market chain is quite simple. Another important aspect is that recirculating water system is a technology used for more efficient production of aquacultures.

2.2.2. Enabling framework –Installation of recirculating water system for fisheries

The enabling framework for recirculating water system technology for fisheries is presented below.

Table 9. Enabling framework for Creation of recirculating water system for fisheries

N	Enabling framework	Comments
1.	Legislation	Water saving technologies need to be prioritized in respective legislation to create preconditions for introduction of respective technologies, including recirculating water systems for fisheries.
2.	Technical standards	Development of technical standards for recirculating water system for fisheries will ensure proper quality of technology introduction, at the same time potentially serving as a capacity building tool.
3.	Irrigation water standards	Irrigation water quality standards are needed to make sure the water is treated up to certain standard, prior to being supplied to users. As water discharged from fisheries is used for irrigation purposes too, development of such standards can result in increased demand for recirculating water systems, which also clean the water.
4.	Tariff policy	Current tariff for water used in fisheries is very low, and in it needs to be increased in order to create incentives for fisheries to invest in recirculating water systems.
5.	Financial policy	Provisions of soft loans, tax breaks are needed to help fisheries finance the installation of recirculating water systems.
6.	Corruption	Corruption and conflict of interests control mechanisms are needed to make sure large fisheries do not block the introduction of the technology, or use its introduction as a tool for outcompeting the smaller ones.
7.	Sectorl strategy	Sector-related documents need to include requirements of water efficiency, thus developing favorable conditions for the introduction of respective technologies, such as recirculating water systems.

2.2.3. Barriers – Installation of recirculating water system for fisheries

i. Economic and financial barriers

Low level of used water price– despite recent ten times increase of water price for fisheries it is still very low, especially compared to irrigation water price (AMD 0.5/m3 in comparison to up to AMD 11/m3 for irrigation water). It is noteworthy that water used by fisheries is of high quality and mainly can be used as drinking water. The low price is justified by the fact that fisheries do not consume the water, but rather use it, and the water can then be reused for irrigation purposes. The problem is that fisheries are mostly located at lower elevations and re-use of water will require installation of pumps and development of other infrastructures making water more expensive. As a result of extremely low prices fisheries are not interested in investing in more efficient use of water.

High level of initial investments required for the introduction of the system – depending on the volume of used water installation of recirculating water system may cost around USD 15-25 thousand, which is a significant cost for many fisheries, especially the smaller ones.

Lack of economic incentives –fisheries are among the priorities of the state in agriculture, since the sector is export-oriented. As a result, the industry has most favorable conditions, including absence of any requirements on water use efficiency – an important element of public policy on resource efficiency.

ii. Non-financial barriers

Inconsistency and ambiguity of regulatory policy – the Government policy related to the sector is not consistent and long-term. Conditions can change based on short-term interests.

Weak legislative and normative regulation, poorly drafted regulations – the sector is not properly regulated and many aspects remain contemplative.

Insufficient control over observance of effective legislation and norms –existing regulations and norms are not always observed since control and supervision are not properly implemented by respective agencies.

Corruption and conflict of interests – many of fisheries, especially the largest ones, are often associated with present or former officials, including members of the Government, National Assembly, etc. As a result, fisheries are operating in favorable conditions and making changes in the existing situation may prove to be difficult.

Disregard of water resource protection by decision-makers – the protection of water resources is not taken into consideration while making decisions regarding the fisheries, where the primary goal is income generation.

Lack of information on the technology at all levels – the technology of recirculating water system is not well-known among fishery exploiters, as a result there can be a misunderstanding of the principles of its work, as well as costs and benefits associated with it.

Lack of well-grounded proposals on the introduction of the technology – while there are active discussions regarding the need for introduction of recirculating water systems in fisheries in order to save the high-quality water from Ararat Valley groundwater basin, no recommendations have been presented so far that would included all pros and cons of the technology.

Lack of counseling on the introduction of the technology – there is a need for capacity building of local consultants to support the introduction of the technology.

2.2.4. Proposed action plan – Installation of recirculating water system for fisheries

Technology action plan proposed for the installation of recirculating water system for fisheries is presented in Table 10 below.

Table 10. Technology Action plan for the installation of recirculating water systemfor fisheries

Sector	**Water**
Sub-sector	**Introduction of recirculating water system in fisheries**
Technology	**Installation of closed recirculating water systems in fisheries implies mechanical and biological treatment of the whole volume of used water. Next, after enriching the water with oxygen it goes to fishery. If necessary, it is also disinfected, pH, temperature and other parameters of the water are automatically regulated. In this case, fresh water demand is 6-8%, needed for compensation of water losses during the treatment process. The process is the same in semi-closed systems, but the level of water reuse is 70%, and 30% is compensated by fresh water.**
Intention	**Installation of semi-closed or closed recirculating water systems in 5-7 fisheries within upcoming 5 years**
Benefits	**Application of closed or semi-closed recirculating water system will enable producing 7-fold more fish on the same surface, increasing its annual production up to 50,000 tons, while cutting the use of water by 60-65%. Fish waste removed from the system, can become a source of additional income for fisheries in case of its processing.**

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
1. Development of financial mechanisms	Activity 1.1. Studying of international practice on the introduction and development of the system and development of economic mechanisms	State, international grant	MoA, MoF, MEDI	2 years	Risk 1. Difficulty in localizing international experience Risk 2. Corruption	Criterion 1. Comprehensive studying of international experience Criterion 2. Realistic mechanisms to facilitate the process	Indicator 1. Report on international experience Indicator 2.Clear economic structures and systems Indicator 3. Incentive mechanisms	45,000
	Activity 1.2. State support in terms of provision of grants and low interest loans.	State	MoA, MoF, MEDI	Long-term	Risk 1. Difficulty in finding funds. Risk 2. Lack of interest at the state level. Risk 3. Lack of acceptance by commercial banks	Criterion 1. Financial guarantees. Criterion 2. Consent of some banks to support the process.	Indicator 1.List of international financial institutions ready to provide funding. Indicator 2. List of commercial banks ready to support the process – with clearly specified interest rates.	0

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
2. Increased efficiency of water use in fisheries	Activity 2.1. Development of water use standards for fisheries and legislative stipulation	State, international grant	MNP, MoA, MoF, MEDI	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Corruption risks. 3. Resistance of fisheries.	Criterion 1. Substantiated, realistic and acceptable water use standards.	Indicator 1. Water use standards. Indicator 2. Clear regulation on the observance of standards. Indicator 3. Legally fixed standards.	35,000
	Activity 2.2. Monitoring and revision of compliance of water use permits provided to fisheries	State	MNP	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Resistance of fisheries. Risk 3. Submission of inaccurate data.	Criterion 1. Conduction of highly-professional monitoring. Criterion 2. Substantiations for revision of water use permits.	Indicator 1. Reporting on the monitoring implemented in fisheries. Indicator 2. Proposals on the review of water use permits.	30,000
	Activity 2.3. Improved supervision of observance of water use permit terms	State	MNP	Long-term	Risk 1. Lack of interest among decision-makers. Risk 2. Corruption risks.	Criterion 1. Conduction of highly-professional monitoring.	Indicator 1. Violation of water use permit terms is decreased by 80%.	10,000 annually
	Activity 2.4. Development of new mechanisms for the calculation of water tariff used in fisheries.	State	MNP, MoA, MoF, PSRC	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Corruption risks. 3. Resistance of fisheries.	Criterion 1. Realistic, rightful and acceptable mechanisms. Criterion 2. Development of a need for technology introduction.	Indicator 1. Increased water tariff for fisheries. Indicator 2. Increased water use efficiency.	25,000
3.Creation of enabling framework for the technology introduction	Activity 3.1. Development of a package of technology introduction proposals with technical, economic and environmental substantiations	State, international grant	MoA, MEDI	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Insufficient professionalism by package authors. Risk 3. Lack of funds.	Criterion 1. Compliance with legal and technical documents. Criterion 2. Feasibility of application.	Indicator 1. Package of proposals.	50,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring of implementation	Budget per activity, USD
	Activity 3.2. Implementation of pilot projects in 2-3 fisheries	Grant, private	MoA, MEDI, private sector	3 years	Risk 1. Lack of funds. Risk 2. Design and operation risks.	Criterion 1. Introduction of the technology in selected fisheries.	Indicator 1. Recirculating water system introduced in at least 3-5 fisheries.	900,000
	Activity 3.3. Monitoring and analysis of the technology introduced in pilot areas	State, private	MoA, private sector	3 years	Risk 1. Low level/lack of capacities and skills for implementation of the process	Criterion 1. Fair presentation of indicators characterizing the process. Criterion 2. Substantiated analysis.	Indicator 1. Monitoring indicators for at least 3-5 fisheries. Indicator 2. Indicator analysis.	5,000 annually
4. Development of technology introduction process	Activity 4.1. Spreading of information about the technology among the fisheries, presentation of the results of pilot projects	International grants	MoA, MEDI, private sector, NGOs	Long-term	Risk 1. Low level of interest among fisheries. Risk 2. . Poor quality information materials.	Criterion 1. Interested and active fisheries. Criterion 2. Information materials. Criterion 3. Changing of fishery practices.	Indicator 1. Organization of awareness raising campaigns and presentation of the results of pilot projects in at least 10 fisheries annually. Indicators 2. Readiness of fisheries to introduce the technology.	13,000annually
	Activity 4.2. Organization of trainings for fisheries	International grants, private sector	MoA, MEDI, private sector, NGOs	Long-term	Risk 1. Lack of knowledge on technologies among trainers. Risk 2. Low interest towards the subject.	Criterion 1. Availability of qualified trainers. Criterion 2Training courses	Indicator 1. At least 6-7 specialists trained annually	14,000annually

2.3. Action plan – Installation of wastewater compact treatment plants and application of natural and hybrid treatment systems

2.3.1. Overview – Installation of wastewater compact treatment plants and application of natural and hybrid treatment systems

Complete treatment of neither municipal nor industrial wastewater is not conducted In Armenia, and as a result wastewater is discharged into surface water objects, irrigation channels, land areas without treatment thus polluting, degrading ecosystems and damaging human health.

In countryside recreation, tourism, catering objects located in upper streams of riversthe damage is mostly caused to water ecosystems as a result of absence of wastewater treatment. At the same time, downstream areas of such rivers are also mostly used as recreation zones, where people have direct contact with polluted water.

Installation of local compact wastewater treatment plants in such objects will not only prevent pollution of water ecosystems, but also use treated wastewater for irrigation or technical purposes. Another solution for the issue is the application of natural and hybrid treatment systems. Thanks to credit investments 5 wastewater treatment plants are currently being constructed in Armenia, which conduct only mechanical treatment (lack of finances did not allow the construction of biological treatment structures). But full wastewater treatment is also prevented by circumstances thoroughly analyzed within the frameworks of Support to Development of Wastewater Removal and Treatment National Strategy in Armenia implemented in 2014.

As a result of implementation of pilot projects the following recommendations were given, including:

- Transition from group systems of wastewater treatment to local ones, which will enable leaving water resources of given settlement, basin (in case of considering treated wastewater as water resources) within the territory of settlement/basin and using these for own needs,
- Application of new, modern, relatively cheap treatment technologies,
- Application of natural treatment systems.

Factory manufactured block type compact plant for conventional wastewater treatment ensures deep biological treatment of wastewater before discharging into river or using for other purposes. Treated wastewater can be stored in special reservoirs together with rain water, for future use in irrigation, watering of green areas (lawns, playgrounds, athletic fields), excluding the need for irrigation system.

In natural and hybrid systems, depending on climate conditions, surfaces of available lands, volume and quality of produced wastewater, level of treatment, certain elements of natural and conventional treatment systems are combined. Systems can consist of artificially aerated pond, where air is pumped through by fans and wastewater is aerated, leading to the destruction of organic compounds. Then suspended particles subside in sedimentation pond, creating sludge.

Depending on the particles treated wastewater flows into a pond with natural aeration, where it undergoes additional treatment by aquatic plants. This water can then be used in orchards, parks, lawns, etc. for irrigation. Sludge produced in sediment ponds is moved to sludge bed, where it is dried and either removed for using as a fertilizer or to landfill. Part of the sludge is occasionally transported to aerated pond to accelerate the biological process.

To determine the type of technology it should be divided into two parts, as compact treatment plants and hybrid treatment systems have different market characteristics. While compact plants are foreseen for private houses, as well as hotels, restaurants and other recreation objects, hybrid treatment systems are more applicable at community level. This is due to both by the technological peculiarities of the systems and their cost, thus compact treatment plants can be considered consumer goods, while hybrid treatment plants are publicly provided goods.

2.3.2. Enabling framework – Installation of compact wastewater treatment plants and application of natural and hybrid treatment systems

The enabling framework for compact wastewater treatment plants and natural and hybrid treatment systems technology is presented below.

Table 11. Enabling framework for the Installation of compact wastewater treatment plants and Application of natural and hybrid treatment systems

N	Enabling framework	Comments
1.	Legislation	Existing regulatory framework sets very strict requirements for the quality of treated wastewater, making the introduction of compact and natural/hybrid treatment systems almost impossible, thus it needs to be revised to comply with EU standards.
2.	Technical standards	Development of technical standards for the application of wastewater treatment compact and natural/hybrid systems will ensure proper quality of technology introduction, at the same time potentially serving as a capacity building tool.
3.	Wastewater standards	The adoption of standards for wastewater discharged into collection system will assure that the efficiency of non-conventional treatment systems does not drop as a result of inflow of industrial and food processing wastewater.
4.	Technical knowledge	Though non-conventional treatment systems are not a new technologyas a whole, and Armenia has some experience in its introduction, there is a need for the training of more specialists to ensure proper use of the technology.
5.	Financial policy	Provision of soft loans, tax privileges, etc. can help communities and small businesses invest in the installation of wastewater treatment non-conventional systems.
6.	Corruption	In many cases, non-conventional treatment systems are a chipper alternative to the existing conventional ones, and it is necessary to ensure proper corruption control in order to prevent obstruction of the technology introductionby large water supply and water removal operators.
7.	Tariff policy	Implementation of tariff policy based on environmental impact of applied treatment system may create favorable conditions for the increase of interest towards non-conventional technologies.
8.	Sector strategy	Prioritization of non-conventional treatment systems in respective documents will attract investments into the technology.

2.3.3. Barriers – Installation of compact wastewater treatment plants and application of natural and hybrid treatment systems

i. Economic and financial barriers

Lack of incentive economic mechanisms –the current level of environmental pollution fines is that it is much cheaper to pay them regularly rather than invest in wastewater treatment systems.

High investments costs required for the introduction of the system – although compact treatment plants and natural and hybrid treatment systems are much cheaper than conventional treatment systems, their application still requires substantial investments, which are not always affordable for the users without state support.

Underdeveloped market -treatment system market is at the initial stage of its development and the links between buyers and suppliers are still very weak.

Lack of demand due to low level of consciousness – buyers are not aware about the benefits of the technology, thus the demand for it is low.

ii. Non-financial barriers

Slow progress in establishing and developing community foundations – the technology is best for smaller rural communities, especially the distant ones, where large water supply and treatment operators do not invest yet. The establishing of community foundations is one of the first steps towards organization of wastewater treatment.

Limited number of technology professionals– relevantly small number of professionals is limiting the awareness on the technology among the potential buyers, as well as the options available.

Lack of political decisions – the water supply and treatment operators are currently not required to conduct wastewater treatment, since it is an additional burden for operators, which may cause increasing of the fee paid by consumers.

Unrealistic norms and rules – wastewater treatment norms and rules currently used in Armenia are left from the Soviet period, and these are much stricter as compared to the ones used in the European Union, for instance. This is a serious barrier to the use of non-conventional treatment systems, where wastewater is treated to a degree that meets EU norms[9], but not the unrealistic ones effective in Armenia.

Weak oversight – public agencies responsible for the control of wastewater treatment norms are not fulfilling their functions to a sufficient degree, also there is virtually no control over the quality of wastewater discharged into water removal system. For instance, discharging wastewater from food processing or chemical plants into the system and its subsequent inflow into non-conventional treatment systems can have a significant negative impact on the efficiency of treatment, as natural biological processes can slow down or even stop.

Lack of scientifically substantiated recommendations for the selection of the technology– while non-conventional treatment systems are gradually becoming more popular in Armenia there is still a need to develop science-based recommendations on the selection of specific type of system for each case.

Limited experience for technology introduction– while in Armenia during the Soviet period a number of non-conventional treatment systems have been piloted, there is no data on them. The only well-described experience of non-conventional treatment system application in modern Armenia is the Parakar treatment plant case, which is very promising.

Low levels of training and education in all stages– there are no educational institutions in Armenia, which prepare specialists in the field of non-conventional treatment systems. Moreover, currently none of higher education institutions of Armenia offers high-level courses on wastewater treatment in general.

[9]Chave P. The EU Water Framework Directive.- 2001, IWA Publishing

2.3.4. Proposed action plan – Installation of compact wastewater treatment plants and application of natural and hybrid treatment systems

The action plan proposed for installation of compact wastewater treatment plants and application of natural and hybrid treatment systems technology is presented in Table 12 below.

Table 12. Action plan for compact wastewater treatment plants and natural and hybrid treatment systems technology

Sector	**Water**
Sub-sector	**Introduction of new wastewater treatment technologies**
Technology	**Wastewater treatment natural and hybrid systems consist of naturally or artificially aerated ponds, drainage system (wetlands), as well as other technological structures for mechanical and biological treatment of wastewater and sludge processing, where removing of suspended particles and breakdown of organic compounds is conducted, ensuring wastewater treatment to the required degree. Sludge generated during the treatment is removed and processed in a separate structure, sludge bed, and is used as an organic fertilizer in agriculture or removed to landfill. Sometimes the part of the sludge is moved to aerated pond to accelerate the biological treatment process. In some cases the wastewater that has undergone biological treatment is further treated using aquatic plants and animals. Ready-made wastewater treatment conventional compact plants in addition to the above-mentioned ones also ensure deep biological wastewater treatment.**
Intention	**Construction of WWTP in more than 15 communities and 10 rest houses by the end of 2020, using different technologies.**
Benefits	**Economic benefits of the technology –The use of hybrid treatment systems reduces construction costs up to 2 times, operational costs are reduced by 30-50%, price for the treatment of 1 cubic meter of wastewater reduces up to 2 times. In case of compact treatment systems – reduction of construction cost by up to 30-40%, up to 10% reduction of operational costs. Environmental and social benefits – protection of aquatic and terrestrial ecosystems from pollution, improvement of sanitary conditions of communities, reduction of health risks of the population (reduction of waterborne diseases), ensuring human food safety.**

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
1. Revision of Water Code and other legal documents with regards to wastewater removal and treatment / Development of a new law and sub-legislative package	Activity 1.1. Analysis of the existing legislation, development and adoption of a new legislative package	State budget, international grant	MNP, MoA, SCWE	2 years	Risk 1. Lack of interest towards revision of the legislation. Risk 2. Lack of financing for the implementation of required activities. Risk 3. Lack of professionalism of the working group.	Criterion 1. Compliance with EU Directives. Criterion 2. Feasibility of application Criterion 3. Corruption.	Indicator 1. Improved legislation. Indicator 2. Law on wastewater removal and treatment.	100,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
on water removal	Activity 1.2. Review of approaches on imposing environmental fines and penalties to enforce wastewater treatment.	State budget, international grant	MNP, MoA, SCWE	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Resistance of businesses. Risk 3. Mild, minor changes bypassing the requirements.	Criterion 1 Adequate compensation for damage. Criterion 2. Feasibility of application Criterion 3. Acceptance by the beneficiaries.	Indicator 1. New system to enforce environmental fines and penalties. Indicator 2. Budgeting of funds for wastewater treatment by businesses.	35,000
	Activity 1.3. Revision of treatment level depending on the purpose of wastewater re-use (determination of TLOs)	State budget, international grant	MNP, MoA, SCWE	1 year	Risk 1. Lack of interest among decision-makers. Risk 2. Dependence of currently effective norms, inherited from USSR. Risk 3. Resistance by businesses and corruption risks	Criterion 1. Realistic and acceptable treatment level.	Indicator 1. Established and legally enforceable TLOs.	30,000
2. Development of financial mechanisms	Activity 2.1. Study of international experience supporting the construction of WWTPs by the businesses and development of new economic mechanisms.	State budget, international grant	MNP, MoA, SCWE, MoF, MEDI	3 years	Risk 1. Lack of interest among decision-makers. Risk 2. Lack of funding	Criterion 1. Realistic mechanisms supporting the process.	Indicator 1. Report on international experience. Indicator 2. Proposals on economic mechanisms and selected acceptable options.	50,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
	Activity 2.2. Adopting of phased approach for wastewater treatment.	State budget, international grant	MNP, MoA, SCWE, MoF, MEDI	1 year	Risk 1. Lack of interest among decision-makers. Risk 2. Dependence of currently effective norms, inherited from USSR. Risk 3. Corruption.	Criterion 1. Well-grounded and acceptable options for phased approach Criterion 2. Solutions supporting the process.	Indicator 1. Approach enforced by law Indicator 2. Clear regulation for phased approach.	20,000
	Activity 2.3. State support through provision of grants and creation and development of community funds.	State budget, international grant	MNP, MoA, SCWE, MoF, MEDI	10 years	Risk 1. Difficulty in finding funds. Risk 2. Lack of interest at the state level.	Criterion 1. Financial guarantees.	Indicator 1. Inclusion of WWTPs construction in the community development plans. Indicator 2. Fixed budget for WWTPs construction.	0
	Activity 2.4. Set up and development of community funds for management of WWTPs.	State and community budgets, international grants, private investments	MTAD, MoF	7 years	Risk 1. Lack of interest at the state level. Risk 2. Lack of experience at the community level. Risk 3. Low awareness.	Criterion 1. Set up and operation of community funds. Criterion 2. Capability of managing community funds.	Indicator 1. Community funds set up in at least 10 communities. Indicator 2. Community funds set up in progress in 10 more communities.	18,000annually
3. Support to the introduction of new effective technologies	Activity 3.1. Development of package of proposals for technology selection with feasibility and environmental justifications.	State budget, international grant	SCWE, MNP	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Insufficient professionalism of package developers. Risk 3. Lack of funds.	Criterion 1. Compliance with legal and technical documents. Criterion 2. Feasibility of application	Indicator 1.Package of proposals.	50,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
	Activity 3.2. Construction of demo/pilot WWTPs using different technologies.	State and community budget, international grant, private investment	SCWE, MNP	5 years	Risk 1. Lack of funds. Risk 2. Design, construction and operational risks. Risk 3. Discrediting of selected technology/ies.	Criterion 1. WWTPs constructed using different technologies.	Indicator 1. Construction of WWTPs using different technologies in at least 15 communities. Indicator 2. Construction of WWTPs in at least 10 rest houses.	1,200,000 annually
	Activity 3.3. Monitoring and analysis on the work of constructed WWTPs	State budget, international grant, private investment	SCWE, MNP	3 years	Risk 1. Low level/absence of skills and possibilities for implementation.	Criterion 1.Unbiased presentation of indicators characterizing the process. Criterion 2. Justified analysis.	Indicator 1. Construction of WWTPs using different technologies in at least 15 communities. Indicator 2. Construction of WWTPs in at least 10 rest houses.	25,000
4. Staff training and awareness raising	Activity 4.1. Training of specialists in design, construction and operation of WWTPs.	State budget, international grant, private investment	MSE, private specialized organizations	Long-term	Risk 1. Lack of knowledge on modern technologies among the trainers. Risk 2. Low professional qualification of trainers. Risk 3. Low level of interest towards the subject.	Criterion 1. Trainers. Criterion 2. Training courses. Criterion 3. Respective qualified specialists.	Indicator 1. At least 10 specialists trained annually.	25,000 annually

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
	Activity 4.2. Spreading the idea of treated wastewater as a water resource and developing of a new attitude towards the re-use of treated wastewater among the population.	International grant, private investor	SCWE, MNP	Long-term	Risk 1. Lack of interest among the population. Risk 2. Lack of funds. Risk 3. Low qualification of implementers.	Criterion 1. Interested and active population. Criterion 2. Training materials. Criterion 3. Changing of the behavior of population.	Indicator 1. Readiness of population of selected five communities to pay for water removal.	12,000 annually

2.4. Action plan – Diffusion and expansion of drip irrigation system

2.4.1. Overview: Diffusion and expansion of drip irrigation system

In Armenia Irrigated agriculture is conducted using canals. Inter-farm and intra-farm canals are mostly located closer to the surface. Irrigation system losses amounted 60-75%. Recently implemented irrigation system improving projects are aimed at energy saving through transition from the use of pumps to gravity feed irrigation systems.

Since irrigation water is mostly supplied through rivers, water intake volume from the rivers is likely to increase towards the headwaters and there is a shortage of water downstream, which leads to disturbance of river ecosystems. Given that downstream of most of the rivers flows through settlements, where untreated wastewater is discharged, often only wastewater gets carried downstream (the negative effect of this is well noticeable on the example of rivers flowing into Lake Sevan).

Transition to drip irrigation system will not only reduce flow losses of the system, but will also ensure reduction of irrigation costs and increasing of yield.

Drip irrigation is based on the principle of allowing water to drip slowly to plant root system. Water is applied close to plants so that only part of the soil in which the roots grow is wetted from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Drip irrigation allows to save water, fertilizers, pipelines, energy and reduce labor costs. In addition, drip irrigation has several important advantages, such as early harvest, prevention of soil erosion, as well as spreading of diseases and weed growth.

Drip irrigation technology is characterized as a consumer product, including a high number of potential buyers, complex supply chain, etc.

2.4.2. Enabling environment –Diffusion and expansion of drip irrigation system

The enabling environment for drip irrigation technology is presented below.

Table 13. Enabling environment for diffusion and expansion of drip irrigation system

N	Enabling environment	Comments
1.	Legislation	Water saving technologies need to be prioritized in respective legislation to create prerequisites forintroduction of respective technologies, including drip irrigation systems.
2.	Technical standards	Development of technical standards for drip irrigation system will ensure proper quality of technology introduction, at the same time potentially serving as a capacity building tool.
3.	Irrigation water standards	Development of irrigation water quality standards is necessary to ensure that farmers receive proper quality irrigation water not requiring excessive investments into filters, as well as maintenance costs.
4.	Financial policy	Soft loans for the introduction of advanced agricultural technologies, such as drip irrigation, will create a favorable environment and incentives for farmers.
5.	Corruption	Proper corruption control mechanisms in irrigation water supply system are necessary to make sure that respective actors provide irrigation water of good quality and in sufficient quantity.
6.	Tariff policy	Tariff policy including progressive fees will create incentives for investing in water saving technologies, such as drip irrigation.
7.	Sector strategy	While drip irrigation is included in development documents, greater attention will increase awareness on technology and promote implementation of relevant activities by regional and republican agricultural support centers.

2.4.3. Barriers – Diffusion and expansion of drip irrigation system

i. Economic and financial barriers

High cost of technology introduction – despite noticeable reduction of drip irrigation system costs in recent years, still remains essential and not affordable for farmers, except for use in greenhouses. The spread of the technology in open field is still very expensive.

High interest rates offered by banks and lack of soft loans – bank interest rates vary between 14-24%, which makes it very expensive to take loans and is risky for farmers.

Lack of economic incentives – there are no economic mechanisms for the promotion of drip irrigation, such as reduced fee for irrigation water. Moreover, water users associations, which supply irrigation water to farmers, are interested in selling more water, and the promotion of drip irrigation creates conflict of interests.

ii. Non-financial barriers

Absence of local standards for irrigation water quality – Armenia has no irrigation water quality standards, as a result the farmers pay for the water, that cannot be used in drip irrigation systems, as it quickly blockers the emitters, leading to replacing or costly maintenance. This also results in additional costs related to maintenance of filters, tanks, pumps and other equipment.

Lack of mechanisms to promote efficient use of water – irrigation water supply is conducted by water users associations, which are interested in selling as much water as possible.

Lack of public regulation and support – there is no public support for the transition to drip irrigation, it is not promoted by agricultural strategies, though the decision-makers have a common understanding of its benefits.

Lack of information for farmers and low-quality trainings–farmers have a general idea on the principles of drip irrigation functioning, however they lack specific knowledge on maintenance and requirements of the system which often leads to its early wear and relevant losses. As a result, many farmers avoid drip irrigation due to negative experiences of others.

Lack of information on the advantages of the technology – though many farmers are aware that drip irrigation may help save water, they are less aware about the possibility of adding fertilizers into the water during irrigation.

Low level of consulting services on the selection of respective technology – there is still shortage of specialists who can consult farmers on the selection of drip irrigation systems for their specific needs.

Small local production capacity – the number of local producers is still small and their number needs to be increased in order to develop the market, as well as decrease the installation costs.

2.4.5. Proposed action plan – Diffusion and expansion of drip irrigation system

The action plan proposed for Diffusion and expansion of drip irrigation system technology is presented in Table 14 below.

Table 14. Action plan for Diffusion and expansion of drip irrigation system technology

Sector	**Water**
Sub-sector	**Drip irrigation**
Technology	**Drip irrigation is based on the principle allowing water to drip slowly to plant root system. This technology implies direct supply of the water to the root zone of the plant, in small volumes, using drippers or emitters. Drip irrigation enables saving of water, fertilizers, and costs relate to pipelines, energy and labor. Besides, drip irrigation has several important advantages – early harvest, lessened soil erosion, reduction of the probability of spreading of diseases and weed growth.**
Intention	**Introduction of drip irrigation system in at least five farms during five years**
Benefits	**Economic benefits – 30-50% reduction of irrigation costs, 20-50% increasing of yield.** **Environmental and social benefits – irrigation of land plots inaccessible for water canals, improving of social conditions, exclusion of irrigation with polluted water, ensuring food security of the population, protection of aquatic ecosystems, prevention of the risk of soil erosion and increasing of groundwater level.**

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
1. Introduction and development and of local standards for irrigation water	Activity 1.1. Review of international standards of irrigation water.	State, international grants	MoA, MoH, SCWE	1 year	Risk 1. Skills of specialists involved in the study. Risk 2. Lack of time.	Criterion 1. Extensive study of international experience. Criterion 2. The experienceis introduced to public.	Indicator 1. Report on the international standards. Indicator 2. The most acceptable options presented.	20.000
	Activity 1.2. Development of national irrigation water standards and stipulating by law.	State, international grants	MoA, MoH, SCWE	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Resistance by farmers.	Criterion 1. National standards developed through localization of international experience. Criterion 2. Extensive consultations.	Indicator 1. National irrigation water quality standards. Indicator 2. National standards stipulated by law and acceptable for beneficiaries.	35.000
	Activity 1.3. Creating irrigation water quality control system.	State, international grants	MoA, MoH, SCWE	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Resistance by farmers.	Criterion 1. The system developed as a result of cooperation of interested parties. Criterion 2. Proper functioning of the system is ensured.	Indicator 1. System functioning stipulated by law. Indicator 2. Structural elements of the system. Indicator 3. Financial mechanisms of the system are created.	350,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
2. Development of financial and economic mechanisms for system introduction	Activity 2.1. Study of international experience on the introduction and development of the system and economic mechanisms.	State, international grant	MoA, MoF, MEDI	2 years	Risk 1. Difficulties in localizing international experience. Risk 2. Incomplete study of experience	Criterion 1. Complete study of international experience. Criterion 2. Realistic mechanisms to facilitate the process.	Indicator 1. Report on international experience. Indicator 2. Clear economic mechanisms. Indicator 3. Incentives.	35,000
	Activity 2.2. State support for provision of grants and low interest credits.	State	MoA, MoF, MEDI	Long-term	Risk 1. Difficulty of funding. Risk 2. Lack of interest at the state level. Risk 3. No consent on the part of commercial banks.	Criterion 1. Financial guarantees. Criterion 2. Consent of banks to support the process.	Indicator 1. List of international financial institutions willing to provide funding. Indicator 2. List of commercial banks willing to support the process – with clearly specified interest rates.	0
3. Development of an enabling environment for the introduction of the technology	Activity 3.1. Development of a package of proposals for technology introduction for farmers with feasibility and environmental studies.	State, international grant	MoA, MEDI	2 years	Risk 1. Lack of interest among decision-makers. Risk 2. Insufficient professionalism of package developers. Risk 3. Lack of funds.	Criterion 1. Compliance with legal and technical documents. Criterion 2. Feasibility of application.	Indicator 1. Package of proposals.	40,000
	Activity 3.2. Implementation of pilot projects for different crops in at least 5 farms.	Private, grant	MoA, MEDI, private sector	3 years	Risk 1. Lack of funds. Risk 2. Difficulty in obtaining the consent of farmers	Criterion 1. Technology introduced in selected farm.	Indicator 1. Drip irrigation system introduced in at least 5 farms.	650,000

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
					and co-financing.			
	Activity 3.3. Monitoring and analysis on the introduction of the technology in pilot areas.	State, private	MoA, private sector	3 years	Risk 1. Low level/ lack of capacity and opportunities for implementation.	Criterion 1. Unbiased presentation of indicators characterizing the process. Criterion 2. Well-grounded analysis.	Indicator 1. Monitoring indicators conducted in at least 5 farms. Indicator 2. Indicator analysis	8,000annually
4. Development of the process of technology introduction	Activity 4.1. Spreading of information on the technology among the farmers.	International grants	MoA, MEDI, private sector, NGOs	Long-term	Risk 1. Low level of interest among the farmers. Risk 2. Low level of professionalism of information spreaders. Risk 3. Inaccurately developed information materials.	Criterion 1. Interested and active farmers. Criterion 2. Access to information materials. Criterion 3. Farmers' behavioral change	Indicator 1. Readiness of farmers to introduce the technology.	12,000annually
	Activity 4.2. Spreading of information on the results of pilot project.	International grant, private sector	MoA, MEDI, private sector and NGOs	Long-term	Risk 1. Low level of professionalism of information spreaders. Risk 2. Insufficient analysis and inaccurately developed information materials.	Criterion 1. Information materials.	Indicator 1. Presentation of the results of pilot projects in at least 10 farms annually.	7,000 annually

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Timeframe	Risks	Success Criteria	Indicators for monitoring and implementation	Budget per activity, USD
	Activity 4.3. Organization of training courses for farmers.	International grants, private sector	MoA, MEDI, private sector and NGOs	Long-term	Risk 1. Lack of knowledge on the technology among trainers. Risk 2. Low level of interest towards the subject.	Criterion 1. Qualified trainers. Criterion 2. Training courses.	Indicator 1. At least 6-7 farmers trained annually.	14,000 annually
	Activity 4.4. Promoting local production of equipments for the technology.	Commercial banks, grants, private sector	MoA, MEDI, private sector	Long-term	Risk 1. Corruption Risk 2. Lack of interest among local producers.	Criterion 1. Development of local market. Criterion 2. Interest of local producers.	Indicator 1. Local producers. Indicator 2. Local cheaper production.	20,000 annually

Chapter 3. Project Ideas

3.1. Agriculture Sector

Agriculture is one of the most important sectors of the Armenian economy and the issues related to its development are complex. Three technologies prioritized during the TNA process include windbreaks, local reclamation and diversified agriculture. While the first one has some history in the country, specifically during the Soviet era, the other two are almost completely new and introduction of those will require enhanced efforts related to water sector. In agriculture sector it has been decided to focus on piloting of windbreaks, while the implementation of project ideas for the water sector will create enabling environment for the introduction of the other prioritized technologies of agriculture sector.

Barrier analysis phase of the project has allowed to identify that one of the main barriers to transfer and diffusion of windbreaks technology is the absence of recent pilot projects that can demonstrate the benefits of the technology. Given that Shirak marz of Armenia is among the ones having previous experience in establishment of windbreaks, as well as one of the leading regions in terms of production of grains, it has been decided to focus on this part of the country for piloting of windbreaks technology. The project idea for piloting of this technology is presented in Table 15 below.

Table 15. Project idea I –Windbreaks establishment in at least 3 pilot communities of Shirak marz

Background information	Increasing of air temperature, reduction of precipitations and irrigation water reserves, increased frequency of droughts, winds and sandstorms as a result of climate change require application of agricultural reclamation systems with long-term stable impact and relatively low cost. In plain areas of the Republic of Armenia it is recommended to install windbreaks, as such systems. The latter reduces the speed of wind, keeps the snow in the fields, increases soil humidity, improves the microclimate, protects sowing from drought and promotes increasing of yield. Extended observations have shown that in case windbreaks are used the crop yield increases by 10-25% in comparison with open fields. Windbreaks are linear planting of treesand shrubs with total width of up to 15 meters. Depending on tree species a planting scheme with 2.5-4-meter spacebetween the lines and 2-3 meters between the plants is used. Depending on peculiarities of the terrain each windbreak can stretch 200-600 meters along the width and 1,000-1,200 meters along the length of fields. 10-15-meters wide spaces are left for agricultural equipment and vehicles. If after harvesting the area is used for grazing of cattle, then the width of spaces can be up to 20-25 meters. Preference is given to tree species with higher density of foliage (poplar, beech, elm, apple, plum, pear, sweet cherry, etc.). Tree planting scheme is used in case of which penetration of wind becomes more difficult. Farms in Armenia are small and their number in relatively small areas can reach several dozens. Thus, fruit trees well adapted to given climate conditions can also be used if beneficiaries agree upon the installation of windbreaks.
Objectives and outputs	• Increased yield of grains – up to 10-25%, • Up to AMD 2.0 million additional income for each hectare of

	windbreaks, • Increased access to beautiful landscapes, cleaner air, and recreation zones, • Carbon sequestration, prevention of wind erosion and decreased humidity loss.
Link to country development priorities	While windbreaks are not directly included in the strategic documents of the Republic of Armenia as a tool for achieving national development priorities, these can support implementation of the goals and visionof the Government of Armenia, listed in 2010-2020 Strategy of Sustainable Development of Armenia's Agriculture: • Development of agricultural organizations, cooperatives and family farms integrated with market infrastructure, through application of intensive technologies, • Stable food security of population and meeting demands of agriculture processing raw materials through realistic combination of food security interests and comparative advantage of external trade of agriculture and food products, • Increasing of gross product in the agriculture solely via increased labor productivity, comparative reduction of the number of agricultural employees and use of part of excess labor force in servicing of agriculture and non-agriculture sectors via trainings, • Processing of the significant part of produced agricultural goods in the processing facilities developed in communities as a result of development of small and medium enterprises(SME), • Prevalence of production of agricultural products providing high added value in crop production and cattle breeding, • High level of food security of the population, self-sufficiency of in basic foodstuffs, reduction of rural poverty and emigration.
Scope and activities	The pilot project will include planting and of windbreak maintenance during 5 years in at least 3 rural communities of Shirak region, about 70 ha or 150,000 seedlings in total. As it is estimated that 2.4 ha of windbreaks can protect up to 100 ha of arable lands, this will ensure protection of around 2,900 ha of agricultural land in three communities, potentially providing additional AMD 140 million income annually. 3 pilot communities will be selected out of Akhuryan (1,845 ha), Arevik (938 ha), Azatan (2,492 ha), Aygabats (1,045 ha), Akhurik (563 ha), Arapi (783 ha), Karnut (672 ha), Kamo (906 ha), Jajur (364 ha), Hatsik (656 ha), Voskehask (1,154 ha), Mayisyan (635 ha), Shirak (909 ha), Gharibjanyan (431 ha) and Beniamin (417 ha) communities of Shirak marz of Armenia, which have total of over 14,000 ha of arable land that can benefit from planting of windbreaks.
Timeline	Total of 5 years: • Years 1 and 2 o Adaptation of model design in accordance with conditions of pilot project communities, o Development of cost estimate of the project, • Years 3 and 4 o Implementation of soil and tree planting works,

	o Keeping and security of the plantations
Budget	Total of USD 385,000, including: • USD 12,000 – Adaptation of model design to conditions of pilot project communities, • USD 15,000 – Development of cost estimate of the project, • USD 210,000 – Implementation of soil and tree planting works, • USD 148,000 – Keeping and security of the plantations.
Potential risks	• Difficulty in obtaining consent with farmers and co-financing, • Unfavorable weather conditions – drought, freezing, etc., • Insufficient accessto high quality seedlings, • Damaging of the seedlings by locals due to unawareness on the importance of the technology.
Responsibilities and coordination	• Ministry of Agriculture, educational institutions – overall coordination and adaptation of model design in accordance with conditions of pilot project communities, • Agricultural Support Regional Center of Shirak marz, local self-government bodies – Development of cost estimate of the project, • Local Self-Government bodies, agricultural cooperatives – implementation of soil and tree planting activities, organization of maintenance and security of the plantation.

3.2. Water Sector

During the TNA phase of the Project the following technologies of water sector have been prioritized by the stakeholders – (i) creation of recirculating water system of fisheries, (ii) installation of compact treatment plants and application of natural and hybrid treatment systems, and (iii) diffusion and expansion of drip irrigation system. While all three are extremely important for the economy of the country, and particularly for its agriculture sector, it has been decided to focus on second and third technologies, as the first one is currently one of the focus areas of the Government of Armenia, supported by USAID office in the Republic of Armenia. Nevertheless, the adoption of national standard for irrigation water quality, proposed as one of the project ideas for water sector to help transfer and diffuse drip irrigation technology can also contribute to creation of recirculating water system of fisheries, through its implication on demand for irrigation water supplied by fisheries.

Absence of national standard of irrigation water quality has been identified as one of the key obstacles for transfer and diffusion of drip irrigation technology, as supply of irrigation containing large volumes of sediment leads to increased maintenance costs, thus making the technology less attractive for farmers, despite its benefits, especially in case of use in larger open-field operations. Project idea on development and introduction of local standards of irrigation water is presented in Table 16 below.

Table 16.Project idea II – Development and introduction of local standards of irrigation water

Background information	Irrigated farming in Armenia is carried out using canals, of which inter-farm and intra-farm channels are mostly located close to the surface. Water losses within irrigation system are 60-75%. Recently implemented projects on improving of irrigation systems are aimed at energy saving via transition from theuseof pumps to gravity

	feed irrigation systems. Since irrigation water supply is mostly carried out through rivers, water intake volume from the rivers is likely to increase towards the headwaters and there is a shortage of water downstream, which leads to disturbanceof river ecosystems. Given that downstream of most of the rivers flows through settlements, where untreated wastewater is discharged, often only wastewater gets carried downstream(the negative effect of this is well noticeable on the example of rivers flowing into Lake Sevan). Transition to drip irrigation system will not only reduce flow losses of the system, but will also ensure reduction of irrigation costs and increasing of yield. Drip irrigation is based on the principle of allowing water to drip slowly to plantroot system.Water is applied close to plants so that only part of the soil in which the roots grow is wettedfrom a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Drip irrigation allows saving water, fertilizers, pipelines, energy and labor costs. In addition, drip irrigation has several important advantages, such as early harvest, soil erosion, spreading of diseases and weed growth is lessened.
Objectives and outputs	• Reduction of irrigation expenses by 30-50%, • Yield increasing by 20-50%, • Irrigation of lands inaccessible for canals, • Yield increasing by 20-50%, • Increased incomes, improved social conditions, • Excluding of irrigation with polluted water, ensuring food security of the population, • Protection of water ecosystems, • Prevention of the risk of soil erosion and increasing of ground water level.
Link to country development priorities	The efficient use of irrigation water is one of the goals of 2010-2020 Sustainable Rural Development Strategy of Armenia. The RA Law on National Water Programme and the RA Law Fundamentals of National Water Policy are two major documents regulating the water sector in Armenia, the objective of which are meeting needs of population and economy via efficient use of water resources, environmental sustainability, regulation and use of strategic water reserves, protection of national water reserve, etc.
Scope and activities	The activities of the project include: • Review of international standards for irrigation water. • Development of national standards for irrigation water and stipulationby law. • Development of a system for the supervision of irrigation water quality.
Timeline	Total of 3 years, including: • Year 1 o Review of international standards for irrigation water

	• Years 2 and 3 o Development of national standards for irrigation water and stipulation by law o Development of a system for the supervision of irrigation water quality
Budget	Total of USD 405,000, including: • USD 20,000 – Review of international standards of irrigation water. • USD 35,000 – Development of national standards of irrigation water and stipulation by law. • USD 350,000 – Development of a system of supervision of irrigation water quality.
Potential risks	• Limited skills of specialists conducting the review of international standards for irrigation water, • Lack of interest among the decision-makers, • Resistance by farmers (water users associations).
Responsibilities and coordination	• Ministry of Agriculture – Review of international standards for irrigation water, • Ministry of Agriculture, Ministry of Health and respective specialized entities of these scientific institutions, National Assembly of RA – Development of national standards for irrigation water and stipulation by law. • State Committee of Water Economy – overall coordination and development of a system for the supervision of irrigation water quality

Limited number of pilot projects on the installation of wastewater treatment alternative systems, including hybrid and compact, has been identified as one of the key barriers toinstall compact treatment plants and use of natural and hybrid treatment systems, thus support to the introduction of new effective wastewater treatment technologies has been selected for the development of respective project idea, presented in Table 17 below.

Table 17.Project idea III – Support to introduction of new effective wastewater treatment technologies

Background information	Due to credit investments Armenia has 5 wastewater treatment plants constructed, which conduct only mechanical treatment (lack of finances has not enabled construction of biological treatment structures). But full treatment of wastewater is also prevented by the circumstances thoroughly analyzed within the frameworks of Support to Development of Wastewater Removal and Treatment National Strategy in Armenia implemented in 2014. As a result of the implementation of the Project recommendations have beenprovided, namely: ✓ Transition from the group systems of wastewater treatment to local, which will enable leaving water resources of the given settlement, basin (in case of considering treated wastewater as water resources) within the territory of settlement/basin and using these for their own needs, ✓ Application of new, modern, relatively cheap treatment technologies,

	✓ Application of natural treatment systems. Development of the process of full treatment of wastewater (mechanical and biological) will enable not only re-use treated wastewater, but also use the sludge as a fertilizer produced in the result of biological treatment or for the purpose of production of methane. In natural and hybrid systems, depending on climate conditions, surfaces of available lands, volume and quality of produced wastewater, level of treatment, certain elements of natural and conventional treatment systemsare combined. Systems can consist of artificially aerated pond, where air is pumped through by fans and wastewater is aerated, leading to the destruction of organic compounds. Then suspended particles subside in sedimentation pond, creating sludge. Depending on the treated particles wastewater flows into a pond with natural aeration, where it undergoes additional treatment by aquatic plants. This water can then be used in orchards, parks, lawns, etc.for irrigation. Sludge produced in sediment ponds is moved to sludge bed, where it is dried and it is removed for to be used either as a fertilizer or to landfill. Part of the sludge is occasionally transported to aerated pond to accelerate the biological process. Two different types of technology should be applied for compact treatment plants and hybrid treatment systems have different market characteristics. While compact plants are foreseen for private houses, as well as hotels, restaurants and other areas for recreation, hybrid treatment systems are more applicable at community level. This is due to both the technological peculiarities of the systems and their cost. Thus compact treatment plants can be considered consumer goods, while hybrid treatment plants are publicly provided goods.
Objectives and outputs	Construction costs of hybrid systems are 4-5 times lower in comparison with conventional treatment plants, where operational costs are dozens of times more expensive. Improvment of sanitary conditions of the environment, protection of health and ensuring food security of population. Possibility of using treated wastewater as irrigation water and processed sludge as fertilizer at a lower cost. Protection of surface and groundwater sources, agricultural land, water and terrestrial ecosystems, landscapes from pollution and degradation, reduction of methane emissions.
Link to country development priorities	National Water Policy- Two major documents regulating the water sector in Armenia, include satisfaction of the needs of population and the economy as theirobjectivesthrough efficient use of water resources, ensuring environmental sustainability, regulation and use of strategic water reserves, protection of national water reserve, etc.
Scope and activities	Construction of WWTP in more than 15 communities and 10 rest

	houses by the end of 2020, using different technologies, including: • Development of technology selection package with feasibility and environmental substantiations. • Construction of demo/pilot WWTPs using different technologies, including hybrid and compact technologies, • Monitoring and analysis of the work of constructed WWTPs.
Timeline	Total of 10 years, including: Years 1 and 2 • Development of technology selection package with feasibility and environmental substantiations. Years 3 to 7 o Construction of demo/pilot WWTPs using different technologies, including hybrid and compact technologies • Years 8 to 10 o Monitoring and analysis of the work of constructed WWTPs
Budget	Total of USD 6,075,000, including: • USD 50,000 – Development of technology selection package proposals for with feasibility and environmental substantiations, • USD 6,000,000 – Construction of demo/pilot WWTPs using different technologies, including hybrid and compact technologies, • USD 25,000 – Monitoring and analysis of the work of constructed WWTPs.
Potential risks	• Lack of interest among decision-makers, • Insufficient professionalism of those drafting proposal package • Design, construction and operation risks, • Low level/absence of skills and possibilities for implementation.
Responsibilities and coordination	• Ministry of Nature Protection – Development of package of proposals for technology selection with feasibility and environmental substantiations • Local self-government bodies, rest houses and water supply and removal companies – Construction of demo/pilot WWTPs using different technologies, including hybrid and compact technologies • State Committee of Water Economy – overall coordination and monitoring and analysis of work of constructed WWTPs.

Chapter 4. Summary and Conclusions

Technology Action Plan (TAP) Report has been developed to conclude the work done during the first two stages of Technology Needs Assessment Project, during which the climate change adaptation technologies for agriculture and water sectors have been prioritized and analyzed. Based on the results of barrier analysis measures have been identified which can help overcome the barriers to transfer and diffusion of prioritized technologies.

While agriculture and water sectors are already closely interrelated, the prioritized technologies in these sectors are also synergic and all six technologies can potentially be piloted under one large program. The recommended actions for the technologies support the presumption that many of the activities to be implemented are almost identical. This means that there is a good opportunity for supporting transfer and introduction of several technologies by implementing selected activities out of the proposed list. For instance, the development and adoption of irrigation water quality standards can be helpful for the expansion of drip irrigation, agriculture diversification and local reclamation. The same is true for the dissemination of information on drip irrigation technology.

The budget for the promotion of different technologies is different. In case of local reclamation technology the budget is less than USD 100,000, while the budget for wastewater treatment plants reaches up to millions of US dollars. The summary of budgets for each technology is presented below.

Table 18. Budgets of actions included in TAPs

Technology	Action	Budget, USD	
		Initial	Annual
Windbreaks	1. Studying of windbreaks	12,000	
	2. Legal regulation for windbreaks establishment	7,000	
	3. Selection of communities for the implementation of pilot projects and specifying relations with stakeholders	3,600	
	4. Model design for establishmentof windbreaks	24,000	
	5. Implementation of pilots in at least 3 communities	385,000	
	6. Spreading information on the technology in rural communities	7,000	
Total		**438,600**	
Local reclamation	1. Studying of international best practice and development of economic incentives for the application of the technology.	5,000	
	2. Development of technology introduction package with feasibility and environmental substantiations.	30,000	
	3. Development of mechanisms and criteria for the selection of pilot areas.	20,000	
	4. Spreading of information on the results of pilot project	19,000	
	5.Experimental training days for beneficiaries.	20,000	
Total		**94,000**	
Agriculture diversification	1. Feasibility study of effectiveness of diversified agricultural production	3,000	
	2. Assessment of agricultural production market	9,000	
	3. Specifying financial and economic mechanisms	80,000	
	4. Development of a criteria for the selection of territories	5,000	
	5. Organization of propagation of seedlings and development of irrigation network reconstruction project	2,200[10]	

[10]Per hectare.

	6. Development and implementation of orchard planting and crop sowing plan.	5,600[11]	
Total		**97,000[12]**	
Recirculating water system for fisheries	1. Development of financial mechanisms	45,000	
	2. Increased efficiency of water use in fisheries	90,000	10,000
	3. Developming enabling environment for the introduction of technology	950,000	5,000
	4. Development of technology introduction process		27,000
Total		**1,085,000**	**42,000**
wastewater treatment plants and natural and hybrid treatment systems	1. Revision of Water Code and other legal documents on wastewater removal and treatment / Draft a new law and sub-legislative package on water removal	185,000	
	2. Development of financial mechanisms	90,000	18,000
	3. Support to introduction of new effective technologies	95,000	1,200,000
	4. Training of human resources and awareness raising		37,000
Total		**370,000**	**1,255,000**
Drip irrigation	1. Development and introduction of local standards for irrigation water	405,00	
	2. Development of financial and economic mechanisms for the introductionof the system	35,000	
	3. Development of enabling environment for introduction of the technology	690,000	8,000
	4. Developing technology introduction process		51,000
Total		**1,130,000**	**59,000**

Main risks of the technologies presented in the action plans are related to lack of interest with decision-makers, as well as resistance of main actors of the sector, such as farmers or owners of fisheries. Another group of risks is related to lack of capacity and low level of professionalism of service providers, such as trainers, awareness raising campaigners, etc.

Involvement of the working group of Interagency Council for the coordination of requirements and provisions of UN Framework Convention on Climate Change in the Project has enabled triggering of some interest with decision-makers. Thus, it is expected that the first group of risks will partially be mitigated through further involvement of the working group in the activities stemming from TNA. As for the second group of risks, it can be mitigated by ongoing monitoring at project level, as well as through investments in capacity building, trainings etc.

[11] Per hectare.
[12] Does not includes items 5 and 6.

List of literature

1. 2010-2020 Strategy of Sustainable Development of Armenia's Agriculture.
2. Armenian Statistical Yearbook (2001-2013) / Armenian National Statistical Service.
3. Avetisyan S., Agriculture and agro processing of Armenia, Yerevan, Limush, 2010.
4. Avetisyan S., Agriculture of Armenia, Yerevan, Limush, 2008.
5. Chave P. The EU Water Framework Directive.- 2001, IWA Publishing.
6. Climate Risk Management in Armenia Report, Yerevan. UNDP-BCPR, 2013.
7. Common implementation strategy for the Water Framework Directive: Guidance documentn 24 - River Basin Management in a Changing Climate.- 2009.
8. Environment and Natural Resources in the Republic of Armenia in 2012, Armenian National Statistical Service.
9. External Trade of the Republic of Armenia. Armenian National Statistical Service, 2001-2013
10. Gevorgyan A. Main types of synoptic processes and circulation types generating heavy precipitation events in Armenia //Meteorology and Atmospheric Physics.-2013.-22. Springer
11. Gevorgyan A. Surface and tropospheric temperature trends in Armenia// International Journal of Climatology.- 2014.-doi: 10.1002/joc.3928
12. Gevorgyan, A. Verification of daily precipitation amount forecasts in Armenia by ERA-Interim model// International Journal of Climatology.- 2012.-33.
13. Harris S. Beyond Building Models: Using WEAP to inform climate change adaptation policy in Guatemala// Goldman School of Public Policy, University of California, Berkley, May 9.- 2007.
14. Hovhannisyan D., Hollmann R., Vardanyan L., Hovsepyan A., Melkonyan H. The application of CM-SAF data for monitoring of climate system over Armenia// Journal of Energy and Power Engineering.- 2010.- Vol. 4.- No.1 (Serial No.26).
15. Hovsepyan A. In. Brunet M. and Hovsepyan A. (eds). Current status of the observational network and climate data in Armenia// Proceedings of the Second WMO/MEDARE International Workshop: Addressing climate data sources and key records for the Mediterranean Basin in support of an enhanced detection, prediction and adaptation to climate change and its impacts.- World Meteorological Organization, 2012
16. Hovsepyan A., Melkonyan H., Petrosyan Z., Sahakyan V., Astsatryan H., Shoukourian Yu. Climate Change over South Caucasus based on Regional Climate Model Simulations// Conference Proceedings “Computer Science and Information Technology”.- Yerevan.- 2011.
17. Melkonyan A., O. Asadoorian M., Climate impact on agroeconomy in semiarid region of Armenia. Environment, Development and Sustainability .A Multidisciplinary Approach to the Theory and Practice of Sustainable Development. Springer, Volume 15, No 4, 2013
18. Melkonyan H., Hovsepyan A., Hovhannisyan D., Vardanyan L., Climate Change Modeling assessment in the area of Armenia/ National Academy of Scientific-technological newsletter-Yerevan-2009.-N 1
19. Melkonyan K., Ghazaryan H., Manukyan R., Ecological actual state of the agriculture lands, level of land usage, improvement of the management system and efficiency improvement ways. RA – Yerevan, 2004.

20. National Atlas of Armenia, Volume A, State Committee of Real Estate Cadaster adjunct to the RA Government, Yerevan, “Geodesy and Cartography Center” SNCO, 2007

21. Reducing the vulnerability of Armenia's agricultural systems to climate change: impact assessment and adaption options, Yerevan, World Bank, 2014

22. Second National Communication of the Republic of Armenia under UN Framework Convention on Climate Change, 2010.

23. Surenyan G., Synoptic analysis of weather climatic conditions baric fields. Dissertation paper,YSU- 2010

24. Zhang X, Aguilar E, Sensoy S, Melkonyan H. Trends in Middle East climate extreme indices from 1950 to 2003//Journal of Geophysical Research.- 2005.-Vol. 110.

25. АгроклиматическиересурсыАрмянской ССР. Л.: Гидрометеоиздат, 1976*(Agroclimatic resources of Armenian SSR, L.: Hydrometeoizdat, 1976)*

26. Егиазарян Г.М., Геворгян А.Р., Мартиросян Р.М. Воздействие дефицита норм орошения на урожайность сельскохозяйственных культур//Известия аграрной науки.- 2009.-N3. *(Yeghiazaryan G.M., Gevorgyan A.R., Martirosyan R.M., Impact of deficit of irrigation norms on yield of agricultural crops// News of agricultural science.-2009.-N3.)*

27. Мелконян Г.А., Овсепян А.Р., Ирицян А.Р., Халатян Е.С., Геворгян А.М. Оценка изменения климата на территории Армении// Труды Института гидрометеорологии грузинского технического университета.- Тбилиси, 2013.-Том 119.*(Melkonyan H.A., Hovsepyan A.R., Iritsyan A.R., Khalatyan E.S., Gevorgyan A.M. Assessment of climate change on the territory of Armenia// Proceedings of the Institute of hydrometeorology of Georgian Technical University.- Tbilis, 2013.-Volume 119.)*

Annex I. List of stakeholders involved and their contacts

Institutions involved in stakeholder consultation process

Institution	Representative	Contacts
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Annex III. Agenda of stakeholder meeting

Technology Needs Assessment (TNA) Project implemented by
"Environmental Project Implementation Unit" State Agency,
RA Ministry of Nature Protection, and UN Environment Programme

Discussion of Technology Action Plans for priority technologies, presentation of barriers, market description and analysis of favorable environment for Climate Change adaptation and mitigation technologies transfer and diffusion, with the participation of stakeholders

A G E N D A

Venue: Bioresources Management Agency, Ministry of Nature Protection
Address: 3rd Floor, 1/3 Building, Pavstos BuzandiSt., Yerevan, 0010, Armenia,
December 19, 2016

10:00 – 10.05	**Opening of the meeting** *Aram Gabrielyan, TNA National Project Coordinator*
10:05 – 10:30	**Presentation of the measures to overcome barriers to Climate Change Adaptation technologies transfer and diffusion** *Vardan Melikyan, TNA Adaptation Component Team Leader*
10:30 – 11:15	**Presentation of the measures to overcome barriers to Climate Change Mitigation technologies transfer and diffusion** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
11:15 – 11:30	**Discussions**
11:30 – 12:00	**Coffee brake**
12:00 – 13:00	**Technology Action Plan template presentation** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
13:00 – 14:00	**Lunch**
14:00 – 15:30	**Discussions of Technology Action Plans preliminary versions in sectoral working groups** *Samvel Avetisyan, Agriculture Expert* *Arevik Hovsepyan, Water Expert* *Mkrtich Jalalyan, Energy and Industry Expert* *Meruzhan Galstyan, Land Use and Forestry Expert* *Davit Shindyan, Waste Management Expert*
15:30 – 16:00	**Summary**