



GOVERNMENT OF THE REPUBLIC OF ARMENIA

MINISTRY OF NATURE PROTECTION

**TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE
CHANGE ADAPTATION**

**BARRIER ANALYSIS AND ENABLING
FRAMEWORK REPORT**

September, 2016

Supported by:



TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE
CHANGE ADAPTATION
**BARRIER ANALYSIS AND ENABLING
FRAMEWORK REPORT**

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FOREWORD

The impact of Armenia on global climatic system is not significant, our share in global emissions is only 0.014%. Highlighting the need of countries to combine their efforts in contending against climate, Armenia as a developing country, has obligation in limiting greenhouse gas emissions. The quantitative indicators of these contributions are summarized in the Intended Nationally Determined Contributions (INDC) of Armenia, which, as a result of comprehensive consultations, have been approved by both the Government of the Republic of Armenia and the civil society of Armenia and has been presented to the attention of Parties of the UN Framework Convention on Climate Change (UNFCCC). This document represents the official long-term Concept of our country aimed at implementation of the obligation under UNFCCC, and in addition to mentioned mitigation measures also includes climate change adaptation measures, as well as a component on transfer and development of technologies.

We consider the on-going UNEP/DTU TNA project as priority on mentioned technological mechanism, which will develop the path that will ensure continuous selection and implementation of modern and accessible technologies in Armenia, based on examples of several selected mitigation and adaptation projects. TNA project is also important for building of capacities on development and transfer of technologies, thus the results are positive and promising.

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



Simon PAPYAN

List of abbreviations and acronyms

AMD	Armenian drams
ANAU	Armenian National Agrarian University
ANPP	Armenian Nuclear Power Plant
ArmCTCN	Armenian Climate Technology Center and Network
ASMC	Agriculture Support Marz ¹ Center
ASRC	Agriculture Support Republican Center
AUA	American University of Armenia
CARD	Center for Agribusiness and Rural Development
CJSC	Closed Joint-Stock Company
DTU	Technical University of Denmark
EU	European University
FAO	Food and Agriculture Organization
GEF	Global Environmental Facility
GMO	Genetically Modified Object
IFAD	International Fund for Agricultural Development
INDC	Intended Nationally Determined Contributions
LLC	Limited Liability Company
LPA	Logical Problem Analysis
LSGB	Local Self-Governance Body
MoA	Ministry of Agriculture
MoH	Ministry of Health
NGO	Non-Governmental Organization
RA	Republic of Armenia
RA NAS	RA National Academy of Sciences
RAS	Recirculating aquaculture system
REC	Regional Environmental Center
SCWE	State Committee of Water Economy
SNCO	State Non-Commercial Organization
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
WRMA	Water Resources Management Agency
WSS	Water Supply and Sanitation
WUA	Water Users' Association

¹ Marz is the administrative division used in the Republic of Armenia

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Report II

Barrier Analysis and Enabling Framework Report

Executive Summary

Present report is the second one out of three to be produced within the framework of Technology Needs Assessment Project. It is dedicated to the analysis of barriers and enabling framework for transfer and diffusion of technologies prioritized during the first phase of the project. Six technologies have been analyzed for agriculture and water sectors, including (i) Windbreaks as climate change adaptation tool, (ii) Local melioration and low-volume drip irrigation for newly planted orchards, and (iii) Diversification of agriculture *in agriculture sector*, and (iv) Creation of circulatory water system for fisheries, (v) Installation of compact treatment plants and Application of natural *and* hybrid treatment systems, and (vi) Spreading and expansion of drip irrigation system *in water sector*.

The Project is implemented under the overall supervision of 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 of October 2, 2012². It includes representatives of respective ministries and public administration agencies, appointed by the order of Minister of Nature Protection of RA, thus ensuring broader involvement of decision-makers in overall technology needs assessment process. “Environmental Project Implementation Unit” State Institution adjunct to the Ministry of Nature Protection of RA has acted as the implementer of the Project, while National Focal Point for UNFCCC, Mr. Aram Gabrielyan, has been appointed as National Coordinator.

In line with the policy of RA Government, reflected in several documents, including Intended Nationally Determined Contributions of Armenia³, technology needs assessment process is based on ecosystem approach, which requires giving of preference to balanced and combined actions. In accordance with Armenian INDC, *“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”*. Accordingly, ecosystem approach to adaptation is considered a key element of adaptation strategy of Armenia. It is in line with country’s environmental policy and can ensure synergy with respective international conventions and treaties, establishing a basis for inter-sectoral cooperation and supporting cross-border cooperation.

The Project has been implemented in consultation with stakeholders, representatives of the Ministries of Nature Protection, Agriculture, Economy, academic and scientific Institutions, businesses, international organizations, NGOs, etc. In order to conduct the barrier analysis process, there has been established a sectoral technology working group representing relevant stakeholders. National consultants have applied a participatory approach for barrier analysis and identification of enabling measures in respective sectors.

The identified barriers and overcoming measures are summarized in Table 1 below.

² <https://www.e-gov.am/decrees/item/11373/>

³ <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Armenia/1/INDC-Armenia.pdf>

Table 1. Identified barriers and overcoming measures for technology transfer and diffusion

Agriculture technologies					
Windbreaks as climate change adaptation tool		Local melioration and low-volume drip irrigation for newly planted orchards		Diversification of agriculture	
Barriers	Measures	Barriers	Measures	Barriers	Measures
Large number of potential beneficiaries	Development of agricultural cooperatives based on RA Law on Agricultural Cooperatives adopted in 2015.	Imperfection of legislation on melioration of unusable lands and absence of motivation mechanisms	Make respective amendments and supplementations to RA Law on Melioration of agricultural land. Adopt a Strategy of melioration of agricultural lands and its action plan.	Perceived high capital cost	Based on positive experience of peach orchards of Tavush region planting using credit and grant funds of IFAD to improve the mechanisms of Armenian Fruit project and to solve the issue of investments via co-financing of cooperating farms.
Small land parcels	Development of agricultural cooperatives based on RA Law on Agricultural Cooperatives adopted in 2015.	Insufficient level of development of irrigation water infrastructure	Rehabilitation of irrigation water infrastructure using state budget and donor funding.	Insufficient level of development of logistic mechanisms and processing facilities ⁴	For the purpose of overcoming the crop realization barrier right from the beginning, there need to be implemented logistic systems and processing facilities development project, studying of export markets and development of contractual relationship. Another possible measure is development and submission a development of project on fruit post-harvest infrastructure in the regions for the approval of RA Government.
Limited knowledge on potential benefits of the technology	Development of training and awareness raising materials on benefits of windbreaks, distribution of these to the Agricultural support marz centers, local communities, vocational and higher education institutions involved in agricultural education. Conduction of awareness raising campaigns via TV shows, radio broadcasting, newspapers, local level	Limited technological capacities for melioration of rocky soils	Melioration is a professional activity, so it is expedient to implement it on a competitive basis, thus promoting development of professional institutions. Architectural and construction organizations may possess such potential.	Limited number of local nurseries with sufficient capacity	To establish a fruit tree orchard based on the example of forestry nursery founded under FAO technical assistance, as well as to promote the development of private nurseries network. To recover the fruit selection projects and to develop these activities by implementing selection and adaptation activities at local level.

⁴ Avetisyan S., Agriculture and agro processing of Armenia, Yerevan, Limush, 2010

trainings, etc.
Implementation of a pilot project to demonstrate the benefits of the technology.

Limited understanding of climate change consequences	Development of training and awareness raising materials on climate change consequences, distribution of these to the Agricultural support marz centers, local communities, vocational and higher education institutions involved in agricultural education. Conduction of awareness raising campaigns via TV shows, radio broadcasting, newspapers, local level trainings, etc.	Lack of scientific and educational/consulting activities on the technology	Implementation of research, training and consulting projects with the Armenian National Agrarian University, as well as ASRC and ASMCs of RA MoA.	Absence of RA Law on Agriculture	RA Law on Agriculture is in the Standing Committee on Agriculture and Environment of the National Assembly of RA for the third year. It requires final editing and submission for discussion.
Lack of studies on the technology in Armenia	Studying of international experience on development of windbreaks. Assessment of the historical data of benefits of windbreaks previously existing in Armenia, assessment of remaining windbreaks. Implementation of a pilot project to collect data on windbreaks and conduction of respective study.	Lack of assessment of productive and economic potential of unused lands of the Republic of Armenia	Conduction of assessment of productive and economic potential of unusable lands of RA, development of a system of technologies of use and cadaster mapping via targeted financing of State Scientific Committee.	Lack of guidelines on agricultural systems and agricultural rules	Implementation of a pilot project to demonstrate the benefits of the technology. Development of guidelines and rules based on the lessons learned from implementation of pilot project.
No legal acts regulating the technology	Development and submission for the approval of RA Government a Strategy on development of windbreaks in rural communities and inclusion of its implementation in the annual report on implementation of European Landscape Convention in the Republic of Armenia.	Difficulty of consolidation of different land owners due to negative experience of collective farms in Soviet period	Implementation of a pilot project based on the principle of development of production cooperative, public private partnerships and co-financing. Regulation of cooperatives will also regulate the land allocation issues.	Difficulty of consolidation of different land owners	Implementation of a pilot project based on the principle of development of production cooperative, public private partnerships and co-financing.
				Uncertainty over climate change patterns	Development of awareness raising materials regarding the climate change patterns, periodic updating of the predictions and spreading of the updated results among farmers in affected areas.
				Limited research on agriculture diversification	To implement research, training and consulting projects with the Armenian National Agrarian University, as well as ASRC and ASMCs of RA MoA.

Water sector technologies					
Creation of circulatory water system for fisheries		Installation of compact treatment plants and Application of natural <i>and</i> hybrid treatment systems		Spreading and expansion of drip irrigation system	
<i>Barriers</i>	<i>Measures</i>	<i>Barriers</i>	<i>Measures</i>	<i>Barriers</i>	<i>Measures</i>
Low level of fee for the used water	Increasing of used water fee.	Lack of promotional economic mechanisms	Development of promotional and encouraging economic mechanisms – soft loans, state support, tax benefits, etc. Increasing of the level of fines and penalties. Introduction of the idea of wastewater as a valuable resource within the society.	High cost of technology introduction	Development of a network of local suppliers and consulting companies. Reducing of the risk of market entry – introduction of insurance system. Promotion of local production.
High level of initial investments required for introduction of the system	Promotion of local producers.	High cost of investments for introduction of the system	Support to capacity building of local suppliers and consulting companies	High level of bank interest rates and lack of soft loans	Subsidization of interest rates for installation of drip irrigation systems.
Lack of promotional and encouraging economic mechanisms	Development of promotional and encouraging mechanisms – low bank interest rates, state support, tax benefits, etc. Development of links between the suppliers and users. Development of opportunities for experience expansion	Slow progress of establishing and development of community foundations	Support to establishing and development of community foundations.	Lack of promotional economic mechanisms	Development of promotional and encouraging economic mechanisms – soft loans, state support, tax benefits, etc.
Inconsistency and ambiguity of regulatory policy	Implementation of clear policy on efficient use of water resources by respective public administration agencies.	Limited number of professionals with knowledge of technology	Training of professionals possessing the technology.	Absence of local standards of irrigation water quality	Development and introduction of local standards of irrigation water. Development of water quality supervision system.
Weak legislative and normative regulation, poorly designed regulations	Clear legislative and normative regulation.	Lack of political decisions	Development of clear policy of wastewater removal and treatment. Development and adoption of law on wastewater removal and treatment.	Lack of mechanisms promoting efficient use of water	Development of encouraging mechanisms for efficient water use.
Insufficient control over observance of effective legislation and	Strict oversight of observance of effective legislation and norms by respective public administrative agencies. Consistency of implementation of	Unrealistic norms and rules	Revision of norms and rules of wastewater treatment in order to bring this in compliance with EU standards.	Lack of public regulation and support	Inclusion of drip irrigation promotion in agricultural development strategic papers.

norms	decisions. Close cooperation between decision-makers and entities supervising the implementation.				
Corruption and conflict of interests	Assessment of corruption and conflict of interest risks and development of respective elimination action plan	Weak oversight	Strengthened supervision.	Limitedness of information available to farmers and low level of training	Awareness raising of farmers regarding the technology.
Disregard of water resources' protection by decision-makers	Assessment of the damage caused to water resources due to inefficient use of water by fisheries. Spreading of the results of assessment through media and among key decision making public administration agencies.	Lack of database of scientifically justified proposals on technology selection	Spreading of information about technology at all levels. Work with media – towards publicizing of the technology and its advantages. Development of a database of scientifically substantiated proposals on technology selection and its presentation to the public.	Limitedness of information about the advantages of the technology	Development of information regarding the advantages of the technology and its spreading, implementation of pilot projects.
Limitedness of information on technology at all levels	Spreading of information on the technology at all levels. Organization of social advertising about the technology. Coverage of the technology and its advantages in the media.	Limited experience in introduction of technology	Expansion of the experience of technology introduction, implementation of a pilot project.	Low level of consulting services on selection of respective technology	Development of consulting services for selection of respective technology. Development and spreading of a package of scientifically substantiated proposals on technology selection.
Lack of well-grounded proposals on introduction of the technology	Development and spreading of database of substantiated proposals on technology introduction.	Low level of training and education at all levels	Development of higher education courses on wastewater treatment.	Low capacity of local production	Support to local producers. Development of technology localization and new technologies' development process.
Lack of consulting supporting introduction of the technology	Expansion of consultancy supporting introduction of the technology.				

Development of the Report has been based on knowledge obtained during the training conducted in Bangkok, Thailand, during March 8-11, 2016, as well as the instructions of Second Edition of UDP Guidebook on Overcoming Barriers to the Transfer and Diffusion of Climate Technologies⁵.

The first step of the project has been the analysis of barriers hindering the priorities of development and climate change adaptation in Armenia, followed by overview and investigation of specific sub-sectoral objectives, which are necessary to meet the national targets. Then, in order to understand the details of reasons preventing transfer and diffusion of priority technologies there has been conducted a desk study of documents and reports. Finally, the results of two initial steps have been presented to stakeholders and discussed with them.

In order to understand the fundamental problems in technology transfer, the working group of each sector has applied Logical Problem Analysis (LPA). The cause-effect relations have been developed in Problem tree, having the main problem put as a starter problem, causes at the bottom of the tree and their effects in the upper part. Using LPA, the working groups have been able to bring together the key features of problems, apply logical analysis of interconnected elements, and identify linkages between problem components and external factors. Thus, the Problem trees were used for understanding the causal relations of barriers, their linkages.

As a result of discussion with the stakeholders there have been developed the problem and objective trees for each of the technologies, as well as there has been conducted the market mapping. Finally, there have been identified the measures for overcoming of barriers, which have been also been approved by the stakeholders.

⁵ http://www.tech-action.org/-/media/Sites/TNA_project/TNA%20Guidebooks/Overcoming-Barriers-to-the-Transfer-and-Diffusion-of-Climate-Technologies-2nd-Ed_FINAL.ashx?la=da

Chapter 1. Introduction

1.1. About the TNA project

The Technology Needs Assessment for the Republic of Armenia has three main outputs, including the Technology Needs Assessment Report, present Barrier Analysis and Enabling Framework Report, as well as the Technology Action Plans to be developed based on the results of first two reports.

The Project is implemented under the overall supervision of 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 of October 2, 2012⁶. It includes representatives of respective ministries and public administration agencies, appointed by the order of Minister of Nature Protection of RA, thus ensuring broader involvement of decision-makers in technology needs assessment process. “Environmental Project Implementation Unit” State Institution adjunct to the Ministry of Nature Protection of RA has acted as the implementer of the Project, while National Focal Point for UNFCCC, Mr. Aram Gabrielyan, has been appointed as National Coordinator.

Based on the results of consultations and desk research the agriculture and water sectors have been selected for conduction of technology needs assessment. Climate change adaptation technologies prioritized for each of these sectors have been further analyzed in order to identify possible barriers for transfer and diffusion of prioritized technologies. Based on the results of barrier identification and analysis there have been developed recommendations regarding the enabling frameworks for diffusion of each of prioritized technologies.

The following technologies have been prioritized by stakeholders during the technology needs assessment process:

Agriculture	Water
<ul style="list-style-type: none">• Windbreaks as climate change adaptation tool• Local melioration and low-volume drip irrigation for newly planted orchards• Diversification of agriculture	<ul style="list-style-type: none">• Creation of circulatory water system for fisheries• Installation of compact treatment plants and Application of natural and hybrid treatment systems• Spreading and expansion of drip irrigation system

For each of the technologies there has been conducted barrier analysis and development of enabling framework based on recommendations of the Second Edition of UDP Guidebook on Overcoming Barriers to the Transfer and Diffusion of Climate Technologies. The process includes the following steps:

- Characterization of technology, identification of its type (capital, consumer, non-market and public goods),
- Collection of available information on prioritized technologies, market mapping,
- Identification of potential barriers, root causes, prioritization of barriers,
- Identification of measures for overcoming the barriers, prioritization of measures,
- Further analysis of measures for the purpose of grouping the measures for different technologies.

⁶ <https://www.e-gov.am/decrees/item/11373/>

The study is based on ecosystem approach, which is one of the key elements of environmental policy of RA Government and implies ensuring the process of integrated and comprehensive management of natural resources.⁷

Since other important processes have been developing in parallel with TNA, such as determining of Intended Nationally Determined Contributions of the Republic of Armenia under UN Climate Change Framework Convention, these have been coordinated to ensure integrity and interlinkage of different activities implemented in climate change sector. Bases and approaches to adaptation recommended by INDC have been used for preparation of this report (see Box 1).

Box 1. Adaptation in INDC

- 1) 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. Thus, the natural ecosystems adaptation approach in INDC is considered pivotal for Armenia’s adaptation strategy and actions (contributions), and a basis for the development of the national adaptation plan.
- 2) The Republic of Armenia embraces the ecosystem approach for adapting to climate change. The approach is in harmony with the environmental policy of the country, can ensure synergy with other international environmental conventions and treaties, will lay the ground for inter-sectoral coordination, and will support establishment of cross-border cooperation and solidarity environment.
- 3) Adaptation activities will be prioritized based on the most vulnerable sectors to climate change:
 - a. Natural ecosystems (aquatic and terrestrial, including forest ecosystems, biodiversity and land cover)
 - b. Human health
 - c. Water resource management
 - d. Agriculture, including fishery and forests
 - e. Energy
 - f. Human settlements and infrastructures
 - g. Tourism

⁷ [Excerpt N 24 from the minutes of RA Government meeting of June 23, 2011](#)

Chapter 2. Agriculture Sector

2.1. Preliminary targets for technology transfer and diffusion

The technologies prioritized for the agriculture sector 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 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 Agriculture⁸. These include the following:

- Development of agricultural organizations, cooperatives and family farms integrated with market infrastructure, through application of intensive technologies,
- Sustainable food security of population and supply of agricultural produce to processors through realistic combination of the interests of national food security and the principles of comparative advantages of foreign trade,
- Increasing of gross product in the agriculture solely via increased labor productivity, reduction of the number of agricultural employees and use of part of excess labor force in servicing of agriculture and non-agricultural sectors via trainings,
- Processing of the significant part of produced agricultural goods in the processing facilities developed in the communities as a result of development of small and medium enterprises,
- Prevalence of production of agriculture produce providing high added value in crop production and cattle breeding,
- 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 contribute to this vision to certain degree, particularly by providing opportunities for increased incomes, intensification of agricultural practices, better cooperation between farmers, increased crops, etc.

⁸ 2010-2020 Strategy of Sustainable Development of Armenia's Agriculture

2.2. Barrier analysis and possible enabling measures – Windbreaks as climate change adaptation measure

2.2.1. General description of Windbreaks as climate change adaptation measure

Windbreaks have been used for land melioration purposes around the world for long time and the technology is not new for Armenia either. During the soviet period, many of the agricultural lands, especially those used for grain production, have been 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%⁹. In addition to their direct function, these have also been used for local recreation purposes, as well as a source of wood occasionally.

Given that climate change risk for Armenia includes intensiveness and frequency of strong winds the technology is becoming very important for the country, where most of 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 there can be used a planting scheme with 2.5-4-meter distance between the lines and 2-3 meters between the plants.

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 corridors are left for agricultural machinery and vehicles. If after harvesting the area is used for grazing of cattle, then the width of corridors can be up to 20-25 meters. Preference is given to tree species with higher density of canopy (poplar, beech, elm, apple, plum, pear, sweet cherry, etc.). There is used a tree planting scheme, which makes penetration of wind more difficult.

Since historically most of the windbreaks in Armenia have been planted by the state on the territories of collective farms, the technology can be considered other non-market good, though during the larger-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 number of farmers.

Based on Second Edition of UDP Guidebook on Overcoming Barriers to the Transfer and Diffusion of Climate Technologies, the technology is mostly defined as 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 public or cooperatives of farmers.

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

⁹ 2015 annual report of “Gyumri selection station” CJSC of the Ministry of Agriculture of RA

2.2.2. Market analysis of Windbreaks as climate change adaptation measure

The market of this technology is quite simple, especially in case of implementation by the government, when windbreaks can be established by state forestry agency, using seedlings produced in its own nurseries. Nevertheless, market mapping tool has been used to present the main actors and enabling factors for given technology (see [Figure 13](#) for details).

The enabling framework of the technology includes common items like legislation, financial policy, sectoral strategy and technical standards, as well as more specific items, like illegal logging, forest management and National Forest Program of Armenia. These are especially important given the experience of losing of previously existing windbreaks as a result of illegal logging during the energy crisis of the beginning of 1990s. Since many of previously existing windbreaks have been managed by the forestry agency, in many cases respective land is still owned by the State Forestry Agency “Hayantar”, so establishing of new windbreaks will need to be coordinated with it. On the other hand, the Agency can also be directly involved in planting of windbreaks, especially in demo projects, necessary to show the benefits of the technology to farmers.

Market actors, among others, include farmers and communities, as well as foresters, nurseries and processing companies. While farmers and communities are the primary beneficiaries and potential buyers of the technology, foresters and nurseries can act as consultants and suppliers of goods. Finally, processing companies can be co-beneficiaries of the technology, as higher productivity and better protection of farms from climate risks will potentially lead to more reliable supply of agricultural products to them at lower prices.

The service providers for given technology include Agricultural support marz (regional) centers, Armenian National Agrarian University, Hayantar, financial institutions, NGOs and international organizations. Among these, the first two have an important role due to their capacity building and awareness raising functions.

2.2.3. Economic analysis of Windbreaks as climate change adaptation measure

While determining the economic feasibility of establishing windbreaks there has to be taken into consideration that in the fields protected by these there can be produced different crops. Thus, it is first of all necessary to identify the yield of each crop and the level of impact of the measure on cultivation costs, after which there can be assessed the economic feasibility.

In the Republic of Armenia, the surface of windbreaks for each 100 ha can be 1,600 m X 15 m = 24,000 m² or 2.4 ha. If the scheme of planting of four rows is taken as 3.75 m X 3 m, then the number of trees will be 2,133. Based on selected tree species, the total cost of planting and maintenance during the first year will be AMD 1.5 million. In three years, the height of trees will exceed 3.5 m, gradually ensuring protection of fields. The surface of arable lands of 230 thousand beneficiaries requiring windbreaks is 90 thousand ha, and the surface of windbreaks is 2,160 ha. Thus, the cost of establishing of windbreaks will be equal to 2,160 ha X AMD 1.5 million = AMD 3,240 million, and the maintenance cost will be AMD 460 million per year.

Studies conducted in the fields of “Gyumri selection station” CJSC of Shirak region have shown, that existence of windbreaks ensures average additional yield of 340 kg/ha of winter wheat and 270 kg/ha of spring barley, other things being equal. Based on 2015 data the surface of winter wheat has

been 95 ha here, and the surface of spring barley has been 75 ha. Thus, the additional yield of winter wheat has been 32.3 tons, which equals to additional income of AMD 5,168,000 based on price of AMD 160/kg. And the additional yield of spring barley will be 20.25 tons ensuring additional income of AMD 2,835,000, based on price of AMD 140/kg.

The total surface of windbreaks for 170 ha of arable land of “Gyumri selection station” CJSC is 4 ha, these have been planted 65 years ago, and the total cost of maintenance, including the land tax, is only AMD 480 thousand. Thus, thanks to each ha of windbreaks the additional income from grain crops is around AMD 2.0 million¹⁰.

2.2.4. Identification of barriers for Windbreaks as climate change adaptation measure

The process of identification of barriers has been based on the recommendations of the Second Edition of Guidebook on Overcoming Barriers to the Transfer and Diffusion of Climate Technologies developed by UNEP DTU Partnership. In order to identify the barriers related to the windbreaks technology and the rest of agricultural and water sector technologies the sectoral experts in cooperation with the adaptation team leader and Project coordinator have conducted literature survey and interviews with respective specialists.

The initial list of barriers for each of the technologies has been discussed amongst the Project team as the first step towards prioritization of the barriers. As a result, the barriers have been classified and the most important ones have been selected.

For each of the identified barriers there have been suggested measures for overcoming and together with the barriers those have been presented to the participants of workshop held on September 2, 2016. The participants of the workshop have discussed the barriers and respective measures and made recommendations regarding the priority of barriers, as well as have presented their vision on what can be the solutions for those. The workshop participants have been familiarized with the recommendation of the above-mentioned Guidebook, including the categories of barriers, such as killer (non-starter), crucial, important, less important, insignificant (easy starter).

The results of discussion held during the workshop have been taken into consideration during the identification of the final list of most important barriers presented below, as well as the measures to overcome the barriers.

i. Economic and financial barriers

The cost of this project is not significant, so it is not really a barrier for the 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.

¹⁰ 2015 annual report of “Gyumri selection station” CJSC of the Ministry of Agriculture of RA.

Other issues, such as technical means and seedlings are quite accessible and are not significant 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 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 do not prioritize the technology. Planting of windbreaks is an additional work for farmers with unknown results.
- *No 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 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 reach an agreement with all of these farmers, which will be quite 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 interest in investing into new technologies. Moreover, due to small size of parcels, many of these are not used by the owners.
- *Limited understanding of climate change consequences* – since most of the farmers have a limited understating of climate change and its potential impact on their activities, they also do not give importance to the adaptation measures.

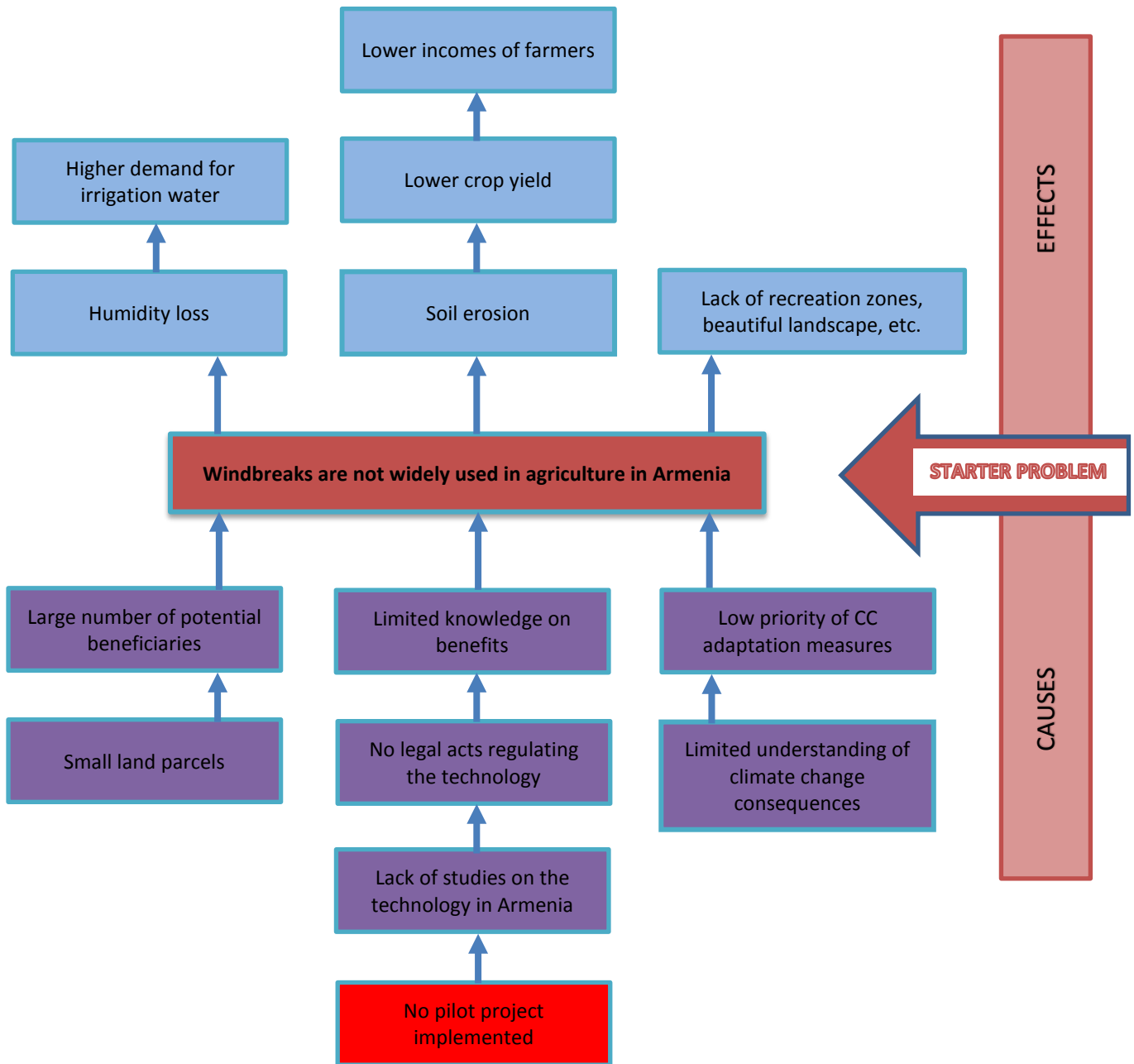
Meeting participants on September 2, 2016 have prioritized the barriers for transfer and diffusion of windbreaks technology the following way:

Table 2. Prioritization of barriers for the windbreaks technology

N	Barrier name	Barrier category	Barrier importance
1.	Large number of potential beneficiaries	Market conditions	Crucial
2.	Small land parcels	Market conditions	Crucial
3.	Limited knowledge on benefits of the technology	Information and awareness	Crucial
4.	Limited understanding of climate change consequences	Information and awareness	Important
5.	Lack of studies on the technology in Armenia	Information and awareness	Important
6.	No legal acts regulating the technology	Legal and regulatory	Less important
7.	Cost of implementation and maintenance	Economical and financial	Insignificant (easy starter)
8.	Availability of machinery and seedlings	Technical	Insignificant (easy starter)

The problem tree for windbreaks as climate change adaptation technology, developed based on the discussion with meeting participants on September 2, 2016, is presented below. As a root cause for the problem there has been identified the lack of pilot projects on establishing of windbreaks. It is believed that implementation of such will result in better understanding of benefits of windbreaks by farmers and higher willingness to invest into the technology.

Figure 1. Problem tree for windbreaks technology



2.2.5. Identified measures

i. Economic and financial measures

As it has been mentioned above, economic and financial barriers are not significant for the technology. Nevertheless, for the implementation of a pilot project the required costs can be covered either by an identified community cooperative, Ministry of Agriculture of Armenia or by donors, such as UNDP, IFAD, FAO, WB, etc., as well as local NGOs working in agriculture/forestry fields.

ii. Non-financial measures

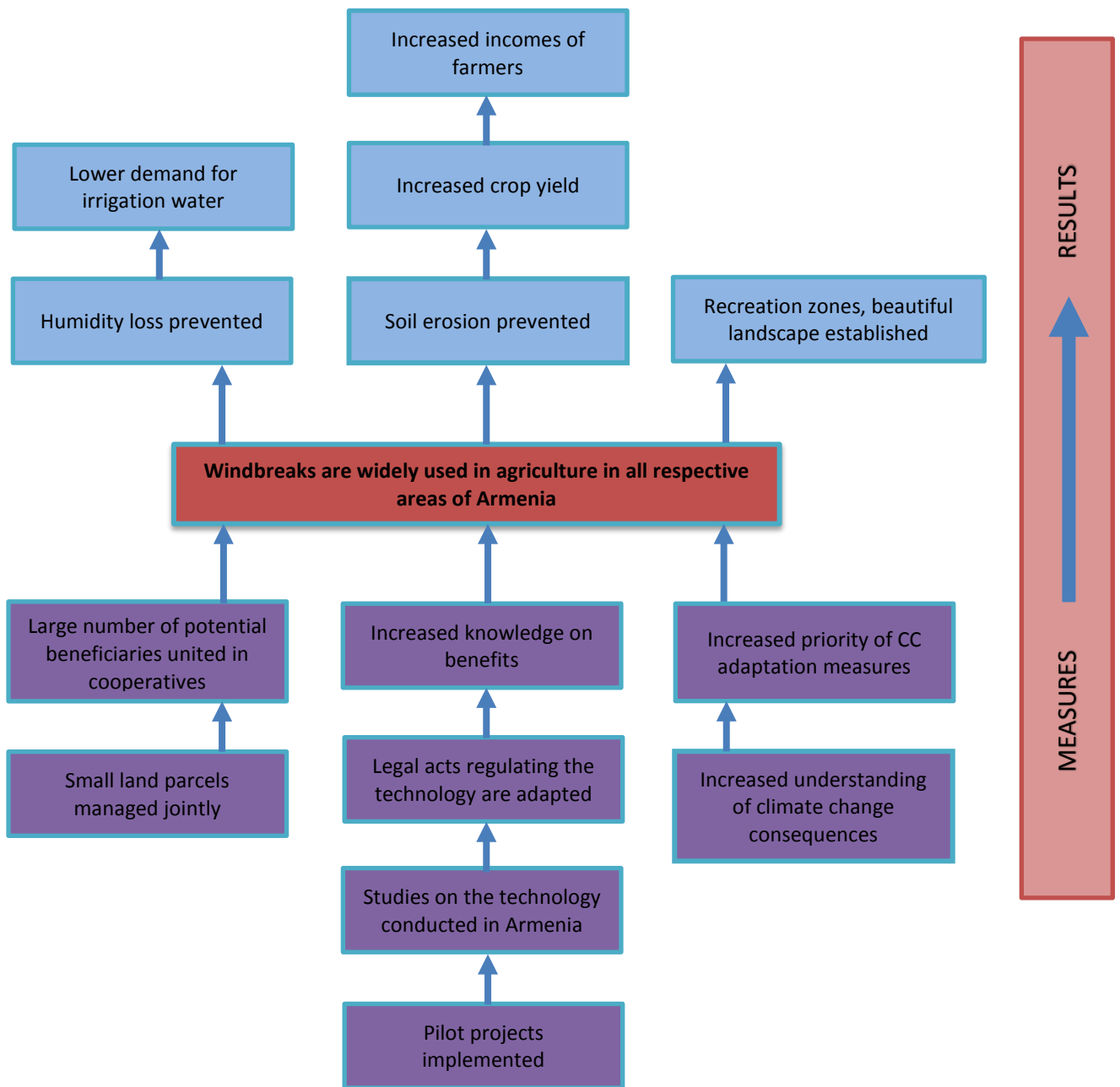
The following measures have been identified for overcoming of non-financial barriers for transfer and diffusion of windbreaks technology.

Table 3. Measures for overcoming non-financial barriers of windbreaks technology.

N	Barrier	Measure for overcoming
1.	Large number of potential beneficiaries	Development of agricultural cooperatives based on RA Law on Agricultural Cooperatives adopted in 2015.
2.	Small land parcels	Development of agricultural cooperatives based on RA Law on Agricultural Cooperatives adopted in 2015.
3.	Limited knowledge on benefits of the technology	Development of training and awareness raising materials on benefits of windbreaks, distribution of these to the Agricultural support marz centers, local communities, vocational and higher education institutions involved in agricultural education. Conduction of awareness raising campaigns via TV shows, radio broadcasting, newspapers, local level trainings, etc. Implementation of a pilot project to demonstrate the benefits of the technology.
4.	Limited understanding of climate change consequences	Development of training and awareness raising materials on climate change consequences, distribution of these to the Agricultural support marz centers, local communities, vocational and higher education institutions involved in agricultural education. Conduction of awareness raising campaigns via TV shows, radio broadcasting, newspapers, local level trainings, etc.
5.	Lack of studies on the technology in Armenia	Studying of international experience on development of windbreaks. Assessment of the historical data of benefits of windbreaks previously existing in Armenia, assessment of remaining windbreaks. Implementation of a pilot project to collect data on windbreaks and conduction of respective study.
6.	No legal acts regulating the technology	Development and submission for the approval of RA Government a Strategy on development of windbreaks in rural communities and include its implementation in the annual report on implementation of European Landscape Convention in the Republic of Armenia.

The objective tree for windbreaks technology is presented below.

Figure 2. Objective tree for windbreaks technology



2.3. Barrier analysis and possible enabling measures – Local melioration and low-volume drip irrigation for newly planted orchards

2.3.1. General description of Local melioration and low-volume drip irrigation for newly planted orchards

The Republic of Armenia has around 12 thousand ha of unusable land in dry subtropical and continental climatic zones. The reason is 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 reduction of precipitation and increasing of mean air temperature. In fact, these processes are already more acute in Armenia than in most of the world, with reduction of precipitations by about 10% over the last decades and increasing of air temperature by over 1.1⁰ C¹¹.

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 within the contour accessible only for the roots of the tree, and planting of orchards of thermophilic fruit trees using drip irrigation. In Armenia, there are such territories in Ararat, Armavir, Aragatsotn, Kotayk, Tavush and Syunik provinces, use of which can help to ensure climate change adaptation and will have economic, social and environmental significance.

The over important components of this technology include removing of stones, sand, soil without humus from the tree stem zone and melioration with carried fertile soil, conduction of watering and nourishing of seedlings or group of seedlings using a drip irrigation system with pipes attached to small barrels on the territories with dry subtropical and severe continental climate.

Depending on 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 barrels will be about AMD 2.5-3 million¹². 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 evenly 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 initially the technology may mostly be attractive for large farms and state, it can be used by smaller farms as well. Taking into consideration that there are around 12 thousand ha of land in dry subtropical and continental climatic zones that need melioration, and the average land plot owned by households is around 1 ha in Armenia, the technology can 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.

2.3.2. Market analysis of Local melioration and low-volume drip irrigation for newly planted orchards

The market map of the technology has three levels, including the enabling framework, market actors and service providers (see [Figure 14](#) for details). The enabling framework includes legislation,

¹¹ Third National Communication on Climate Change of the Republic of Armenia

¹² Calculations has been made based on baseline data provided to TNA agriculture sector expert Samvel Avetisyan by the suppliers of respective equipment.

financial policy, land cadaster, technical standards, sectoral strategies, irrigation water standards and melioration programs. The last two are the more important elements, as these are also related to the main barriers identified for the technology. Specifically, development of national standards of irrigation water quality will help to ensure supply of irrigation water of higher quality, required for drip irrigation systems. This will also potentially lead to decreasing of maintenance costs, thus making the technology more attractive for farmers.

Main market actors of the technology are agricultural cooperatives, farms, communities, nurseries, local producers and importers of the technology elements, as well as designated administrative entities and processing companies. While eventually all of these may have equal role, at the initial stage the cooperatives may be more important, since the technology will be implemented in risky areas with limited access to infrastructure. Owners of small farms will have difficulties dealing with these issues, thus development of cooperatives will be required to succeed.

Agricultural support marz centers, Armenian National Agrarian University, financial institutions, NGOs, international organization and water users' associations are among the service providers for the technology. Water users' associations have a special role, since these provide the irrigation water, quality and quantity of which are very important for the technology.

2.3.3. Economic assessment of Local melioration and low-volume drip irrigation for newly planted orchards

Depending on conditions of site, distance from water source and crop type, planting of 1 ha of orchard and installation of low-volume drip-irrigation system will cost around AMD 2.5-3 million. Maintenance of one ha of apricot and peach orchard requires AMD 400 thousand annually, and harvesting of each ton costs AMD 40 thousand. This cost changes based on the yield of given year. Gross income from selling of harvest of one hectare of apricot orchard is AMD 7 million (in case of 30 tons of harvest), and the average net income is around AMD 5 million.

Calculations of costs and benefits of the technology are based on data presented in the table below. Since the warming of climate is obvious it is expedient to apply local melioration for planting of orchards of thermophilic fruits, ensuring higher added value.

Table 4. Main parameters of local irrigation of fruit crops¹³

Crops	The depth of spreading of main root mass, m	Feeding surface, m ²	Characteristics of moisture source		
			Depth, m	Surface, m ²	Width of the source, m
Pome fruits	0.8-1	8-64	0.8-1	2-6	1.0-1.5
Stone fruits	0.6-0.8	8-36	0.6-0.8	2-4	1.0-1.5
Nuts	1.0-1.5	48-64	1.0-1.5	4-6	1.0-1.5
Vineyards	0.6-1.0	2-4	0.6-1.2	0.6-1.2	0.8-1.2
Raspberry	0.6-0.8	1-2	0.6-0.8	0.6-1.0	0.8-1.0

Since the average surface of farms in Armenia is small the calculations in the following table are made for 1,000 m².

Table 5. Irrigation costs for melioration of apple, apricot orchards and vineyards and irrigation system installation costs for 1,000 m² of land, AMD thousand¹⁴

¹³ www.cntimelio.ru/LokMel.pdf

Crop	Irrigation method	Melioration	Digging of grooves	Pipes	Drippers	Tank and pump	Labor	Total
Apple	Furrow	100	20				12	132
	Pipe-furrow	100	20	25			10	155
	Drip	100		28	16	120	10	274
Apricot	Furrow	100	20				12	132
	Pipe-furrow	100	20	25			10	155
	Drip	100		28	16	120	10	274
Grape	Furrow	100	40				20	160
	Pipe-furrow	100	40	25			15	180
	Drip	100		30	32	120	15	297

Table 5 shows that local melioration and installation of drip irrigation system costs AMD 2.7-3.0 million for 1 ha of orchards and exceeds the cost of furrow and pipe-furrow methods more than two-fold. Nevertheless, in case of local melioration it is the most effective options, since it ensures stable and high crop yield while requiring 2.5-fold less irrigation water, prevents spreading and growth of weeds, as well as enables improving of activities related to plant nutrition and fighting diseases and pests.

2.3.4. Identification of barriers for Local melioration and low-volume drip irrigation for newly planted orchards

i. Economic and financial barriers

High cost – the average cost for the local melioration of 1 ha and planting of orchard is about AMD 2.5-3.0 million, which is a significant amount for most of the farmers due to their low solvency. Since most of land requiring melioration is located in hail prone areas it will be necessary to install anti-hail nets to insure the newly planted orchards from hail. While anti-hail nets have already been piloted in Armenia and proved to be beneficial both from financial and technological perspectives, installation of these will require additional investments, which may be unbearable for most of the farmers in Armenia.

ii. Non-financial barriers

Insufficient level of development of irrigation water infrastructure – most of the land requiring melioration is located in areas where irrigation water infrastructure needs rehabilitation, since no agriculture activities have been conducted there at least from the beginning of 1990s. In addition, these are also relatively dry areas and water may need to be brought from a distance.

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

Imperfection of legislation on melioration of unusable lands and absence of motivation mechanisms – given the abundance of unused lands around the country it may be a challenge to find investors

¹⁴ Calculations have been made based on baseline data provided to TNA agriculture sector expert Samvel Avetisyan by the communities.

interested in melioration of rocky soils, if no incentives are provided by the state, which currently has no clear legislation on subject matter.

Difficulty of consolidation of different land owners – while during the Soviet period all farmers have been united in different forms of collective farms, starting from land privatization in the beginning of 1990s most of farmers have become owners of land and despite numerous efforts to unite them around common issues that proves to be very difficult.

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

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

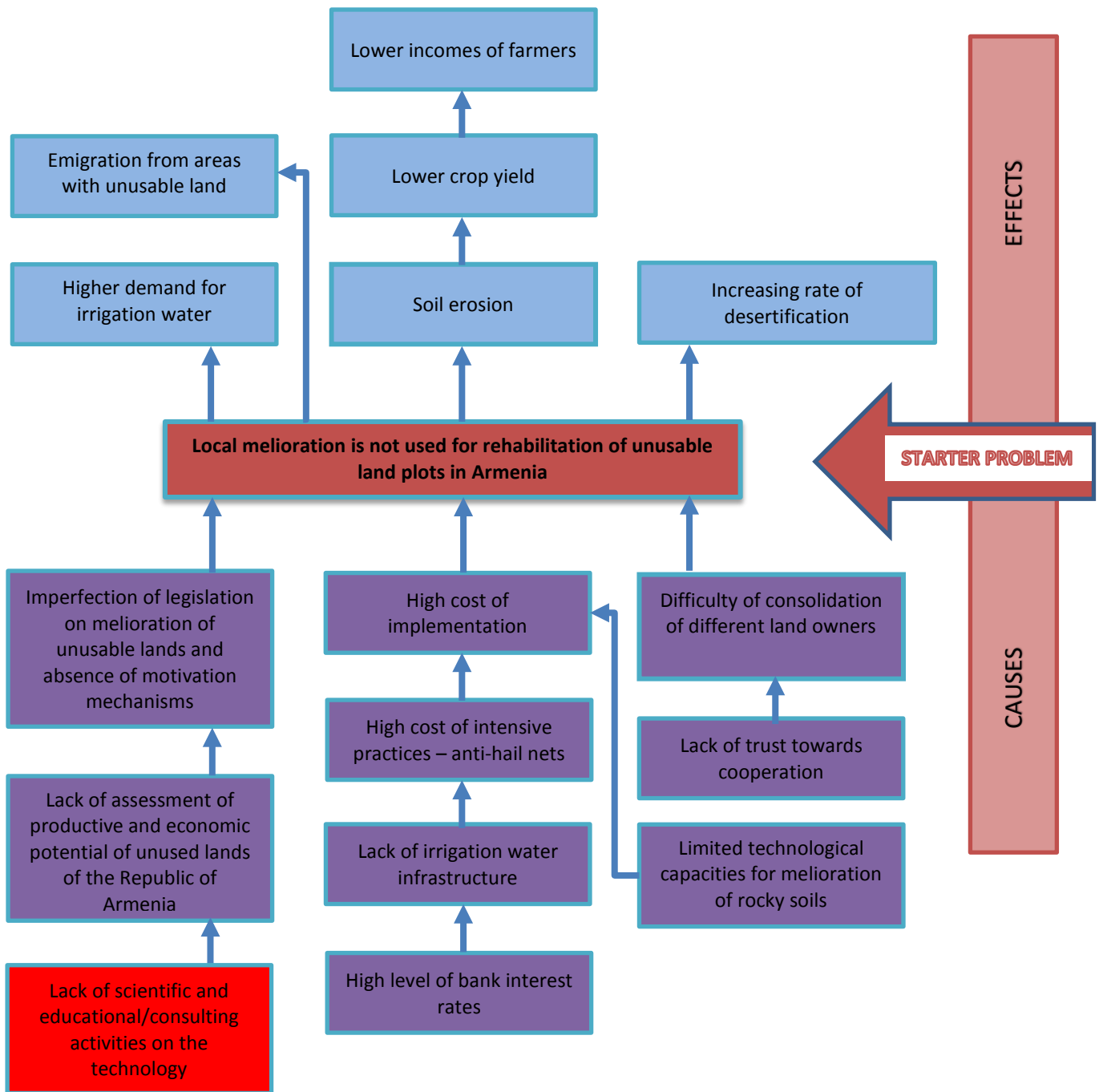
Meeting participants on September 2, 2016 have prioritized barriers for transfer and diffusion of local melioration technology the following way:

Table 6. Prioritization of barriers for the local melioration technology

N	Barrier name	Barrier category	Barrier importance
1.	Imperfection of legislation on melioration of unusable lands and absence of motivation mechanisms	Legal and regulatory	Crucial
2.	High cost	Economic and financial	Crucial
3.	Insufficient level of development of irrigation water infrastructure	Technical	Crucial
4.	Limited technological capacities for melioration of rocky soils	Technical	Important
5.	Lack of scientific and educational/consulting activities on the technology	Information and awareness	Important
6.	Lack of assessment of productive and economic potential of unused lands of the Republic of Armenia	Information and awareness	Important
7.	Difficulty of consolidation of different land owners	Institutional and organizational capacity	Less important

The problem tree for local melioration technology, developed based on the discussion with meeting participants on September 2, 2016, is presented below. As a root cause for the problem there has been identified the Lack of scientific and educational/consulting activities on the technology, and as a consequence the lack of interest in the technology.

Figure 3. Problem tree for local melioration technology



2.3.5. Identified measures

i. Economic and financial measures

To overcome the barrier of high cost for transfer and diffusion of local melioration technology there are few potential measures, including provision of state support through tax benefits and subsidization of loans, development of venture funds, etc. Nevertheless, it is believed that neither of these will be decisive unless certain non-economic measures are undertaken. As it has been noted above, currently there are usable agricultural lands in Armenia, which are not cultivated, so it will be even more difficult to convince investing into melioration of less productive soils, if there are not conducted studies showing the feasibility of such investments.

ii. Non-financial measures

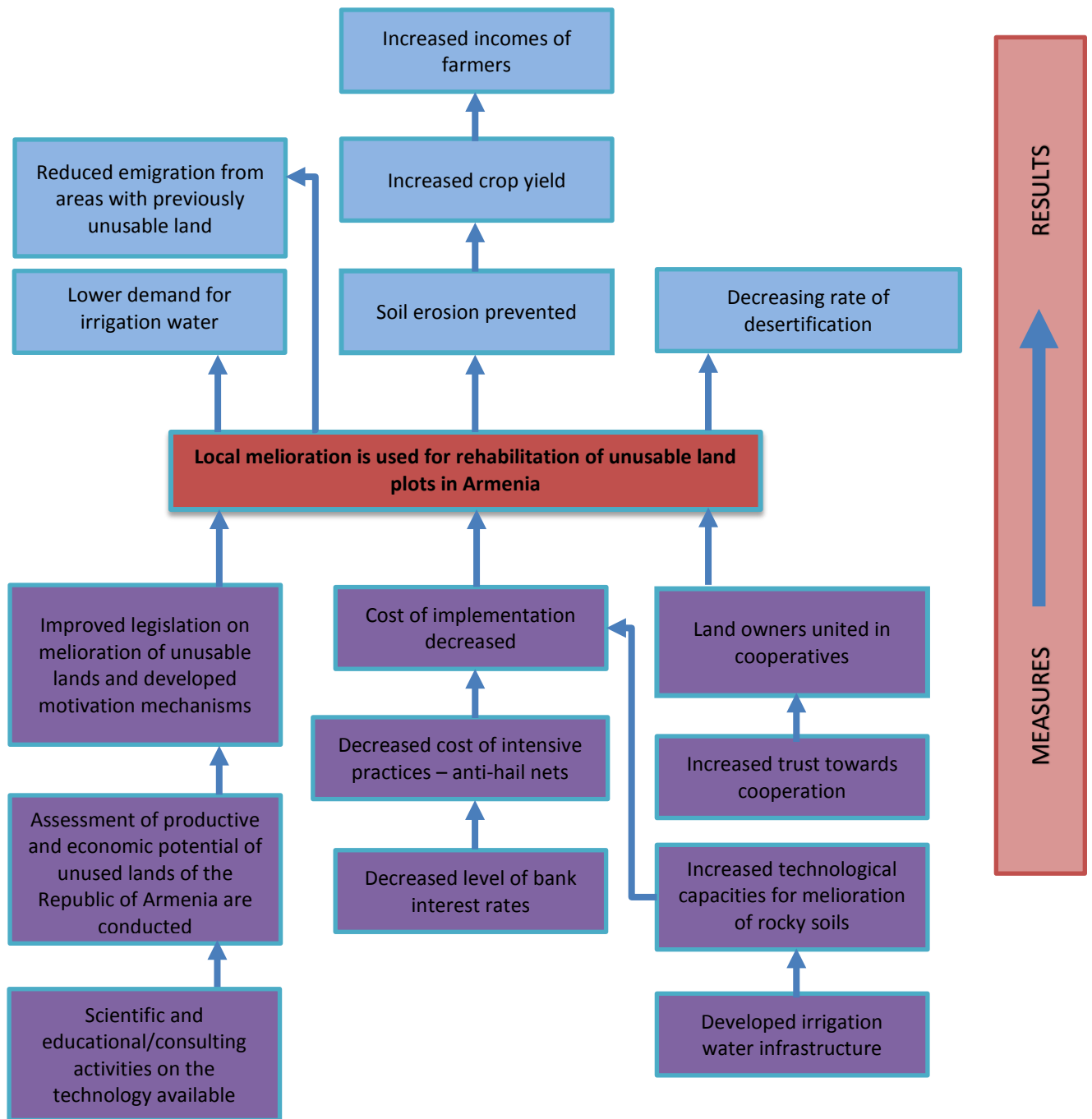
The following measures have been identified for overcoming of non-financial barriers for transfer and diffusion of local melioration technology.

Table 7. Measures for overcoming non-financial barriers of local melioration technology.

N	Barrier	Measure for overcoming
1.	Imperfection of legislation on melioration of unusable lands and absence of motivation mechanisms	Make respective amendments and supplementations to RA Law on Melioration of agricultural land. Adopt a Strategy of melioration of agricultural lands and its action plan.
2.	Insufficient level of development of irrigation water infrastructure	Rehabilitation of irrigation water infrastructure using state budget and donor funding.
3.	Limited technological capacities for melioration of rocky soils	Melioration is a professional activity, so it is expedient to implement it on a competitive basis, thus promoting development of professional institutions. Architectural and construction organizations may possess such potential.
4.	Lack of scientific and educational/consulting activities on the technology	Implementation of research, training and consulting projects with the Armenian National Agrarian University, as well as ASRC and ASMCs of RA MoA.
5.	Lack of assessment of productive and economic potential of unused lands of the Republic of Armenia	Conduction of assessment of productive and economic potential of unusable lands of RA, development of a system of technologies of use and cadaster mapping via targeted financing of State Scientific Committee.
6.	Difficulty of consolidation of different land owners	Implementation of a pilot project based on the principle of development of production cooperative, public private partnerships and co-financing. Regulation of cooperatives will also regulate the land allocation issues.

The objective tree for local melioration technology is presented below.

Figure 4. Objective tree for local melioration technology



2.4. Barrier analysis and possible enabling measures – Diversification of agriculture

2.4.1. General description of Diversification of agriculture

While most of the territory of the Republic of Armenia is located on elevations exceeding 1,000 meters above the sea level, there are certain areas located at elevations of up to 600 m, and climate change risks are more significant for these. The mean air temperature increasing and lack of irrigation water resulting from reduction of precipitation may become a serious threat for these.

Taking into consideration the above-mentioned it may be a good adaptation measure to increase the surfaces of thermophilic crops and develop water saving irrigation technologies. The technology of Diversification of agriculture suggests adaptation to climate change and mitigation of socio-economic consequences via diversification of agricultural production in lower communities of Meghri region¹⁵ of Syunik province and Noyemberyan region of Tavush province of RA.

The technology involves diversification of agricultural activities of the farmers from respective communities by increasing the area of intensive orchard 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 province of RA have been considered as locations for project implementation.

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 characterization, the agriculture diversification technology 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 also has certain characteristics of other non-market good.

2.4.2. Market analysis of Diversification of agriculture

Given the category of the technology, where market and non-market characteristics are mixed, the market analysis is a bit shifted towards capacity building elements (see [Figure 14](#)). While market actors are not different from the other two technologies of agriculture sector, and include nurseries, local producers and importers of technology elements, farms, cooperatives and communities, as well as designated administrative entities and processing companies, service providers are more specific.

In addition to some of service providers, which are similar to the other technologies, such as ASMCs, financial institutions, ANAU, international organizations, NGOs and water users' associations, there are also included the meteorological service and Center for Agribusiness and Rural Development. While the role of the meteorological service is to provide reliable data on the agricultural areas,

¹⁵ Melkonyan A., O. Asadoorian M., Climate impact on agroecology 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

where the technology can be implemented, the role of CARD may be related to capacity building of farmers on marketing of non-traditional fruits, where the organization has serious experience.¹⁶

The enabling framework of the technology includes legislation, technical standards, irrigation water standards, financial policy, sectoral strategy and land cadaster. The latter is important for mapping of land areas with climate conditions required for propagation of non-traditional fruit tree species.

2.4.3. Economic assessment of Diversification of agriculture

The project has been assessed for Zorakan and Haghtanak villages of Tavush region of Armenia. It can also be potentially implemented in other communities of Tavush and Syunik regions.

Climate change trends make obvious the need for diversification of agriculture both in Zorakan and Haghtanak communities, where most of arable lands is used for production of grains and forage, as well as sunflower and onion. Income from the first two crops is very low, especially in comparison with fruits, as shown in the following table.

Table 8. Income from agricultural crops in Zorakan and Haghtanak communities of Tavush region, (2012)¹⁷

Indicators	Wheat	Barley	Sunflower	Onion	Peach	Apple	Persimmon
Yield, t/ha	1.5	1.5	1.3	20.0	20.0	30.0	30.0
Sales price, AMD thousand/ha	150	130	550	150	80.0	150.0	200.0
Gross income, AMD thousand/ha	225.0	195.0	845.0	3,000.0	1,600.0	4,500.0	6,000.0
Costs, AMD thousand/ha	140.0	130.0	320.0	1,800.0	400.0	300.0	300.0
Net income, AMD thousand/ha	85.0	65.0	525.0	1,200.0	1,200.0	4,200.0	5,700.0

It is proposed enlarging the persimmon, pomegranate, olive, fig and other subtropical fruits' orchards, with application of anti-hail nets and low-cost and water-efficient local drip or other irrigation systems.

2.4.4. Identification of barriers for Diversification of 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 realization of their produce, 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 sufficient experience in propagation of seedlings of required species, thus it may be difficult to obtain

¹⁶ Rural development in the region of Meghri Project, 2015 annual report, CARD.

¹⁷ Based on data of 2014 Tavush study "Participatory assessment of competitive advantages (PACA) in Zorakan and Haghtanak communities" implemented under financing of USAID.

necessary seedlings at the moment. Also, most of these do not have a sufficient capacity 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 – 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 agriculture diversification.

Difficulty of consolidation of different land owners – while during the Soviet period all farmers have been united in different forms of collective farms, starting from land privatization in the beginning of 1990s most of farmers have become owners of land and despite numerous efforts to unite them around common issues that proves to be very difficult.

*Uncertainty over climate change patterns*¹⁸ – despite the increasing of mean air temperature, it is difficult to predict what exactly will temperature patterns be in 15-20 years, thus the risk associated with introduction of new species remains high.

Limited research on agriculture diversification – farmers introducing new species take a risk, since studies conducted to assess the efficiency of these in Armenia have limited extent.

Meeting participants on September 2, 2016 have prioritized barriers for transfer and diffusion of agriculture diversification technology the following way:

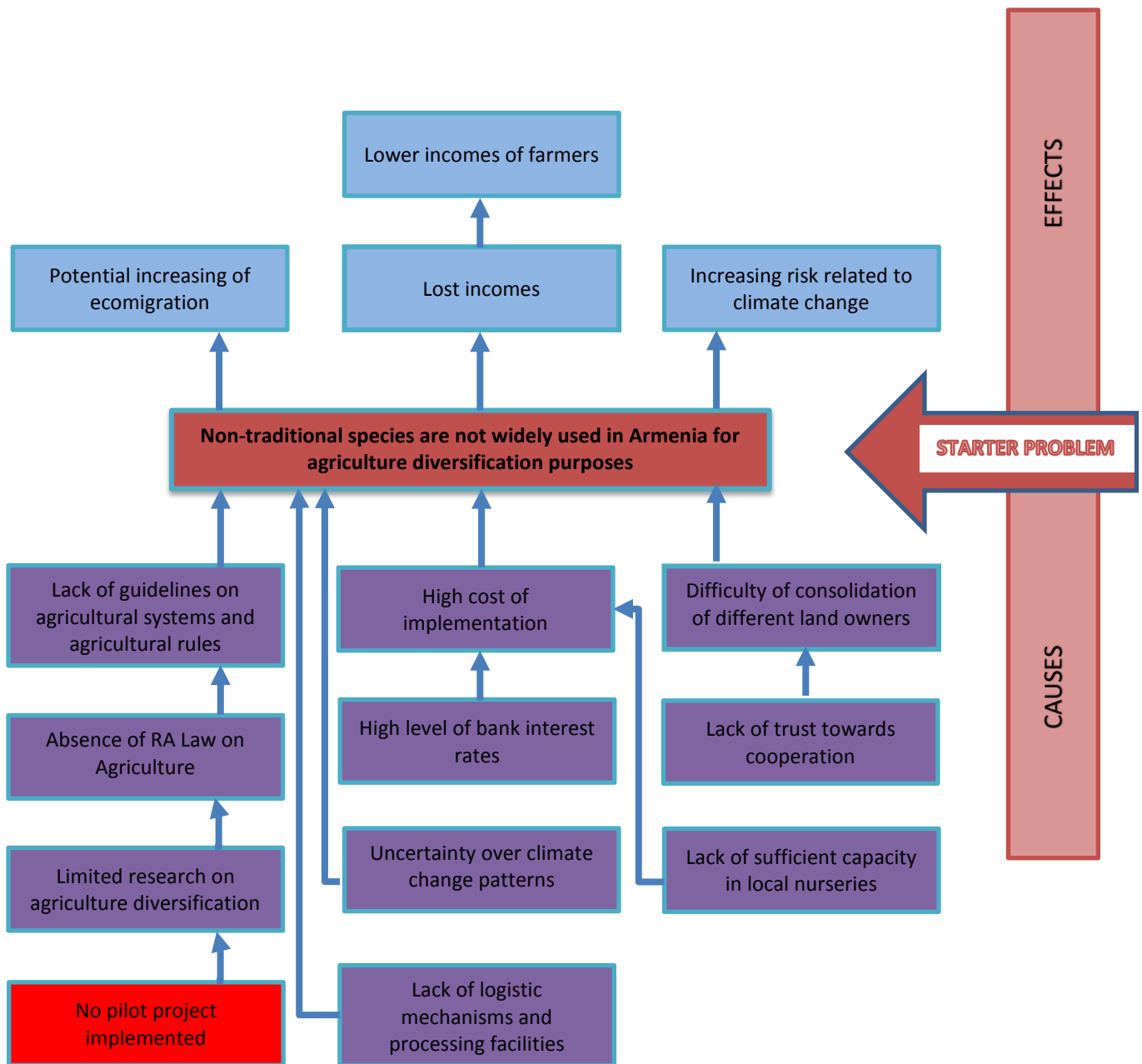
Table 9. Prioritization of barriers for the agriculture diversification technology

N	Barrier name	Barrier category	Barrier importance
1.	Limited research on agriculture diversification	Information and awareness	Crucial
2.	Lack of guidelines on agricultural systems and agricultural rules	Information and awareness	Crucial
3.	Insufficient level of development of logistic mechanisms and processing facilities	Institutional and organizational capacity	Crucial
4.	Limited number of local nurseries with sufficient capacity	Technical	Important
5.	Uncertainty over climate change patterns	Other	Important
6.	Perceived high capital cost	Economic and financial	Important
7.	Absence of RA Law on Agriculture	Legal and regulatory	Important
8.	Difficulty of consolidation of different land owners	Institutional and organizational capacity	Less important

The problem tree for agriculture diversification technology, developed based on the discussion with meeting participants on September 2, 2016, is presented below. As a root cause for the problem there has been identified the lack of pilot projects on agriculture diversification, which can provide data necessary for research activities.

¹⁸ Gevorgyan A. Main types of synoptic processes and circulation types generating heavy precipitation events in Armenia //Meteorology and Atmospheric Physics.-2013

Figure 5. Problem tree for agriculture diversification technology



2.4.5. Identified measures

i. Economic and financial measures

The following measures have been identified for overcoming of economic and financial barriers for transfer and diffusion of agriculture diversification technology.

Table 10. Measures for overcoming economic and financial barriers of agriculture diversification technology.

N	Barrier	Measure for overcoming
1.	Perceived high capital cost	Based on positive experience of peach orchards of Tavush region planting using credit and grant funds of IFAD to improve the mechanisms of Armenian Fruit project and to solve the issue of investments via co-financing of cooperating farms.
2.	Limited level of development of logistic mechanisms and processing facilities	For the purpose of overcoming the crop realization barrier right from the beginning, there need to be implemented logistic systems and processing facilities development project, studying of export markets and development of contractual relationship. Another possible measure is development and submission a development of project on fruit post-harvest infrastructure in the regions for the approval of RA Government.

ii. Non-financial measures

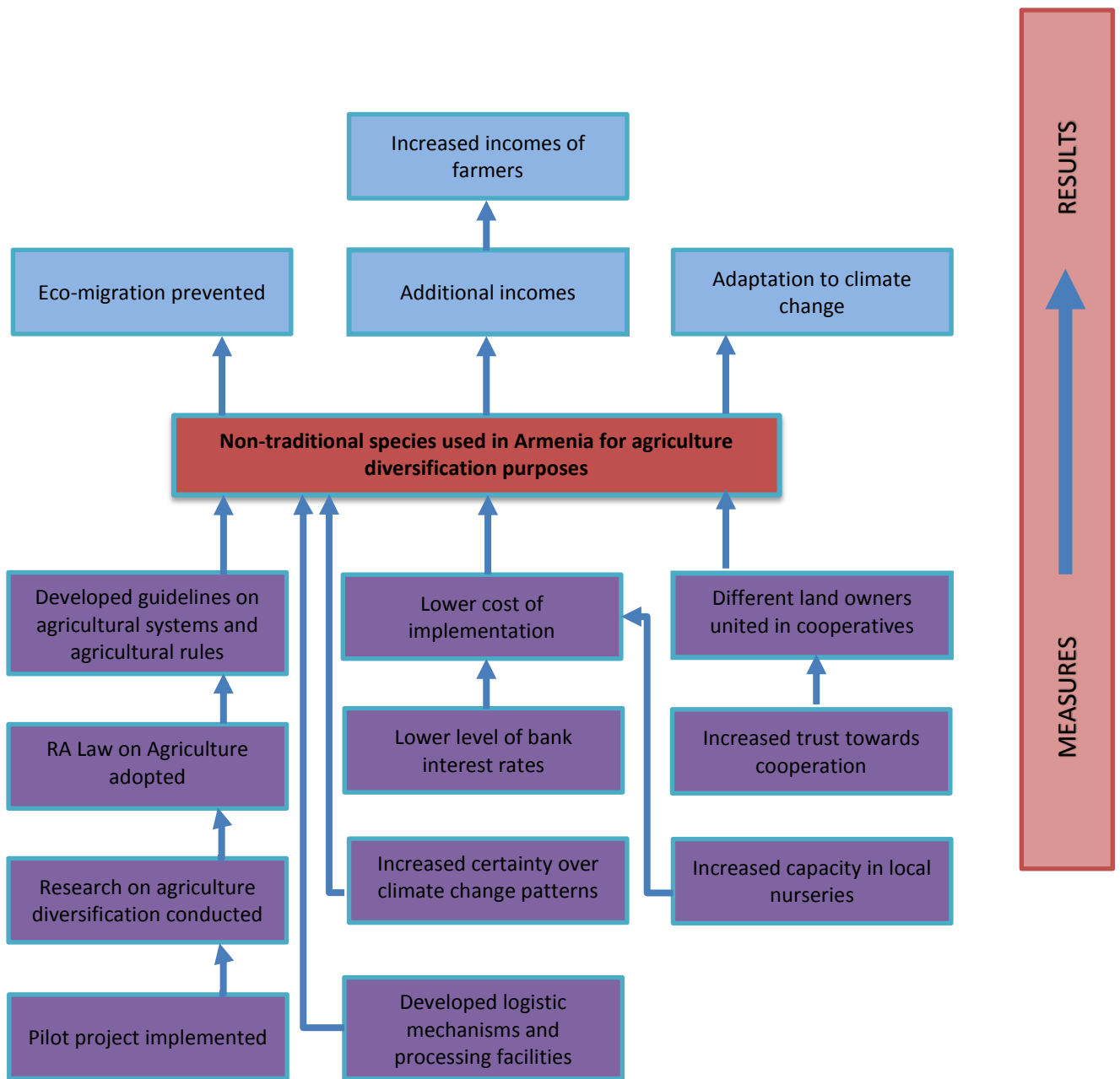
The following measures have been identified for overcoming of non-financial barriers for transfer and diffusion of agriculture diversification technology.

Table 11. Measures for overcoming non-financial barriers of agriculture diversification technology.

N	Barrier	Measure for overcoming
1.	Limited number of local nurseries with sufficient capacity	To establish a fruit tree orchard based on the example of forestry nursery founded under FAO technical assistance, as well as to promote the development of private nurseries network. To recover the fruit selection projects and to develop these activities by implementing selection and adaptation activities at local level.
2.	Absence of RA Law on Agriculture	RA Law on Agriculture is in the Standing Committee on Agriculture and Environment of the National Assembly of RA for the third year. It requires final editing and submission for discussion.
3.	Lack of guidelines on agricultural systems and agricultural rules	Implementation of a pilot project to demonstrate the benefits of the technology. Development of guidelines and rules based on the lessons learned from implementation of pilot project.
4.	Difficulty of consolidation of different land owners	Implementation of a pilot project based on the principle of development of production cooperative, public private partnerships and co-financing.
5.	Uncertainty over climate change patterns	Development of awareness raising materials regarding the climate change patterns, periodic updating of the predictions and spreading of updated results among farmers in affected areas.
6.	Limited research on agriculture diversification	To implement research, training and consulting projects with the Armenian National Agrarian University, as well as ASRC and ASMCs of RA MoA.

The objective tree for agriculture diversification technology is presented below.

Figure 6. Objective tree for agriculture diversification technology



2.5. Linkages of the barriers identified

The linkages of barriers identified for the agriculture sector are mainly related to non-financial ones. Though economic and financial barriers are also important and barriers of all technologies include high cost, but since in most of the cases it is not the most important one, it has been decided to avoid its further analysis. The common barriers of three technologies in agriculture sector are presented in the table below.

Table 12. Common barriers of technologies of agriculture sector.

N	Barrier category	Barriers
1.	Legal and regulatory	<ul style="list-style-type: none"> • Absence of RA Law on Agriculture • Absence or inadequacy of regulations on the technology
2.	Information and awareness	<ul style="list-style-type: none"> • Insufficient awareness of the technology and its benefits • Lack of guidelines on application of the technology • Lack of research on the technology • Lack of inadequacy of consulting services related to the technology
3.	Institutional and organizational capacity	<ul style="list-style-type: none"> • Difficulties of cooperation development in agriculture sector
4.	Other	<ul style="list-style-type: none"> • Insufficient awareness about the climate change impact, its patterns and importance of adaptation measures

The table shows that information and awareness barriers are the most common ones and efforts are needed to raise the awareness of the actors in agriculture sector regarding the technologies and the importance of these from climate change adaptation perspective. In other words, because of lack of knowledge on the technologies at the moment there is lack of demand for these.

Information and awareness barriers are also closely related to insufficient number of experienced agronomists with knowledge of modern technologies in the villages. While in the past graduates of respective educational institutions have been returning to their villages, currently many of them remain in the capital city Yerevan or even move abroad. The low level of incomes and lack of non-agricultural employment in the villages in general leads to intensification of labor migration, depleting already limited capacity of villages.

Another important cross-cutting problem of the agriculture sector is the difficulty related to cooperation in Armenia. Due to mostly negative experience of cooperatives in Soviet period farmers are reluctant to join efforts, while more advanced technologies often require it for efficiency reasons. Moreover, average land plot owned by individual farmers is less than 1 ha in Armenia, and it is very important to promote cooperation in order to reach reduction of costs.

2.6. Enabling framework for overcoming the barriers in Agriculture

One of the main elements of the enabling framework for overcoming barriers in agriculture sector is the adoption of RA Law on Agriculture. The Law has been drafted and submitted to the National Assembly, but the approval is delayed. Once approved it will create a framework for more effective development and introduction of new technologies, such as the ones presented in this report.

Another important element of the enabling framework is the awareness raising on new technologies. While, for instance, windbreaks are a cheap technology known to many farmers in Armenia, they do not know the whole range of its benefits, and especially the monetary expression of the benefits.

To improve the situation, there need to be implemented pilot projects, results of which can become a good basis for conduction of studies and scientific substantiation of advantages of the technologies for decision-makers, farmers, and other market participants.

Awareness raising on climate change risks and importance of adaptation measures can also become an effective measure for diffusion of technologies, as currently most of farmers have limited understanding of climate change patterns and its potential impact on their activities, risks related to climate change, etc.

Financing of new technologies, development of promotion mechanisms is also extremely important, as new technologies are often unaffordable for farmers, especially individual ones. Subsidization of loans, provision of grants is necessary to trigger introduction of new technologies. Requirement of cooperation can be made mandatory for access to cheap financing instruments, so as to create favorable conditions for development of cooperation in agriculture, the Law on which has been adopted in the end of 2015.

The enabling framework for specific technologies of agriculture sector are presented below.

Table 13. Enabling framework for Windbreaks as climate change adaptation tool

N	Enabling framework	Comments
1.	Legislation	Adoption of RA Law on Agriculture will create a framework for development of legal basis for introduction of necessary technologies, including windbreaks.
2.	Technical standards	Development of technical standards for establishing of windbreaks 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 establishing of windbreaks can become a triggering mechanism for spreading of the technology at the initial stage, since most of the farmers are currently not interested in long-term investments, despite being aware 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 fighting against it by better security measures, as well as provision of alternative sources of energy and income, including agroforestry.
5.	Land cadaster	Mapping of agricultural lands requiring establishing of windbreaks will be an important preparatory activity for implementation of the technology.
6.	Forest management plans	According to 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 make sure windbreaks are included into these for protection and proper management purposes.
7.	National forest program	National forest program is the main document regulating forestry policy in

Armenia and inclusion of provisions on windbreaks in it will increase the attention towards the technology, thus also potentially becoming a capacity building tool.

8.	Sectoral strategy	Establishing of windbreaks 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.
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Table 14. Enabling framework for Local melioration and low-volume drip irrigation for newly planted orchards

N	Enabling framework	Comments
1.	Legislation	Adoption of RA Law on Agriculture will create a framework for development of legal basis for introduction of necessary technologies, including local melioration and low-volume drip irrigation for newly planted orchards.
2.	Technical standards	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 introduction of advanced agricultural technologies, such as drip irrigation, will create a favorable environment and incentives for farmers.
4.	Irrigation water standards	Development of irrigation water quality standards is necessary to ensure that farmers receive proper quality irrigation water that will not require excessive investments into filters, as well as maintenance costs.
5.	Melioration programs	Development of respective programs by the Government will become an important signal for farmers and larger investor about the importance of the technology.
6.	Land cadaster	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.	Sectoral strategy	While drip irrigation is included in development documents, melioration is not sufficiently covered. Doing so will become an important step for awareness raising and implementation of respective activities by regional and republican agricultural support centers.

Table 15. Enabling framework for Diversification of agriculture

N	Enabling framework	Comments
1.	Legislation	Adoption of RA Law on Agriculture will create a framework for development of legal basis for introduction of necessary technologies, including diversification of agriculture.
2.	Technical standards	Development of technical standards for agriculture diversification will ensure proper quality of technology introduction, 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 agriculture diversification, will create a favorable environment and incentives for farmers.
4.	Irrigation water standards	Development of irrigation water quality standards is necessary to ensure that farmers receive proper quality irrigation water that will not require excessive investments into filters of drip irrigation systems, as well as maintenance costs.
5.	Land cadaster	Development of a database of lands with respective conditions will make the process of decision-making easier for farmers and investors.
6.	Sectoral 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.

Chapter 3. Water Sector

3.1. Preliminary targets for technology transfer and diffusion

The water sector technologies prioritized during the technology needs assessment phase of the Project have included (i) creation of circulatory water system of fisheries, (ii) installation of compact treatment plants *and* application of natural and hybrid treatment systems, and (iii) spreading and expansion of drip irrigation system. Note that the second technology actually includes two technologies, but since these are very close and the drip irrigation technology is very important for Armenia due to the role of agriculture in its economy, it has been 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 Programme and RA Law on Fundamentals of National Water Policy. The objectives of these documents include satisfaction of the needs of population and the economy via 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 line with the above-mentioned objectives. Given climate change impact on water resources in Armenia, namely the reduction of precipitations and increased surface evaporation, it is important to manage the existing water resources more efficiently, as well as to protect surface and ground water reserves from pollution.

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

Next technology is related to treatment of wastewater, 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 potentially become a serious healthcare and ecosystem issue, since increasing temperatures and evaporation in parallel with reduction of precipitations can result in reduction of water quality, if no actions are undertaken to fix the situation.

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

3.2. Barrier analysis and possible enabling measures – Creation of circulatory water system for fisheries

3.2.1. General description of Creation of circulatory 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 for their operations (more than 450 wells are operated). Renewable groundwater reserves of Ararat Valley are 1,226 million m³, while fisheries have been provided with water use permissions for the volume of 1,496 million m³.

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. In case of not being cultivated, in the future these will degrade and soil will lose the accumulated carbon, thus it will be much more expensive to return these lands into agricultural turnover.

It is recommended installing 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 reuse 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 circulatory water system is a technology used for more efficient production of aquacultures.

3.2.2. Market analysis of Creation of circulatory water system for fisheries

Since technology is considered a capital good, the number of core elements of its market is relatively small and includes fisheries, local producers and importers of technology elements (see [Figure 16](#) for details). But there are also other market actors, which are consulting companies, farmers and their cooperatives, local communities, as well as designated administrative entities and the processing companies. These are important, due to potential benefits related to use of treated water of fisheries and fertilizers produced as a result of treatment process in agriculture.

The enabling framework includes common elements, like legislation, technical standards, irrigation water standards, financial policy and sectoral strategy, as well as more specific elements – corruption and tariff policy. The two latter are very important for the technology, as main barriers for its transfer and diffusion, presented below, are related to these.

Service providers are represented by agricultural support marz centers, financial institutions, ANAU, water users' associations, and NGOs, as well as the more specific State Committee of Water Economy adjunct to the Ministry of Agriculture of RA, Water Resources Management Agency of the Ministry of Nature Protection of RA, USAID (international organizations), as well as the National Academy of Sciences of RA with its respective scientific and research institutes. SCWE and WRMA are the key public administration entities responsible for management and protection of water

resources, while USAID is important due to its role in assessment of Ararat Valley ground water basin and subsequent changes related to supervision of use of ground water in the region. Finally, the Academy and its institutes are important sources of data, as well as scientific knowledge.

3.2.3. Economic assessment of Creation of circulatory water system for fisheries

Closed and circulatory water systems will enable saving the water after it passes through fisheries, and instead to return part of it to the system after treating and recovering qualitative parameters. The share of new water is 30%. In case of closed system, the share of new water is only 3-5% for compensation of evaporated water. These systems enable reducing the water demand significantly and using water resources more efficiently.

Conventional flow systems demand around 30 m³ fresh water for production of 1 kg of trout. While in case of circulatory water systems there is used around 3 m³ of fresh water.

In closed and circulatory systems water is constantly treated by removing fish excrements and enriching water with oxygen. Water running out of basin passes through mechanical and biological filters, it is aerated and returned to basin. If necessary, the system can also include equipment for disinfection with ultraviolet irradiation or ozone, automatic regulation of pH, heat exchange, etc. Table 13 presents the peculiarities of different fisheries for annual production of 1,000 tons of fish and for 1 kg of final product.

Table 16. Fisheries and their peculiarities¹⁹

Fishery type	Nitrogen outflow for 1,000 tons, kg/year	Water volume needed for production of 1 kg of final product, m ³	Land surface needed for production of 1 kg of final product
Conventional flow-through system	38,000	20-30	10
Circulatory system	2,000	5-10	1
Closed system	250	3	0,01

The volume of groundwater used in fisheries in Armenia is 1,300-1,500 million m³, and annual output of fish using it is around 7,000 tons. This means that currently 15-20-fold more water is used for the same output.

Application of circulatory or closed water supply systems in Armenia will enable producing 7-fold more fish, increasing its annual output till 50,000 tons, while using the same surfaces as now and 35-40% of currently used water volume.

Table 17. Fishery systems and their peculiarities²⁰

Type of system	Consumption of new water per kg fish produced per year	Consumption of new water per day of total system water volume	Degree of recirculation at system vol. recycled one time per hour
Flow-through	30 m ³	1,028 %	0 %
RAS low level	3 m ³	103 %	95.9 %
RAS intensive	1 m ³	34 %	98.6 %
RAS super intensive	0.3 m ³	6 %	99.6 %

¹⁹ Decree of RA Government N 1442-N of December 19, 2013, Annex I, Integrated program of recovery of trout in Lake Sevan and development of fisheries

²⁰ A Guide to Recirculation Aquaculture An introduction to the new environmentally friendly and highly productive closed fish farming systems, Author: Jacob Bregnballe, FAO, 2015

In addition, the system enables removing nutrients accumulated in the water (nitrogen, phosphorus), which can be used as organic fertilizers or for production of biogas.

In accordance with Decree of RA Government N 864 on Rates of nature use payments (December 30, 1998) the fee for use of 1 m³ of fresh ground water of drinking quality for fisheries is AMD 1.0. At the same time, in accordance with clause 2 of Article 9 of RA Law on Environmental and nature use payments (December 28, 1998) payers that conduct fish or crab production pay for 5% of total use of water. Thus, the nature use payment for each cubic meter of water has been AMD 0.05. In 2013, the fee has been increased up to AMD 0.5 for ground water and AMD 0.1 for surface water. Fisheries do not pay environmental payment since these are not considered polluters.

Taking into consideration that production of 1 kg of fish requires 30 m³, for which fisheries pay AMD 15.0, and the market price of fish is AMD 1,200-1,500, the cost of water within the price of fish is 1.0-1.5%.

According to different estimates the cost of installation of closed water supply system is about 30-35% of total cost of fishery. And in fisheries, where there is already installed an open system of water supply, according to different sources, the estimated cost of installation of the system can reach up to USD 3-5 (AMD 1,450-2,400) for production of 1 kg of fish. Fisheries in Armenia have different capacities and volumes (5-2,000 tons/year) and installation of circulatory water system in these fisheries can vary significantly, ranging between USD 15,000 and 6 million.

Taking into consideration the above-mentioned, it is critical to increase nature use payments, in order to promote installation of circulatory systems in fisheries, otherwise fisheries will not be interested in doing this due to high cost related to technology.

3.2.4. Identification of barriers for Creation of circulatory water system for fisheries

i. Economic and financial barriers

Low level of fee for used water – despite recent ten-fold increasing of water fee for fisheries it is still very low, especially in comparison with irrigation water fee (AMD 0.5/m³ in comparison with up to AMD 11/m³ for irrigation water). Note, that water used by fisheries is of high quality and in most of the cases can be used as drinking water. The low fee is substantiated 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 reusing of water will require installation of pumps and development of other infrastructure, making water more expensive. As a result of extremely low fees fisheries are not interested in investing in more efficient use of water.

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

Lack of promotional and encouraging economic mechanisms – 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 designed 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 functions 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 operated in favorable conditions and making changes in the existing situation may prove to be difficult.

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

Limitedness of information on technology at all levels – the technology of circulatory water system is not well-known among the operators of fisheries, 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 introduction of the technology – while there are active discussions regarding the need for introduction of circulatory water systems in fisheries in order to save the high-quality water from Ararat Valley ground water basin, so far there have not been presented any proposals that would have included all pros and cons of the technology.

Lack of consulting supporting introduction of the technology – there is need for capacity building of local consultants to support introduction of the technology.

Meeting participants on September 2, 2016 have prioritized barriers for transfer and diffusion of circulatory water system technology the following way:

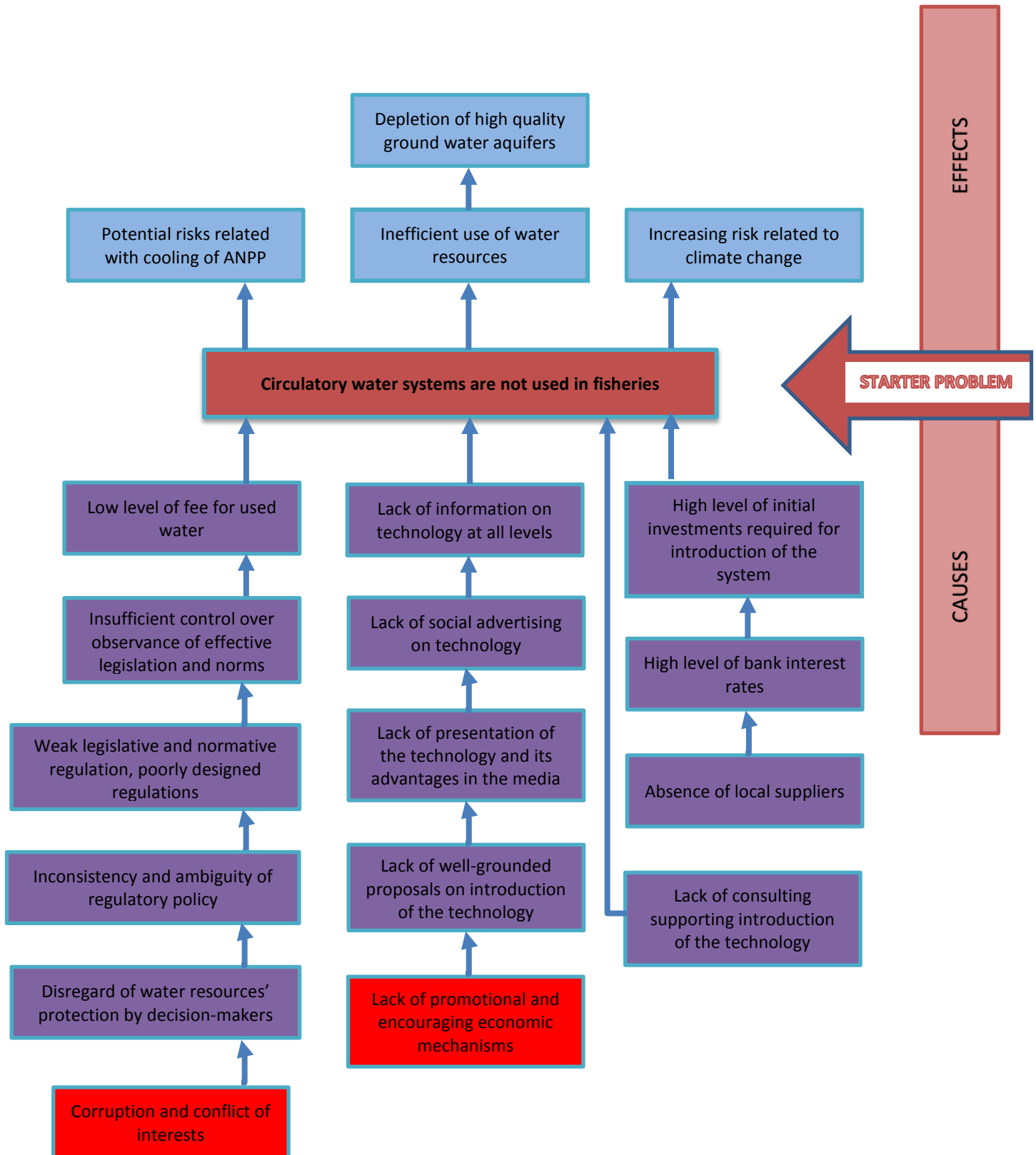
Table 18. Prioritization of barriers for the circulatory water system technology

N	Barrier name	Barrier category	Barrier importance
1.	Corruption and conflict of interests	Legal and regulatory	Killer (no starter)
2.	Low level of fee for the used water	Legal and regulatory	Crucial
3.	Disregard of water resources’ protection by decision-makers	Legal and regulatory	Crucial
4.	Limitedness of information on technology at all levels	Information and awareness	Crucial
5.	Lack of well-grounded proposals on introduction of the technology	Information and awareness	Important
6.	Lack of promotional and encouraging economic mechanisms	Economic and financial	Important
7.	Weak legislative and normative regulation, poorly designed regulations	Legal and regulatory	Important
8.	Insufficient control over observance of effective legislation and norms	Legal and regulatory	Important
9.	High level of initial investments required for introduction of the system	Economic and financial	Less important

10.	Inconsistency and ambiguity of regulatory policy	Legal and regulatory	Less important
11.	Lack of consulting supporting introduction of the technology	Technical	Less important

The problem tree for circulatory water system technology, developed based on the discussion with meeting participants on September 2, 2016, is presented below. As root causes for the problem there have been identified (i) the corruption and conflict of interest and (ii) Lack of promotional and encouraging economic mechanisms.

Figure 7. Problem tree for circulatory water system technology



3.2.5. Identified measures

i. Economic and financial measures

The following measures have been identified for overcoming of economic and financial barriers for transfer and diffusion of circulatory water system technology.

Table 19. Measures for overcoming economic and financial barriers of circulatory water system technology.

N	Barrier	Measure for overcoming
1.	Low level of fee for the used water	Increasing of used water fee.
2.	High level of initial investments required for introduction of the system	Promotion of local producers.
3.	Lack of promotional and encouraging economic mechanisms	Development of promotional and encouraging mechanisms – low bank interest rates, state support, tax benefits, etc. Development of links between the suppliers and users. Development of opportunities for experience expansion

ii. Non-financial measures

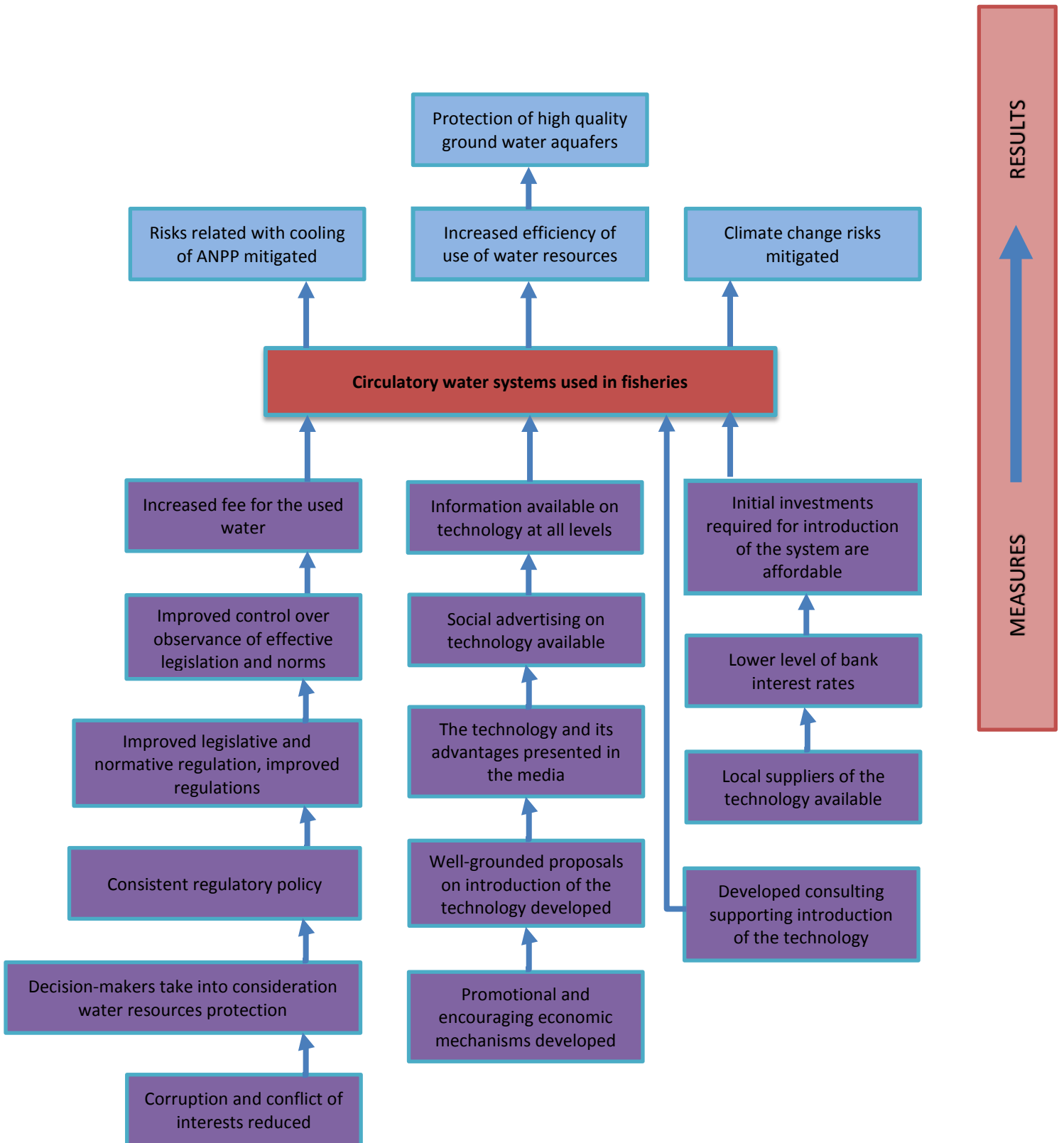
The following measures have been identified for overcoming of non-financial barriers for transfer and diffusion of circulatory water system technology.

Table 20. Measures for overcoming non-financial barriers of circulatory water system technology.

N	Barrier	Measure for overcoming
1.	Inconsistency and ambiguity of regulatory policy	Implementation of clear policy on efficient use of water resources by respective public administration agencies.
2.	Weak legislative and normative regulation, poorly designed regulations	Clear legislative and normative regulation.
3.	Insufficient control over observance of effective legislation and norms	Strict oversight of observance of effective legislation and norms by respective public administrative agencies. Consistency of implementation of decisions. Close cooperation between decision-makers and entities supervising the implementation.
4.	Corruption and conflict of interests	Assessment of corruption and conflict of interest risks and development of respective elimination action plan
5.	Disregard of water resources' protection by decision-makers	Assessment of the damage caused to water resources due to inefficient use of water by fisheries. Spreading of the results of assessment through media and among key decision making public administration agencies.
6.	Limitedness of information on technology at all levels	Spreading of information on the technology at all levels. Organization of social advertising about the technology. Coverage of the technology and its advantages in the media.
7.	Lack of well-grounded proposals on introduction of the technology	Development database of substantiated proposals on technology introduction. Spreading of database of substantiated proposals on technology introduction.
8.	Lack of consulting supporting introduction of the technology	Expansion of consultancy supporting introduction of the technology.

The objective tree of circulatory water technology is presented below.

Figure 8. Objective tree for circulatory water system technology.



3.3. Barrier analysis and possible enabling measures – Installation of compact treatment plants and application of natural and hybrid treatment systems

3.3.1. General description of Installation of compact treatment plants and application of natural and hybrid treatment systems

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

In countryside recreation, tourism, catering objects, located in upper streams of rivers, as a result of absence of wastewater treatment, the damage is mostly caused to water ecosystems. 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 treatment plants in such objects will enable not only excluding pollution of water ecosystems, but also using treated wastewater for irrigation or technical purposes. Another solution for the issue is application of natural and hybrid treatment systems. Thanks to credit investments currently there are constructed 5 wastewater treatment plants in Armenia, 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 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 there have been presented recommendations, 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, there are combined certain elements of natural and conventional treatment systems. Systems can consist of artificially aerated pond, where air is provided by fans and wastewater is aerated, leading to degrading of organic compounds. Then suspended particles subside in sedimentation pond, creating sludge.

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

For the purpose of technology categorization, it has to be divided into two, 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 explained both by technological peculiarities of systems and their cost, thus compact treatment plants can be considered consumer goods, while hybrid treatment plants are a publicly provided good.

3.3.2. Market analysis of Installation of compact treatment plants and application of natural and hybrid treatment systems

The technology combines two elements, one of which, compact treatment plants, is a consumer good, and the other, hybrid treatment plants, is a publicly provided goods. Thus, the market map also includes two different technologies (See [Figure 17](#) for details). For instance, in case of market actors, recreation zones are considered primary users of compact systems, while hybrid systems can be used by communities and water supply and sewage companies. Other market actors include consulting companies, local producers and importers of technology elements, as well as food producers and industrial companies, which can both be buyers of technologies and have a serious impact on the efficiency of systems used by others, by discharging their wastewater into common collection systems.

The enabling framework has several common elements, such as legislation, technical standards, technical knowledge, financial policy and sectoral strategy, as well as specific elements, like wastewater standards, corruption and tariff policy. The wastewater standards are important to make sure that, for instance, food industry pre-treats its wastewater prior to discharging it to wastewater collection system, to avoid negative impact on natural processes related to wastewater treatment in hybrid systems.

Among service providers, the Academy of Sciences, State Engineering University of Armenia, and the Ministry of Health have a special role, due to their capacity building and awareness raising functions. Other service providers include financial institutions, water users' associations, NGOs, SCWE, WRMA, and international organizations.

3.3.3. Economic assessment of Installation of compact treatment plants and application of natural and hybrid treatment systems

For the purpose of sustainable removal and treatment of wastewater, "Basics of sanitation strategy" developed for Armenia recommends application of alternative treatment systems for small communities, as well as small entities, in addition to conventional treatment plants.

Exclusively natural treatment systems are mostly applicable in communities, which have relatively large territories, as the main constraint of this technology is the availability of land. Thus, in Armenia the most convenient technology is hybrid treatment systems, which enables decreasing the required surface by including elements of conventional technology in treatment plants.

The table below shows the construction and operational costs of treatment systems of different capacity, using conventional and hybrid methods. The calculations have been made by the experts of Jinj engineering-consulting company²¹.

Table 21. Construction and operation costs of hybrid and conventional treatment systems

Q-plant capacity, m ³ /day	Population	Construction cost, USD		Operational cost, USD		Treatment cost price, USD/m ³ , only operational costs		Treatment cost price*, USD/m ³ , (construction + operational cost)	
		Hybrid	Conventional	Hybrid	Conventional	Hybrid	Conventional	Hybrid	Conventional
500	2,800	180,000	425,000	12,000	17,000	0.066	0.093	0.132	0.248
1,000	5,900	270,000	720,000	18,000	32,000	0.051	0.088	0.100	0.219
3,000	29,000	1,100,000	2,280,000	76,000	133,000	0.042	0.073	0.082	0.167

* for 15 years of payback period

Compact treatment plants are applicable in case of smaller capacity – starting from one private house to small facilities. Such treatment systems enable reduction of construction costs by up to 30-40%, and the operational costs by up to 10%. These do not require large land areas (up to 5-fold reduction of land area.), thus are more convenient for use by private households and small to average businesses, including hotels and restaurants. The costs of compact plants with different capacities are presented below, using the example of Topol treatment plant produced in Czech Republic.

Table 22. Cost of compact treatment plants with different capacities.

Q, capacity, m ³ /day	People	Cost, USD
0.75	5	2,500
4.5	30	8,000
10	65	13,800

Wastewater treatment will help protecting water and terrestrial ecosystems from pollution, improving the sanitary conditions of communities, will promote reduction of health risks (reduction of waterborne diseases) and food safety of population (untreated wastewater will not mix with irrigation water).

3.3.4. Identification of barriers for installation of compact treatment plants and application of natural and hybrid treatment systems

i. Economic and financial barriers

Lack of promotional economic mechanisms – currently level of fines for environmental pollution is such, that it is cheaper to pay these on a regular basis rather than invest in wastewater treatment systems.

High cost of investments for introduction of the system – although compact treatment plants, natural and hybrid treatment systems are much cheaper than conventional treatment systems, still

²¹ <http://jinjconsult.com/>

application of these requires substantial investments, which are not always affordable for users without public support.

Germinal level of market – the market of treatment systems is at the initial stage of its development and the links between buyers and suppliers are still very weak.

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

ii. Non-financial barriers

Slow progress of establishing and development of 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 professionals with knowledge of technology – relevantly small number of professionals is limiting the awareness on the technology among the potential buyers, as well as the available options.

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 coming from Soviet period, and these are much stricter than the ones used in European Union, for instance. This is a serious barrier for application of non-conventional treatment systems, where wastewater is treated to a degree sufficient for EU norms²², but not for unrealistic ones, effective in Armenia.

Weak oversight – public agencies responsible for 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 database of scientifically justified proposals on technology selection – while non-conventional treatment systems are gradually becoming better known in Armenia there is still need for development of scientifically justified proposals on selection of specific type of system for each case.

Limited experience in introduction of technology – while in Soviet period few non-conventional treatment systems have been piloted in Armenia, there is no data left on these. The only well-documented attempts of application of non-conventional treatment system in modern Armenia is the case of Parakar treatment plant, which is very promising.

Low level of training and education at all levels – there are no educational institutions in Armenia, which conduct training of specialists in non-conventional treatment systems. Moreover, currently

²² Chave P. The EU Water Framework Directive.- 2001, IWA Publishing

none of higher education institutions of Armenia offers high-level courses on wastewater treatment in general.

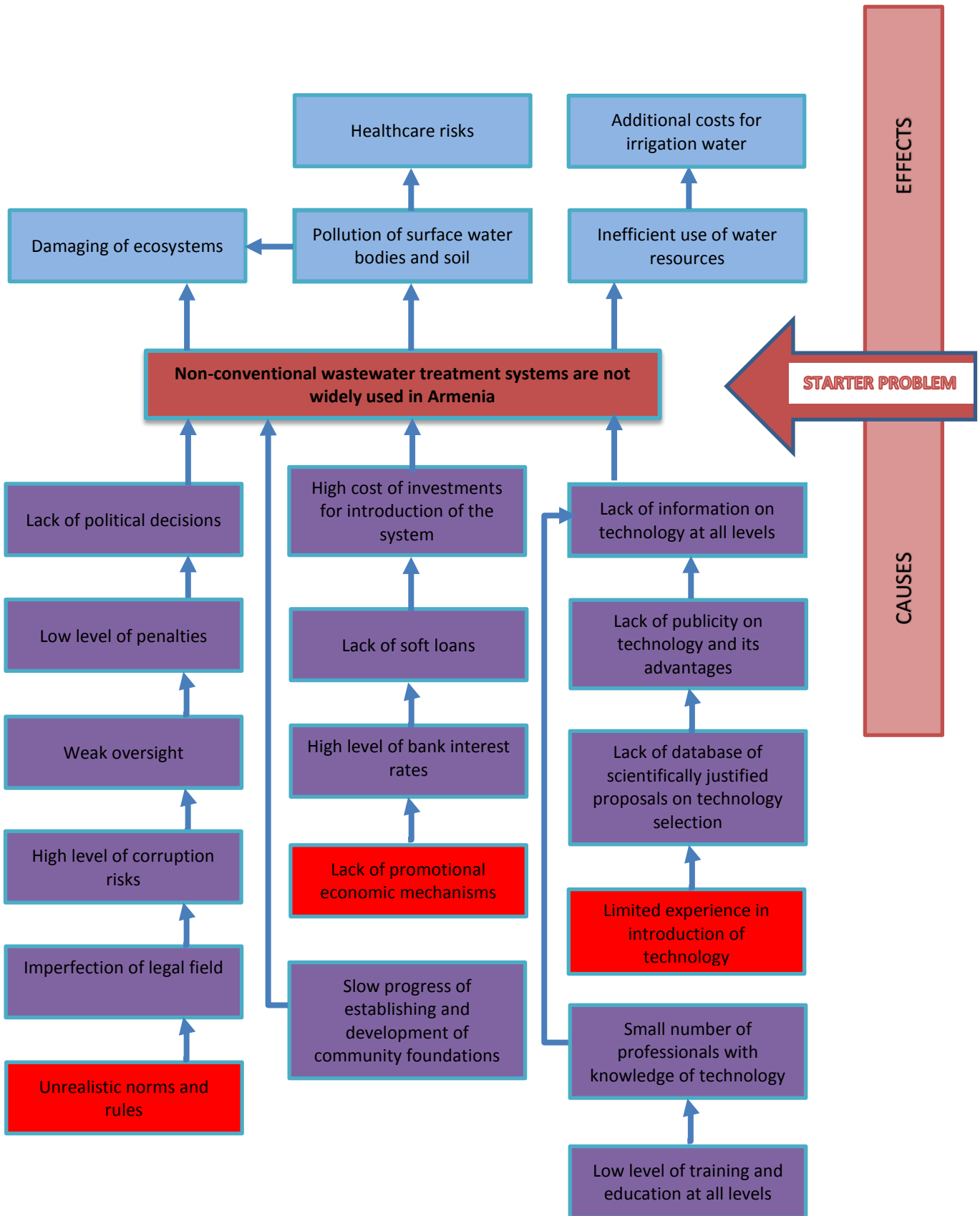
Meeting participants on September 2, 2016 have prioritized barriers for transfer and diffusion of compact treatment plants and application of natural and hybrid treatment systems technology the following way:

Table 23. Prioritization of barriers for the compact treatment plants and application of natural and hybrid treatment systems technology

N	Barrier name	Barrier category	Barrier importance
1.	Lack of political decisions	Legal and regulatory	Crucial
2.	Unrealistic norms and rules	Legal and regulatory	Crucial
3.	Lack of promotional economic mechanisms	Legal and regulatory	Crucial
4.	High cost of investments for introduction of the system	Economic and Financial	Important
5.	Weak oversight	Legal and regulatory	Important
6.	Limited number of professionals with knowledge of technology	Human skills	Important
7.	Low level of training and education at all levels	Human skills	Important
8.	Limited experience in introduction of technology	Technical	Important
9.	Lack of database of scientifically justified proposals on technology selection	Information and awareness	Less important
10.	Slow progress of establishing and development of community foundations	Institutional and organizational capacity	Less important
11.	Germinal level of market	Market conditions	Insignificant (easy starter)
12.	Absence of demand due to low level of consciousness	Market conditions	Insignificant (easy starter)

The problem tree for compact treatment plants and application of natural and hybrid treatment systems technology, developed based on the discussion with meeting participants on September 2, 2016, is presented below. As root causes for the problem there have been identified (i) Unrealistic norms and rules, (ii) Lack of promotional economic mechanisms, and (iii) Lack of experience in introduction of technology.

Figure 9. Problem tree for compact treatment plants and application of natural and hybrid treatment systems technology



3.3.5. Identified measures

i. Economic and financial measures

The following measures have been identified for overcoming of economic and financial barriers for transfer and diffusion of compact treatment plants and application of natural and hybrid treatment systems technology.

Table 24. Measures for overcoming economic and financial barriers of compact treatment plants and application of natural and hybrid treatment systems technology.

N	Barrier	Measure for overcoming
1.	Lack of promotional economic mechanisms	Development of promotional and encouraging economic mechanisms – soft loans, state support, tax benefits, etc. Increasing of the level of fines and penalties. Introduction of the idea of wastewater as a valuable resource within the society.
2.	High cost of investments for introduction of the system	Support to capacity building of local suppliers and consulting companies

ii. Non-financial measures

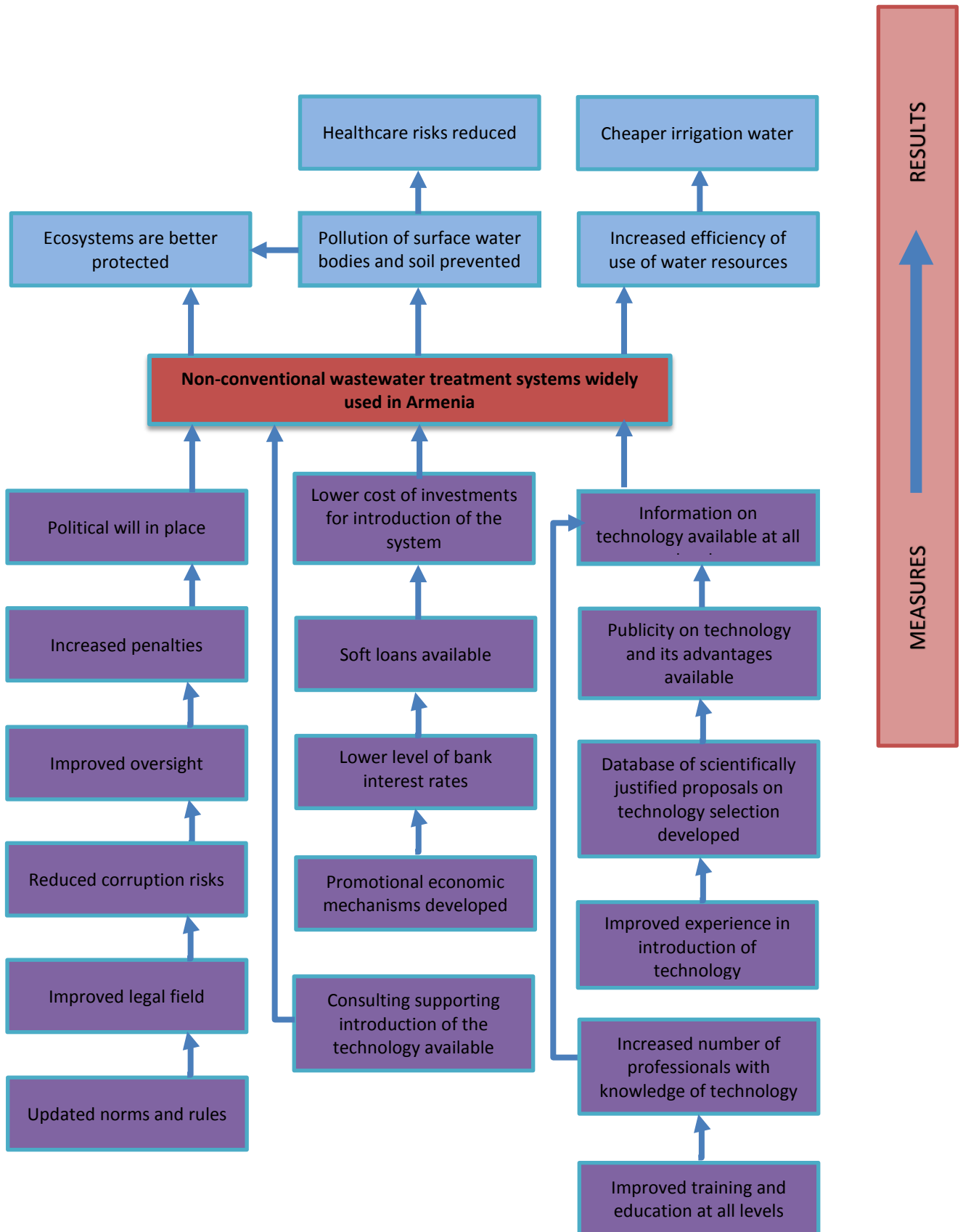
The following measures have been identified for overcoming of Non-financial barriers for transfer and diffusion of compact treatment plants and application of natural and hybrid treatment systems technology.

Table 25. Measures for overcoming non-financial barriers of compact treatment plants and application of natural and hybrid treatment systems technology.

N	Barrier	Measure for overcoming
1.	Slow progress of establishing and development of community foundations	Support to establishing and development of community foundations.
2.	Limited number of professionals with knowledge of technology	Training of professionals possessing the technology.
3.	Lack of political decisions	Development of clear policy of wastewater removal and treatment. Development and adoption of law on wastewater removal and treatment.
4.	Unrealistic norms and rules	Revision of norms and rules of wastewater treatment in order to bring this in compliance with EU standards.
5.	Weak oversight	Strengthened supervision.
6.	Lack of database of scientifically justified proposals on technology selection	Spreading of information about technology at all levels. Work with media – towards publicizing of the technology and its advantages. Development of a database of scientifically substantiated proposals on technology selection and its presentation to the public.
7.	Limited experience in introduction of technology	Expansion of the experience of technology introduction, implementation of a pilot project.
8.	Low level of training and education at all levels	Development of higher education courses on wastewater treatment.

The objective tree for compact treatment plants and application of natural and hybrid treatment systems technology is presented below.

Figure 10. Objective tree for compact treatment plants and application of natural and hybrid treatment systems technology



3.4. Barrier analysis and possible enabling measures – Spreading and expansion of drip irrigation system

3.4.1. General description of Spreading and expansion of drip irrigation system

Irrigated farming in Armenia is conducted using channels, of which inter-farm and intra-farm channels are mostly 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 use of pumps to gravity systems.

Since irrigation water supply is mostly conducted via rivers, water intake from rivers gradually increases towards the headwaters and there is a lack of water in downstream areas, which leads to imbalance of river ecosystems. Taking into consideration that downstream areas of most of rivers pass through settlements, where untreated wastewater is discharged, often in downstream areas of rivers there is only wastewater (the negative effect of this is well noticeable on the example of rivers flowing into Lake Sevan).

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

Drip irrigation is based on direct supply of water to the root system of plant. The system is provided for local watering of soil in crop development zone, via drip dispensers with small portions. Drip irrigation enables saving of water, fertilizers, pipelines, energy and labor expenses. In addition, drip irrigation has several important advantages, such as early crop, prevention of soil erosion, decreased probability of spreading of diseases and weeds.

Drip irrigation technology has the characteristics of consumer good, including the high number of potential buyers, complicated supply chain, etc.

3.4.2. Market analysis of Spreading and expansion of drip irrigation system

Main market actors for drip irrigation technology include producers and importers of technology elements, consulting companies, and farmers, cooperatives, communities, as well as food producers. The latter can potentially cooperate with users of the technology by co-financing its installation to seek better yield and lower prices.

Service providers include the Academy, NGOs, financial institutions, the Agrarian University, Agricultural Support Republican Center, international organizations, SCWE, WRMA, as well as water users' associations. Given the nature of main barrier for transfer and diffusion of the technology, which is the poor quality of irrigation water, last three service providers are especially important, since these are responsible for management, protection and distribution of water.

The enabling framework includes legislation, financial policy, tariff policy, technical standards, irrigation water quality standards, corruption and sectoral strategies, of which quality standards are especially important (see [Figure 18](#) for details).

3.4.3. Economic assessment of Spreading and expansion of drip irrigation system

Drip irrigation has several important advantages – early crop, prevention of soil erosion, decreased risk of spreading of diseases and weed.

In addition, drip irrigation system ensures 20-50% increasing of yield and 30-50% cost reduction, potential for production of high quality yield, equal distribution of water in fields and 30-60% water saving (decreased water evaporation and filtration losses), potential for supply of fertilizers in dissolved form, potential for irrigation of lands with complex landscape, prevention of risk of erosion and increasing of ground waters caused by irrigation, potential for automation of irrigation process.

The system consists of head junction (pump, ensuring up to 1-3 atmosphere pressure in the system, valves, filters, water meter, fertilization system and manometer), distribution network consisting of 12-20 mm diameter polyethylene pipes and drippers (2-16 l/hour) installed on these. For the purpose of even watering it is recommended using pipes not exceeding 150 m. The pipe can be installed both on and under the ground.

Drip irrigation can be provided manually, supplying the water by opening and closing the valves, or it can be automatically, including programming of irrigation for the whole year, taking into consideration the rains and freezing.

Table 26. Comparative information of drip irrigation and conventional systems for irrigation of 1 ha of orchard

Ha	Water, m ³ /year		Construction of the system, USD		Operation of the system, USD/year		Productivity, %		Average cost of construction, operation, USD/year	
	Conventional	Drip	Conventional	Drip	Conventional	Drip	Conventional	Drip	Conventional	Drip
1	12,000	4,000	1,700	2,000	800	500	100	130	913	780

3.4.4. Identification of barriers for Spreading and expansion of drip irrigation system

i. Economic and financial barriers

High cost of technology introduction – despite noticeable reduction of cost of drip irrigation systems during recent years, it is still significant and not affordable for farmers, unless it is used in greenhouses. Spreading of the technology in open field conditions is still limited by high cost.

High level of bank interest rates and lack of soft loans – bank interest rates vary between 14-24%, making the loans very expensive and risky for farmers.

Lack of promotional economic mechanisms – there are no economic mechanisms for 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 promotion of drip irrigation is in conflict with their interests.

ii. Non-financial barriers

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

Lack of mechanisms promoting efficient use of water – irrigation water supply is conducted by water users' association, which are interested in selling as much water as possible.

Lack of public regulation and support – there is no public support to transition to drip irrigation, it is not promoted by agricultural strategies, though there is general understanding of its advantages among the decision-makers.

Lack of information available to farmers and low level of training – while farmers have general understanding of the principles of work of drip irrigation, they lack specific knowledge on maintenance and requirements of the system, often leading to its early wearing out and resulting losses. As a result, many farmers avoid drip irrigation due to such negative experience of others.

Limitedness of information about the advantages of the technology – while many farmers are aware that drip irrigation may help saving water, they are less informed about the possibility of applying fertilizers using the system.

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

Low capacity of local production – the number of local producers is still small and there is need for more in order to develop the market, as well as potentially decrease the installation costs.

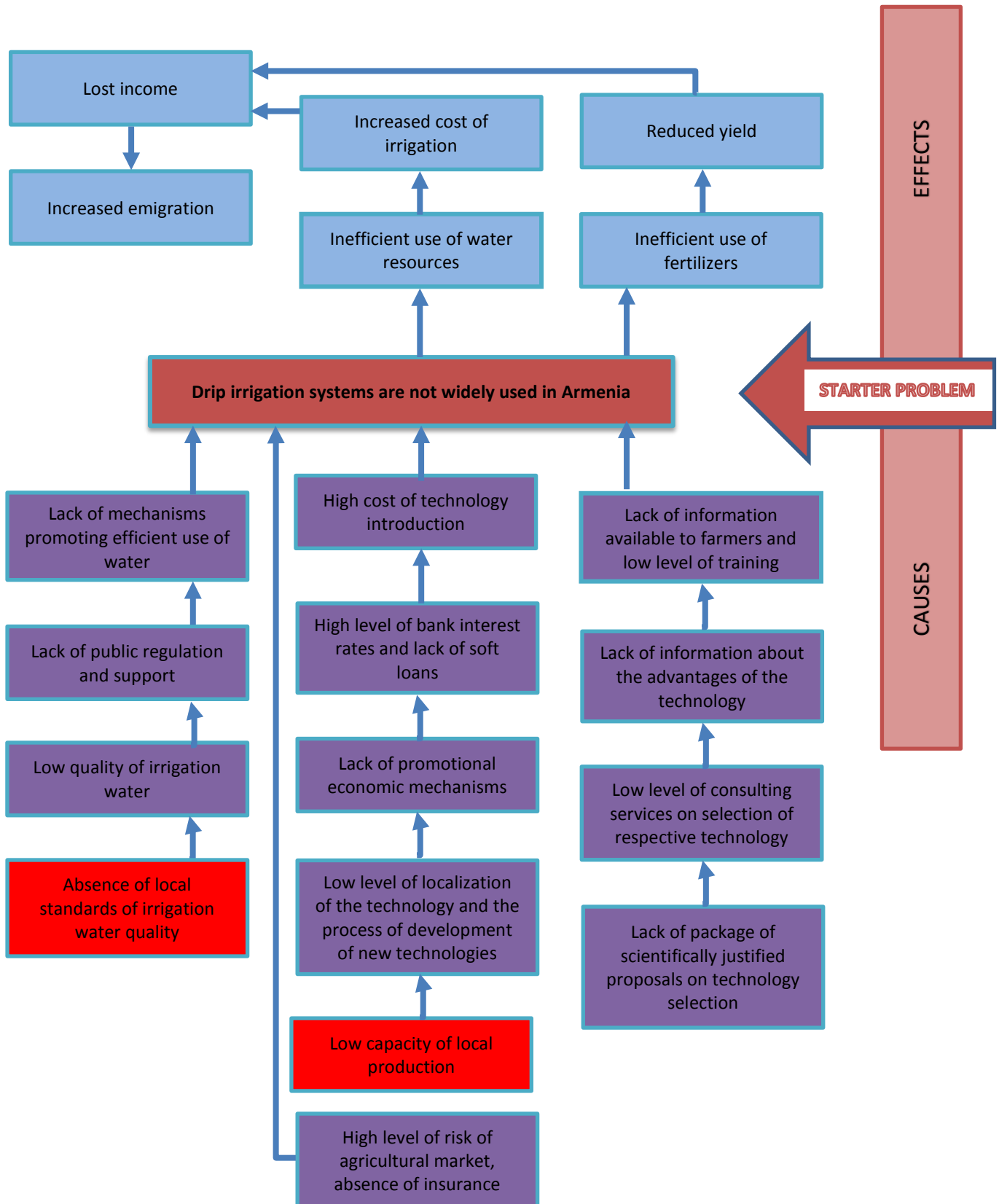
Meeting participants on September 2, 2016 have prioritized barriers for transfer and diffusion of drip irrigation technology the following way:

Table 27. Prioritization of barriers for drip irrigation technology

N	Barrier name	Barrier category	Barrier importance
1.	Absence of local standards of irrigation water quality	Legal and regulatory	Crucial
2.	High cost of technology introduction	Economic and Financial	Crucial
3.	Lack of information available to farmers and low level of training	Information and awareness	Crucial
4.	Lack of promotional economic mechanisms	Economic and Financial	Important
5.	Lack of mechanisms promoting efficient use of water	Legal and regulatory	Important
6.	Lack of public regulation and support	Legal and regulatory	Important
7.	High level of bank interest rates and lack of soft loans	Economic and financial	Important
8.	Limitedness of information about the advantages of the technology	Information and awareness	Less important
9.	Low level of consulting services on selection of respective technology	Human skills	Less important
10.	Low capacity of local production	Technical	Less important

The problem tree for drip irrigation technology, developed based on the discussion with meeting participants on September 2, 2016, is presented below. As root causes for the problem there have been identified (i) Absence of local standards of irrigation water quality and (ii) Low capacity of local production.

Figure 11. Problem tree drip irrigation technology



3.4.5. Identified measures

i. Economic and financial measures

The following measures have been identified for overcoming of economic and financial barriers of drip irrigation technology.

Table 28. Measures for overcoming economic and financial barriers of drip irrigation technology.

N	Barrier	Measure for overcoming
1.	High cost of technology introduction	Development of a network of local suppliers and consulting companies. Reducing of the risk of market entry – introduction of insurance system. Promotion of local production.
2.	High level of bank interest rates and lack of soft loans	Subsidization of interest rates for installation of drip irrigation systems.
3.	Lack of promotional economic mechanisms	Development of promotional and encouraging economic mechanisms – soft loans, state support, tax benefits, etc.

ii. Non-financial measures

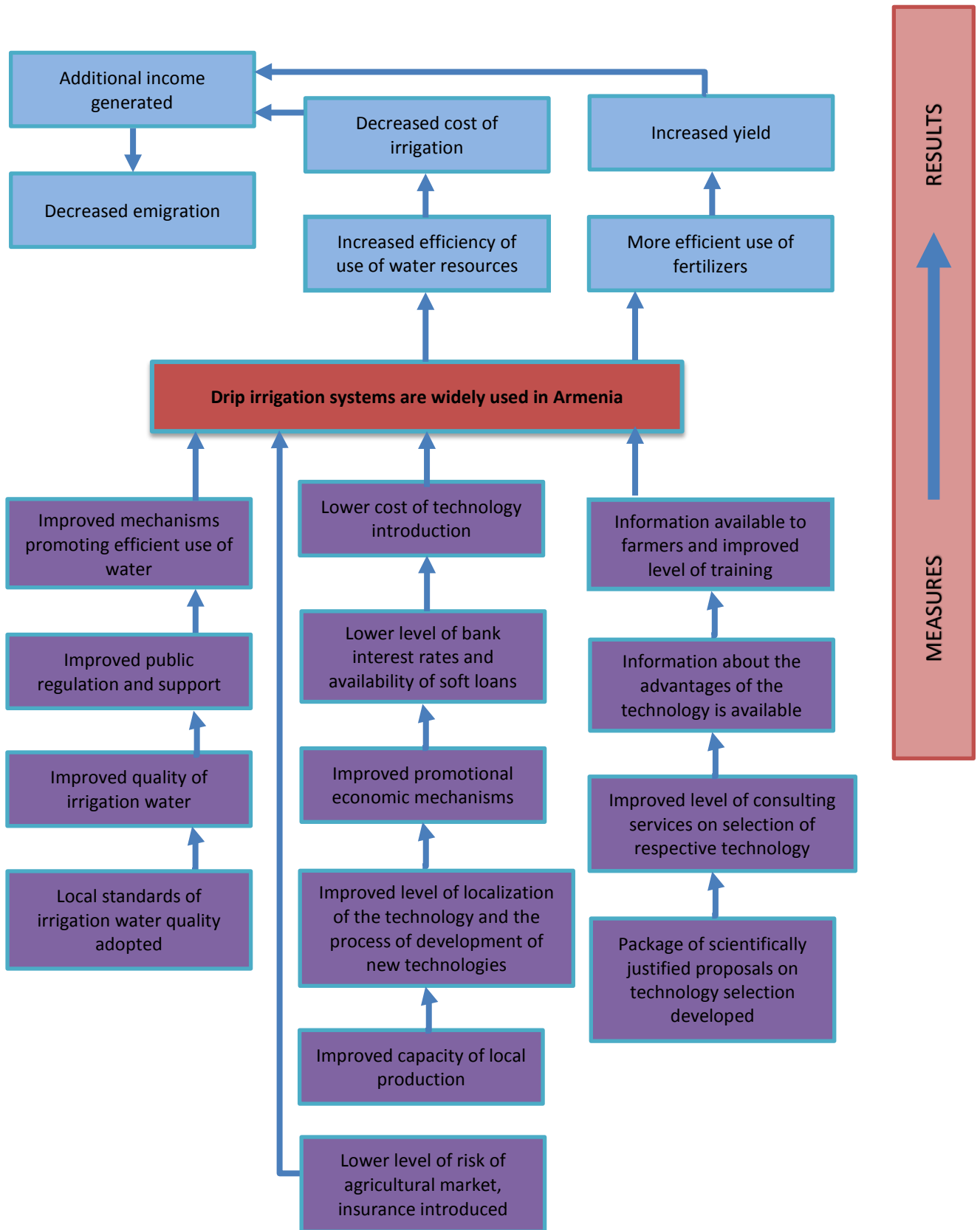
The following measures have been identified for overcoming of non-financial barriers of drip irrigation technology.

Table 29. Measures for overcoming non-financial barriers of drip irrigation technology.

N	Barrier	Measure for overcoming
1.	Absence of local standards of irrigation water quality	Development and introduction of local standards of irrigation water. Development of water quality supervision system.
2.	Lack of mechanisms promoting efficient use of water	Development of encouraging mechanisms for efficient water use.
3.	Lack of public regulation and support	Inclusion of drip irrigation promotion in agricultural development strategic papers.
4.	Lack of information available to farmers and low level of training	Awareness raising of farmers regarding the technology.
5.	Limitedness of information about the advantages of the technology	Development of information regarding the advantages of the technology and its spreading, implementation of pilot projects.
6.	Low level of consulting services on selection of respective technology	Development of consulting services for selection of respective technology. Development and spreading of a package of scientifically substantiated proposals on technology selection.
7.	Low capacity of local production	Support to local producers. Development of technology localization and new technologies' development process.

The objective tree for drip irrigation technology is presented below.

Figure 12. Objectives tree of drip irrigation technology



3.5. Linkages of the barriers identified

The linkages of barriers identified for water sector are mainly related to legislation and regulation. The other important group of barriers is the lack of knowledge both among potential beneficiaries of technologies and decision-makers. High cost is also an important barrier for transfer and diffusion of technologies, but it is believed that the importance of the barrier will decrease, once the rest of the issues are solved.

The common barriers of three technologies in water sector are presented in the table below.

Table 30. Common barriers of technologies of water sector.

N	Barrier category	Barriers
1.	Human skills	<ul style="list-style-type: none"> • Low level of consulting services on selection of respective technology • Small number of professionals with knowledge of technology • Low level of training and education at all levels
2.	Information and awareness	<ul style="list-style-type: none"> • Lack of database of scientifically justified proposals on technology selection • Lack of information about the advantages of the technology • Lack of information on technology at all levels
3.	Legal and regulatory	<ul style="list-style-type: none"> • Lack of public regulation and support • Weak supervision • Inconsistent regulatory policy • Corruption and conflict of interest

The table shows that legal and regulatory barriers are the most common ones and decision-makers need to improve the governance to create favorable conditions for transfer and diffusion of technologies in water sector. This includes development of legislative incentives for development of water saving technologies, adoption of more realistic norms, better supervision of compliance with norms and regulations, etc.

Limited number of specialists and lack of respective technical knowledge is another common barrier in water sector. For instance, in case of wastewater treatment technologies, respective department of State Engineering University of Armenia has been closed and this may lead to further reduction of the number of respective professionals. This in turn can lead to increasing of operational costs, as there may be need for foreign specialists.

Unlike agriculture sector, corruption and conflict of interest are significantly more important in water sector, so there is need for respective measures in this regard as well. This is especially important for circulatory water system and non-conventional wastewater treatment systems. Introduction of these technologies can potentially become a competitor for larger companies, with markets characterized by high degree of monopolization. In addition, in case of circulatory water systems, many fisheries are thought to be affiliated with different public officials, who can affect the decision-making processes.

3.6. Enabling framework for overcoming the barriers in Water sector

Corruption control is one of the key elements of enabling framework for overcoming of barriers in water sector. This is especially important for circulatory water system for fisheries and drip irrigation technologies, where it is necessary to eliminate corruption and conflict of interest risks related to ownership of fisheries and operation of water users' associations.

Next decisive component is the adoption or updating of standards related to irrigation water quality and wastewater treatment. It is important to make sure that these standards are realistic and promote the objective of efficient use of water resources, protection of ecosystems and climate change adaptation.

Similar to agriculture sector, it is important to implement pilot project, based on the results of which there can be made conclusions regarding advantages and shortcomings of technologies in local environmental, and based on lessons learned from these there can be made necessary modifications and improvements. These are very important for the awareness raising of decision-makers, regulators, etc.

The enabling framework for specific technologies of water sector are presented below.

Table 31. Enabling framework for Creation of circulatory 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 circulatory water systems for fisheries.
2.	Technical standards	Development of technical standards for circulatory water system for fisheries will ensure proper quality of technology introduction, while 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 circulatory water systems, which also clean the water.
4.	Tariff policy	Current tariff for water used in fisheries is very low, and it needs to be increased in order to create incentives for fisheries to invest in circulatory water systems.
5.	Financial policy	Provision of soft loans, tax privileges are needed to help fisheries finance installation of circulatory 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.	Sectoral strategy	Respective sectoral documents need to include requirements of water efficiency, thus developing favorable conditions for introduction of respective technologies, such as circulatory water systems.

Table 32. Enabling framework for Installation of compact 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 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 application of wastewater treatment compact and natural/hybrid systems will ensure proper quality of technology introduction, while at the same time potentially serving as a capacity building tool.
3.	Wastewater standards	Adoption of standards for wastewater discharged into collection system will make sure non-conventional treatment systems' efficiency does not drop due to inflow of industrial and food processing wastewater.
4.	Technical knowledge	While non-conventional treatment systems are not a completely new technology, and Armenia has certain experience in its introduction, training of more specialists is needed 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 installation of wastewater treatment non-conventional systems.
6.	Corruption	In many cases, non-conventional treatment systems are a cheaper alternative to the existing conventional ones, and it is necessary to ensure proper corruption control in order to avoid blocking of introduction of the technology by 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 increasing of interest towards non-conventional technologies.
8.	Sectoral strategy	Prioritization of non-conventional treatment systems in respective documents will help attracting investments into the technology.

Table 33. Enabling framework for Spreading and expansion of drip irrigation system

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 drip irrigation systems.
2.	Technical standards	Development of technical standards for drip irrigation system will ensure proper quality of technology introduction, while 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 that will not require excessive investments into filters, as well as maintenance costs.
4.	Financial policy	Soft loans for introduction of advanced agricultural technologies, such as drip irrigation, will create favorable environment and incentives for farmers.
5.	Corruption	Proper corruption control mechanisms in irrigation water supply system are necessary to make sure respective actors provide irrigation water of sufficient quality and in sufficient quantity.
6.	Tariff policy	Conduction of tariff policy that will include progressive fees will create incentives for investing in water saving technologies, such as drip irrigation.
7.	Sectoral strategy	While drip irrigation is included in development documents, more attention will increase awareness on technology and promote implementation of respective activities by regional and republican agricultural support centers.

Chapter 4. Summary and Conclusions

Barrier analysis and enabling framework Report has been developed with the objective of identifying the main reasons hindering transfer and diffusion of agriculture and water sector technologies prioritized during the Technology Needs Assessment phase of the Project. For this purpose, there have been undertaken several steps, particularly, as the first step, there has been conducted a desk study of relevant reports and other documents to identify the preliminary list of barriers for each technology. The results of this activities have been discussed among the Project team, including Project Coordinator, Adaptation Expert Team Leader, as well as Sectoral Experts. This has ensured the initial screening of the results prior to discussion of these with stakeholders.

Stakeholders from public institutions, academia, civil society, private sector and international organizations have been invited to a meeting where the results of desk study have been presented and discussed with them. Following this, together with the stakeholders there have also been finalized the market mapping and problem and objective trees' development exercises. The measures for overcoming of barriers have also been discussed with stakeholders.

Based on these results there have been identified the enabling frameworks for prioritized technologies in agriculture and water sectors. In case of agriculture one of the key preconditions is adoption of RA Law on Agriculture. The Law has been drafted and submitted to the National Assembly, but the approval is delayed. Other important elements include awareness raising on technologies, as well as implementation of pilot projects for the purpose of obtaining practical data on the advantages and shortcoming of technologies in Armenia.

Spreading of knowledge on climate change implications and adaptation importance are also crucial to convince potential users of technologies to pay more attention to these.

In case of water sector technologies one of the main elements is corruption control, which is especially important for circulatory water system for fisheries and drip irrigation technologies, where corruption and conflict of interest risks related to ownership of fisheries and operation of water users' associations need to be eliminated.

The next decisive component is adoption or updating of standards related to irrigation water quality and wastewater treatment. It is important to make sure that these standards are realistic and promote the objective of efficient use of water resources, protection of ecosystems and climate change adaptation.

During the next phase of the Project there will be conducted development of technology action plans for overcoming of barriers for transfer and diffusion of prioritized technologies of agriculture and water sectors.

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Annex I. Market maps

Market maps have been developed by the team of expert of TNA adaptation component to show main actors of markets of respective technologies, as well as the elements needed for successful transfer and diffusion of these in Armenia. Maps consist of three levels, including **market actors**, **service providers** and **enabling framework**. These tools helped to visually present the environment related to prioritized technologies of agriculture and water sectors.

Market actors include the beneficiaries of technologies, such as farmers, farmer cooperatives, local communities, suppliers of technologies, including importers and local producers, as well as providers of consulting services, such as private companies, respective public institutions, etc. Development of relationships between these is very important for proper operation of the market.

Service providers are the “external” actors that can support the development of relationship between market actors, support development of the market through provision of consulting and advisory services, financing, technical knowledge, etc. These include various support services, public institutions, academic and scientific institutions, NGOs, international organizations, public administration agencies, etc.

Finally, the **enabling framework** represents the complex of legislative, institutional, policy, financial and other frameworks, required for promotion of respective technologies in the Republic of Armenia. Improvement in these is essential for succeeding in transfer and diffusion of technologies in long-term. These refer to respective financial and regulatory policies, development programs and strategies, technical standards, etc.

Market maps for prioritized technologies of agricultures and water sectors are presented below.

Figure 13. Market mapping of windbreaks technology

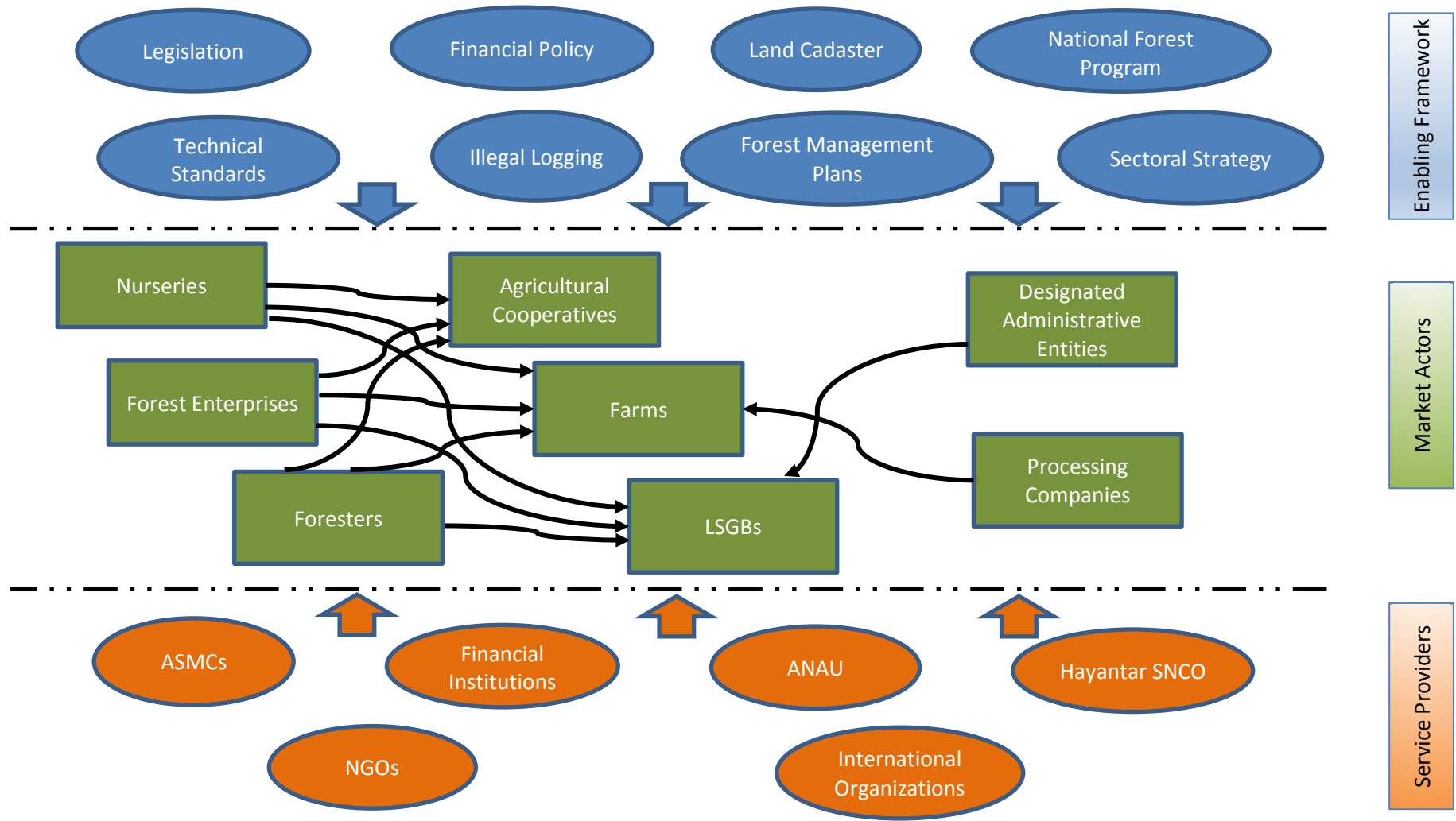


Figure 14. Market mapping of local melioration technology

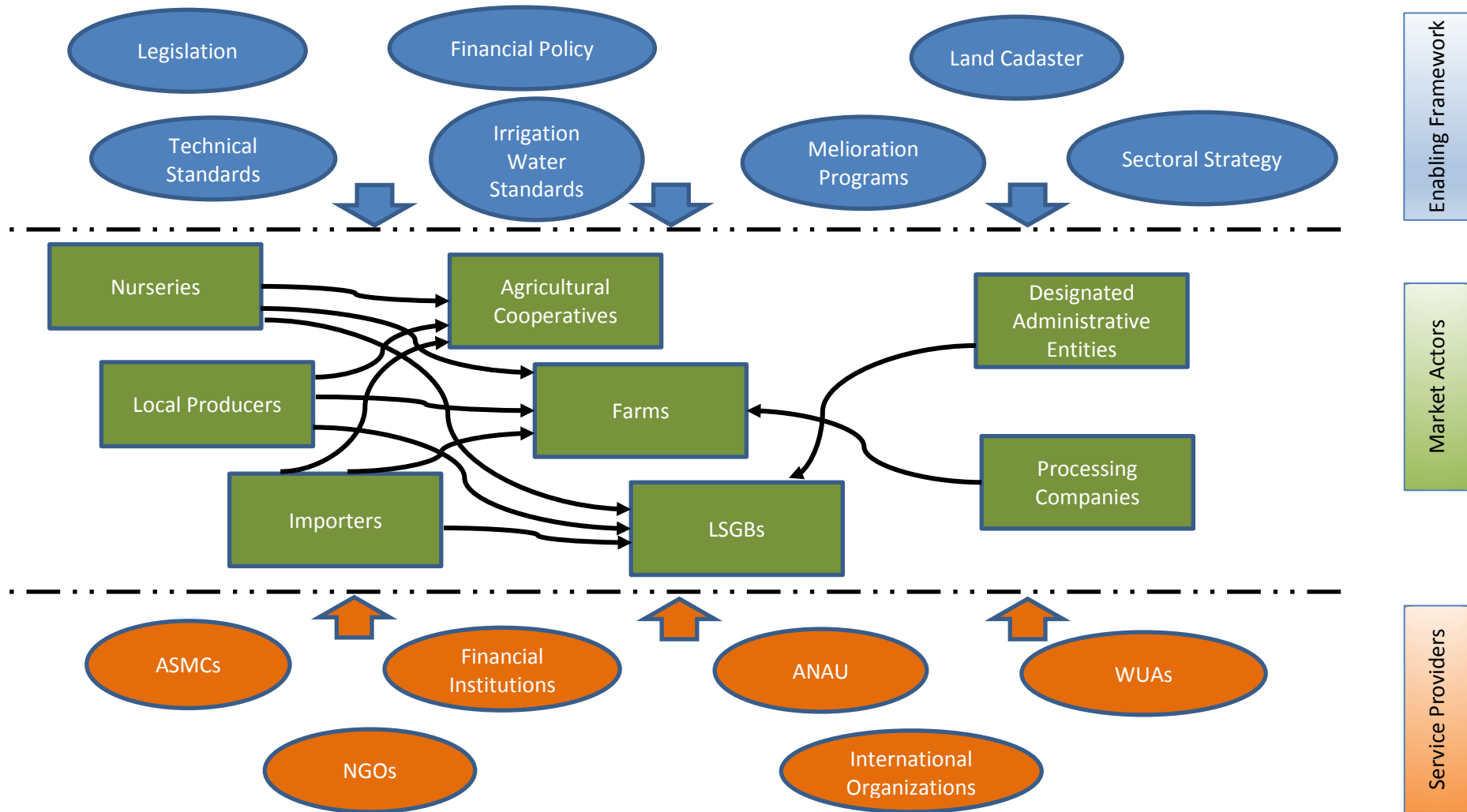


Figure 15. Market mapping of agriculture diversification technology

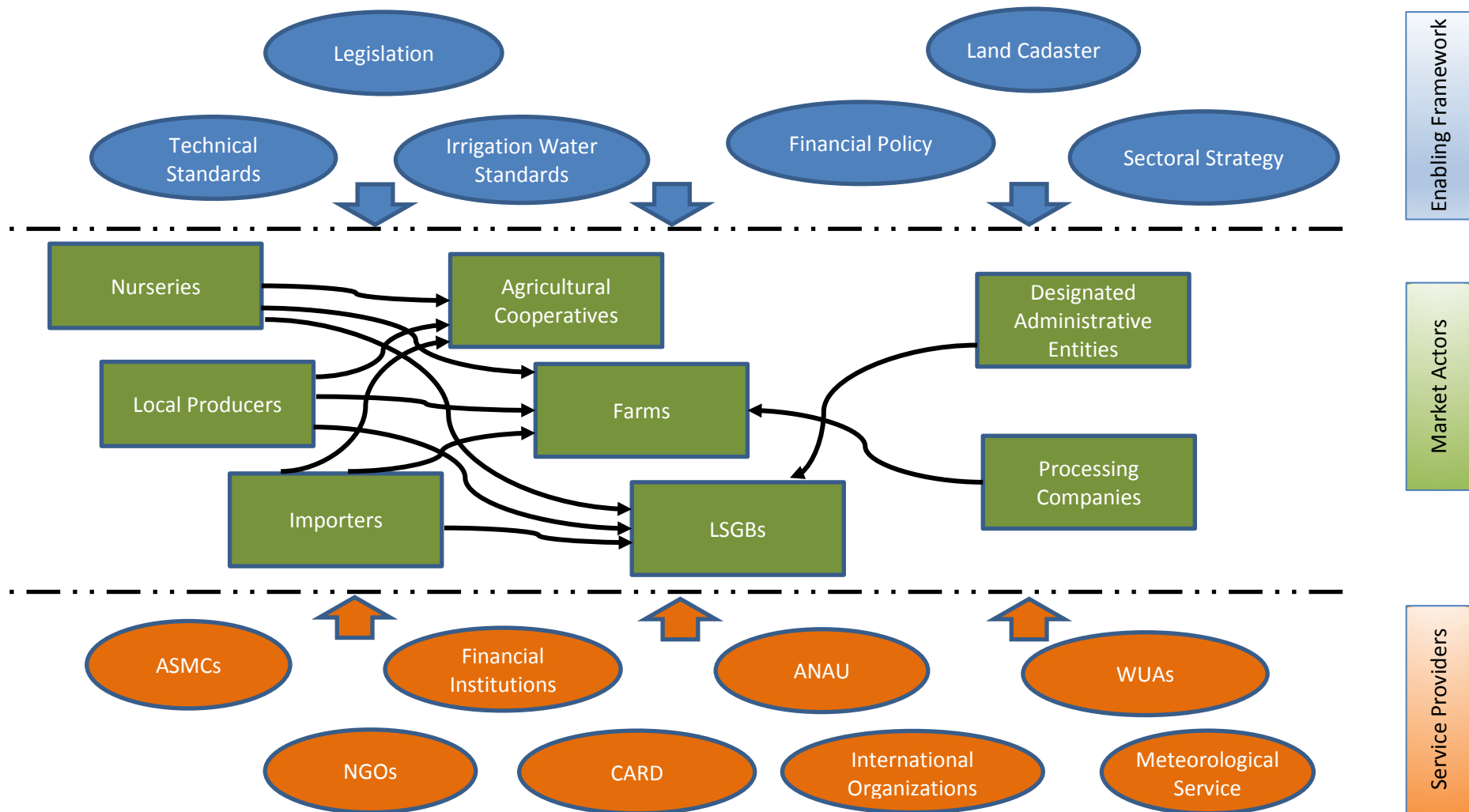


Figure 16. Market mapping of circulatory water system technology

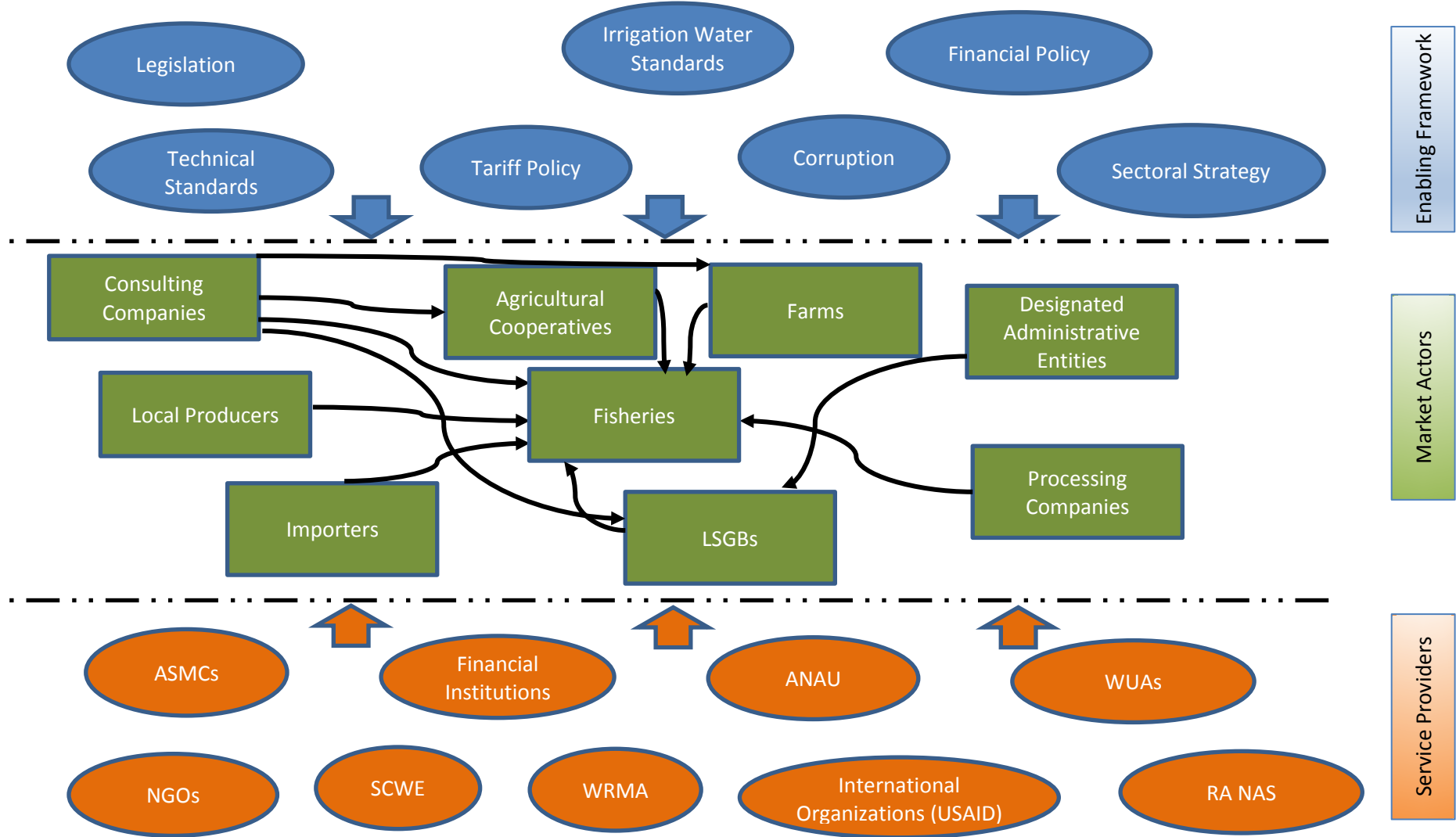


Figure 17. Market mapping of compact treatment plants and application of natural and hybrid treatment systems technology

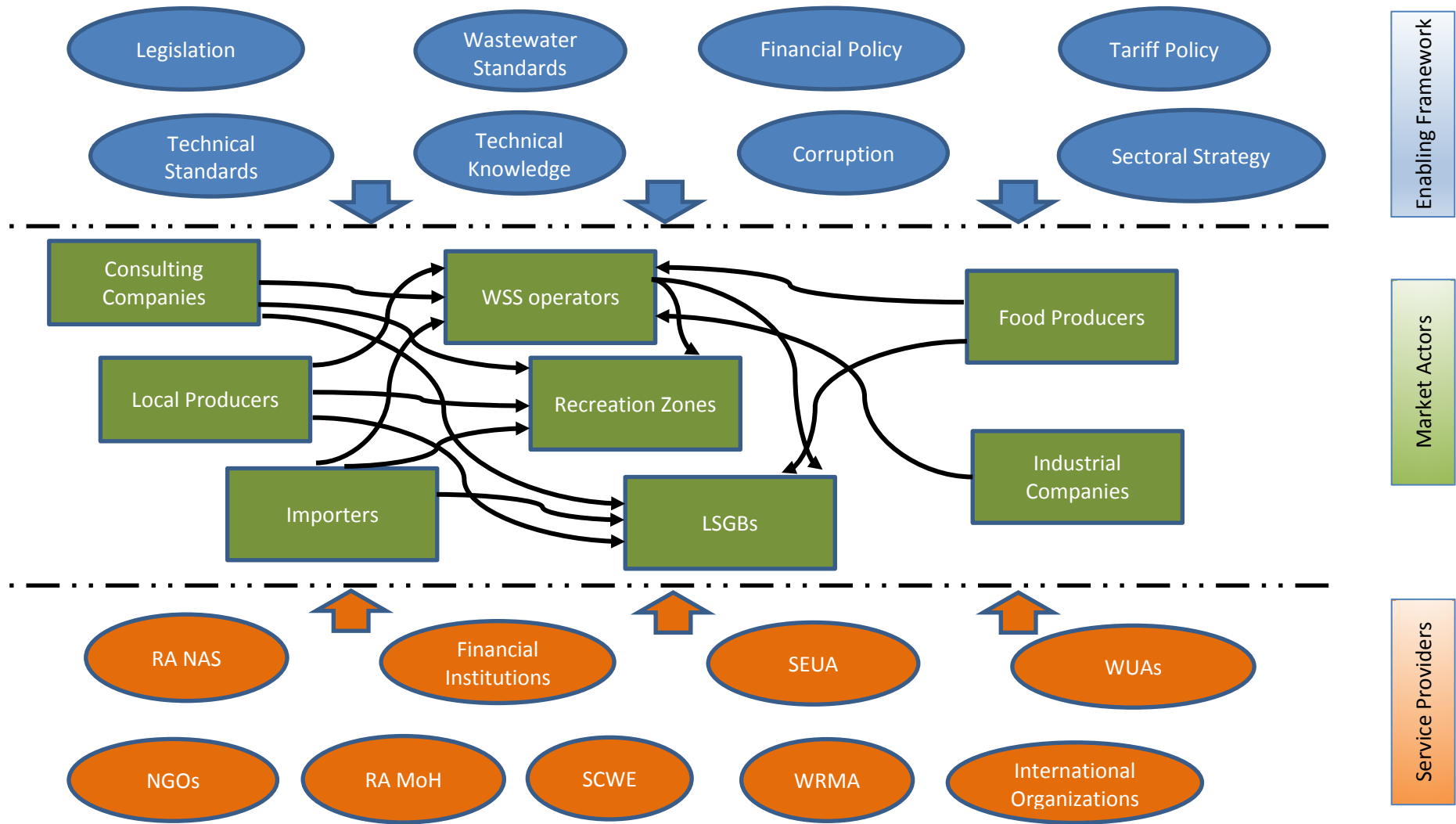
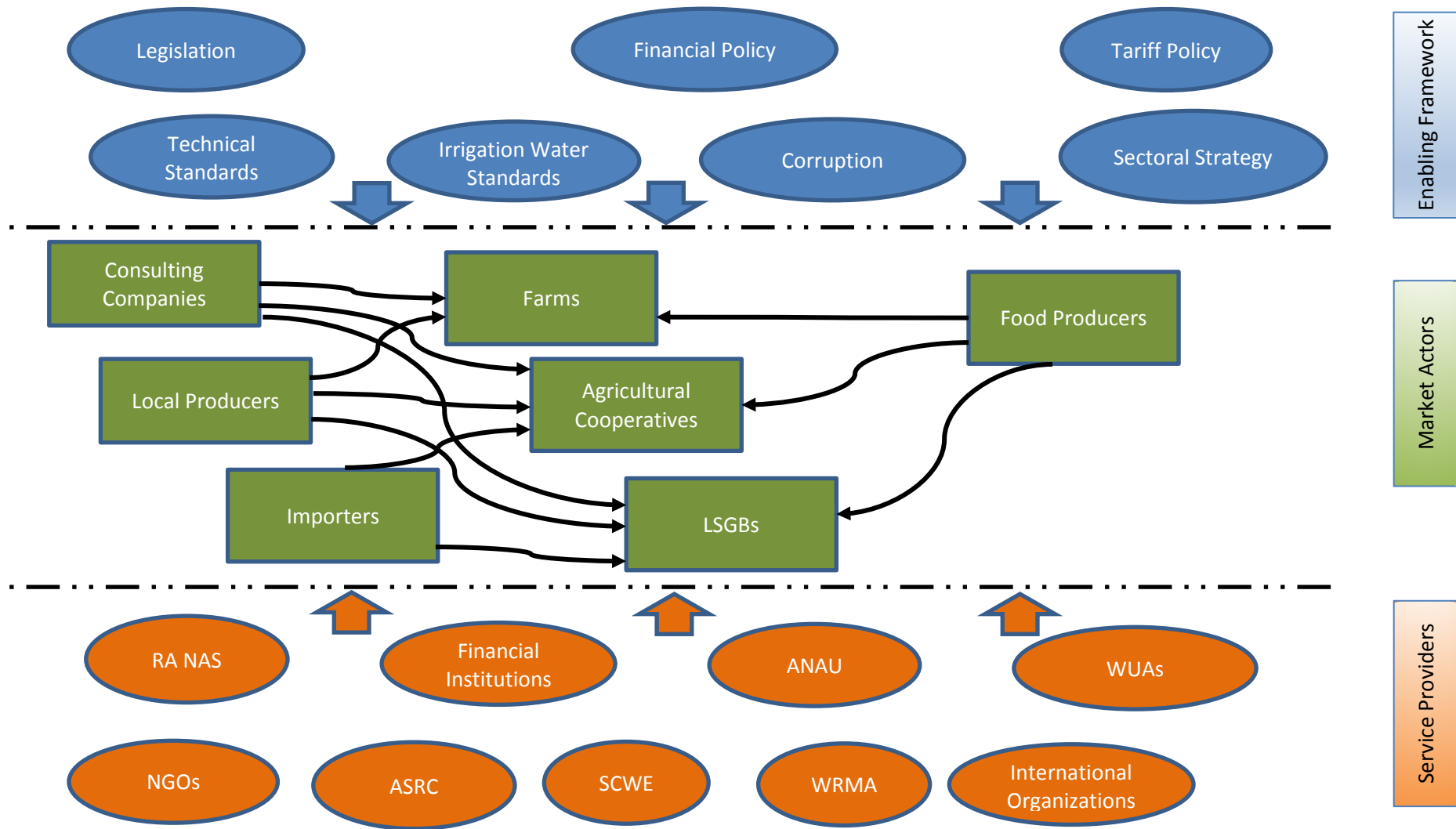


Figure 18. Market mapping of drip irrigation technology



Annex II. List of stakeholders involved and their contacts

Institutions involved in stakeholder consultation process

Institution	Representative	Contacts
Public Administration Bodies		
Environmental Project Implementation Unit State Institution www.mnp.am/?p=291 ; www.epiu.am/	Rubik Shahazizyan Edik Voskanyan	+374 94 251709 rshahazizyan@yahoo.com +374 94 384151
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“Electro power system operator” CJSC Ministry of Energy and Natural Resources www.energyoperator.am	Armen Hovhannisyan	+374 99 971193 office@energyoperator.am
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“Hayantar” SNCO of the Ministry of Agriculture www.hayantar.am	Armen Nalbandyan	+374 93189333 arm_forest@yahoo.com
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NGOs		
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Private Sector		
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Vink LLC www.vink.am	Hayk Gabrielyan	info@vink.am
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American University of Armenia www.aua.am	Tatevik Vardanyan	tvardanyan@aua.am
International Organizations		
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United National Industrial Development Organization http://www.unido.org/office/armenia.html	Anahit Simonyan	a.simonyan@unido.org

Annex III. TNA team contacts

TNA team	Position	e-mail
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Mr. Mkrtich Jalalyan	Energy and Industry Expert	+374 94 424601 mkrtich.jalalyan@gmail.com
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Ms. Arevik Hovsepyan	Water Expert	+374 77 539202 samvelser@gmail.com

Annex IV. Agenda of stakeholder meeting

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

Identification of barriers against priority technologies, market description and analysis of a favorable environment for climate change adaptation in agriculture and water sectors of technology needs assessment, with the participation of stakeholders

A G E N D A

Venue: Bioresources Management Agency, Ministry of Nature Protection
 Address: 3rd Floor, 1/3 Pavstos Buzand,
 Yerevan, 0010, Armenia,
 September 2, 2016

10:00 – 10:05	Opening of the meeting <i>Aram Gabrielyan, TNA Project National Coordinator</i>
10:05 – 10:15	Results of technology needs assessment for climate change adaptation technology <i>Vardan Melikyan, TNA Project Adaptation Team Leader</i>
10:15 – 10:30	Brief description of market mapping of agriculture technologies <i>Vardan Melikyan, TNA Project Adaptation Team Leader</i>
10:30 – 10:45	Discussion of draft market mapping of agriculture technologies with stakeholders, in format proposed by UDP
10:45 – 11:00	Preliminary description of barriers of agriculture technologies <i>Samvel Avetisyan, Agriculture Expert</i>
11:00 – 11:15	Discussion of preliminary description of barriers of agriculture technologies with stakeholders, in format proposed by UDP
11:15 – 11:30	Preliminary description of measures for overcoming of barrier of agriculture technologies <i>Samvel Avetisyan, Agriculture Expert</i>
11:30 – 11:45	Discussion of measures for overcoming of barriers of agriculture technologies with stakeholders, in format proposed by UDP
11:45 – 12:00	Brief description of market mapping of water sector technologies <i>Vardan Melikyan, TNA Project Adaptation Team Leader</i>
12:00 – 12:15	Discussion of draft market mapping of water sector technologies with stakeholders, in format proposed by UDP
12:15 – 12:30	Preliminary description of barriers of water sector technologies <i>Arevik Hovsepyan, Water Sector Expert</i>
12:30 – 12:45	Discussion of preliminary description of barriers of water sector technologies with stakeholders, in format proposed by UDP
12:45 – 13:00	Preliminary description of measures for overcoming of barrier of water sector technologies <i>Arevik Hovsepyan, Water Sector Expert</i>
13:00 – 13:15	Discussion of measures for overcoming of barriers of water sector technologies with stakeholders, in format proposed by UDP
13:15– 13:30	Summary of technologies, recommendations, measures to overcome barriers and analysis of a favorable environment in agriculture and water sectors, in format proposed by UDP <i>Vardan Melikyan, TNA Project Adaptation Team Leader</i>
13:30– 13:40	Summary
13:40 – 14:00	Refreshments