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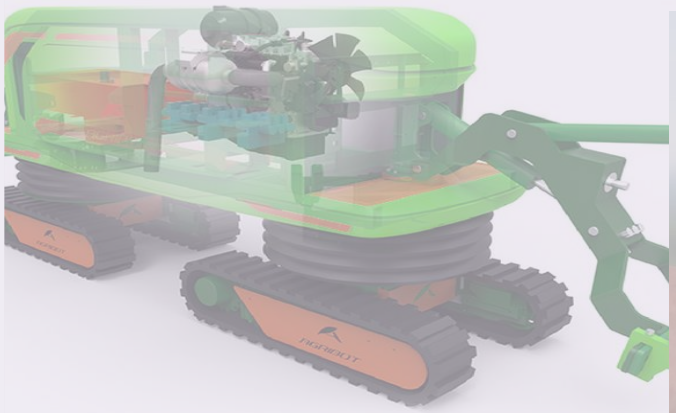
INTERNATIONAL CENTER FOR AGRIBUSINESS RESEARCH AND EDUCATION

NEW AND INNOVATIVE SOLUTIONS FOR INCREASING PRODUCTIVITY IN ARMENIAN AGRICULTURE

NEEDS ASSESSMENT



AGRI CAMP

Yerevan 2021

AKNOWLEDGEMENT

The Needs Assessment of New and Innovative Solutions for Increasing Productivity in Agriculture was conducted by the International Center for Agribusiness Research and Education (ICARE) foundation within the scope of the USAID funded Innovative Agriculture Training and Learning Camp (AGRI CAMP) Program.

The Program team would like to extend its gratitude to all the stakeholders and organizations that supported project implementation through fruitful discussions and individual meetings, in particular, Mr. Arman Khojoyan, Deputy Minister of Economy, Vardan Urutyan, Rector of Armenian National Agrarian University, staff of the relevant departments of the Ministry of Economy (MoE) and Marzpetarans, farmers, women agripreneurs, representatives of local and international organizations, academia and sector experts in the field of agriculture and innovations.

Contents

1. ABBREVIATIONS

ADA – Austrian Development Agency

AI – Artificial Intelligence

AMD – Armenian Drams

APT – Advanced Packaging Tool

ELISA - Enzyme-Linked Immunosorbent Assay

EPS – Encapsulated PostScript

EU – European Union

GDP – Gross Domestic Product

GMO – Genetically Modified Organism

HACCP – Hazard Analysis and Critical Control Points

ICARE – International Center for Agribusiness Research and Education

ID – Identity

IoT – Internet of Things

IT – Information Technology

LA – Latex Agglutination

LED[1] – Local Economic Development

LED[2] – Light-Emitting Diode

MoE – Ministry of Economy

NGO – Non-Governmental Organization

RA – Republic of Armenia

RFID – Radio Frequency Identification

RIA – Radioimmunoassay

SDC – Swiss Development Cooperation

UN – United Nations

UNDP EU-GAIA project – United Nations Development Programme European Union – Green Agriculture Initiative Armenia

USAID – United States Agency for International Development

2. INTRODUCTION

The Needs Assessment of New and Innovative Solutions for Increasing Productivity in Agriculture is carried out within the scope of USAID funded AGRI CAMP Program, which aims to support the establishment of an Innovative Agricultural Training and Learning Camp and provide a wide range of professional agricultural training, skill-building courses as well as camp services for students and graduates of the Armenian National Agrarian University (ANAU) and professionals pursuing a career in the agricultural sector. The Program also focuses on increasing women's access to agricultural innovation and strengthening formal agricultural cooperation and business development in the country.

To be part of the transformation into more sustainable practices, agriculture sector in Armenia needs to give rapid response to the changes and modern approaches applied worldwide. While adoption of innovative technologies could drastically ease the economic burden of farmers and agripreneurs, the country's agriculture sector adopts new practices and technologies quite slowly. By the time technological advancement reaches the country, in most of the cases that is already a common practice in other countries. In this way surely Armenia cannot compete in international markets with its agriculture products neither with quality, nor with produced quantities or prices. *This needs assessment aimed to explore the current challenges and gaps in the agricultural sector of Armenia, reveal the needs of women in ensuring better access to agricultural innovations and highlight the application of new context-relevant technologies and innovations to increase agricultural productivity with a focus on female entrepreneurs and farmers.*

Within the scope of this needs assessment over 100 officials, field experts, farmers, agripreneurs (with focus on female farmers and agriprenuers) and processors were interviewed. In-depth interviews with semi-structured questionnaires and focus groups discussions were used to collect data from the mentioned stakeholders. For data triangulation purposes, online survey was conducted based on google applications which allowed to collect responses from 388 farmers, agripreneurs and field specialists from all Marzes of the country. The collected data was analyzed and presented to a large group of stakeholders for validation. During the validation workshop, 2 work-groups were formed each of which discussed and presented issues and suggestions related to several crucial aspects of the research questions.

The assessment looked at pre-selected sub-sectors in 3 main agriculture sectors: crop production, animal husbandry and processing. The gaps and challenges of agriculture sector as well as sector specific challenges for each mentioned sector were revealed and innovative solutions to the identified issues were suggested. Particular attention was given to revealing the needs of women in ensuring better access to agricultural innovations and identifying the solutions which could enhance women economic roles in the pre-selected sub-sectors. Based on the research results, the application of new context-relevant technologies and innovations to increase agricultural productivity with a focus on female entrepreneurs and farmers were highlighted and topics for

capacity building initiatives were suggested to support adoption of the innovative technologies throughout the country.

3. METHODOLOGY AND SCOPE OF THE NEEDS ASSESSMENT

Agriculture in Armenia needs to adopt modern technologies and approaches applied worldwide, to be part of transformation into more sustainable practices. Technological advancement, stronger knowledge capacity and application of new tools in production can drastically ease the economic burden of farmers and agripreneurs.

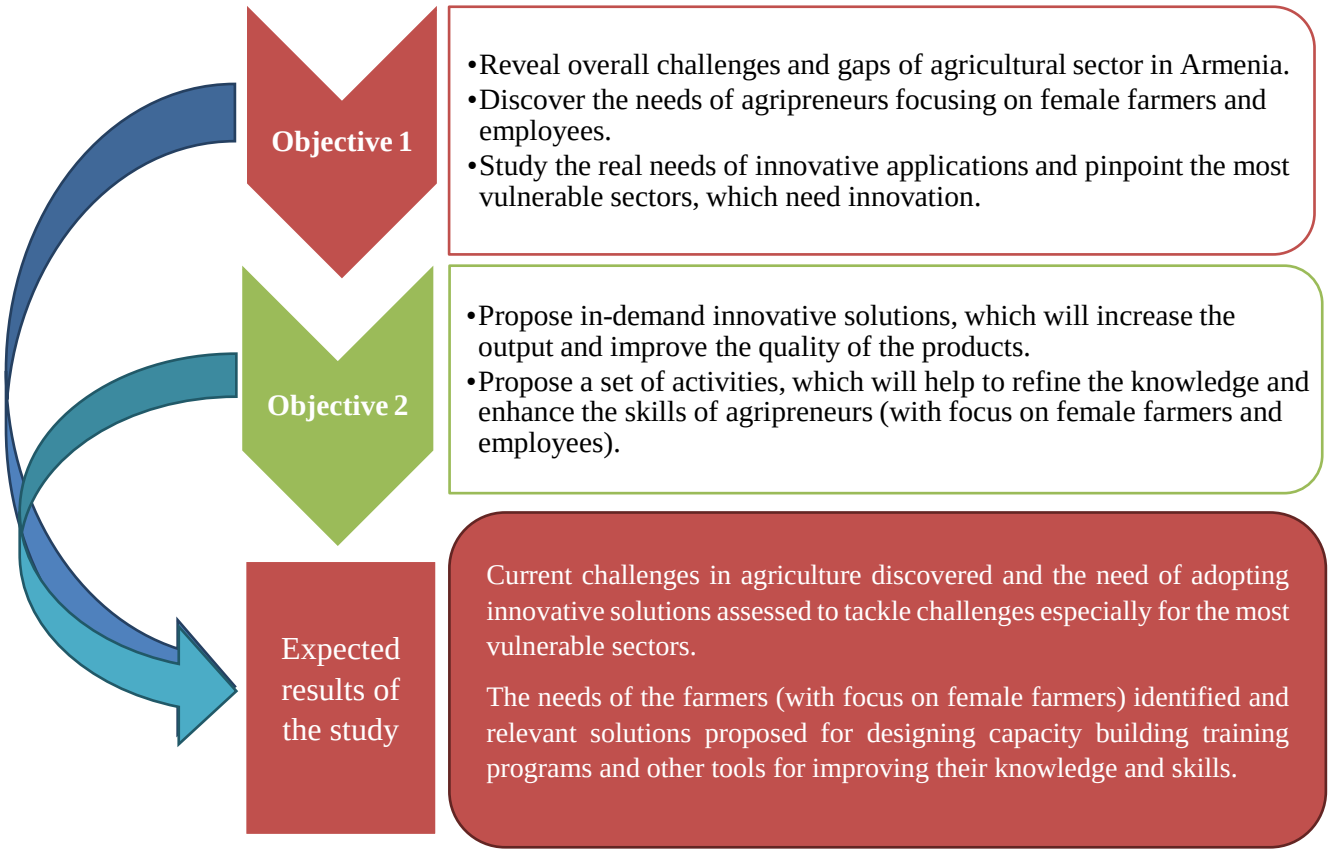
3.1 Objectives and scope of the needs assessment

3.1.1 Goal and objectives

The purpose of this assessment is to explore the current challenges and gaps in the agricultural sector of Armenia, reveal the needs of women in ensuring better access to agricultural innovations and highlight the application of new context-relevant technologies and innovations to increase agricultural productivity with a focus on female entrepreneurs and farmers.

The overall objectives and expected results of the needs assessments are presented below:

Figure 1. The overall objectives and expected results of the needs assessments



For the purpose of this paper the meaning of the term "innovation" is not limited to high-tech and integrated Information Technology (IT) solutions, it refers to all the new concepts and ideas that can be applicable to switch to an alternative production and processing methods, which will impact on agricultural productivity, and can be economically viable, environmentally friendly and socially equitable.

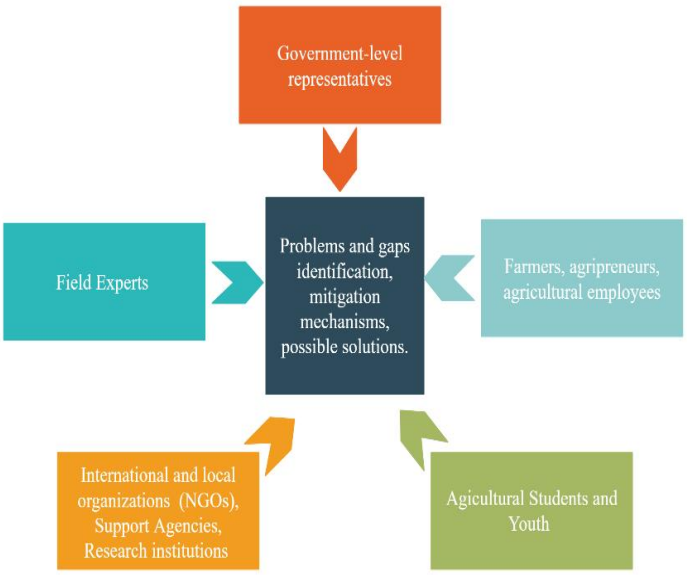
3.1.2 Geography

The research covered 10 Marzes and Yerevan taking the agricultural specificity of that particular marz and the distribution of agricultural gross output over the marzes into consideration. It is noteworthy that in each location, the snowball or chain-referral sampling was applied to identify other people, who are engaged in a specific agricultural activity, which contributed to the needs assessment findings.

3.1.3 Target Group

While conducting the primary data collection, different groups of people were interviewed/surveyed in order to reveal problems and gaps at various levels, identify mitigation mechanisms and possible solutions.

Figure 2. Target group of the study



The Government level representatives, especially from the Ministry of Economy, provided a broader picture of the overall sector, its challenges and gaps.

Then, experts and key informants from a narrower sector provided more detailed information on the current situation of that particular field.

International and local organizations, involved in the agribusiness development significantly contributed to the needs assessment as well considering their holistic experience and network.

The research team also interviewed/surveyed farmers (focusing on female farmers and agripreneurs) to receive valuable information on the existing problems in agriculture and eventually help them overcome those problems through enhanced knowledge and skills set.

3.1.4 Agriculture sectors and subsectors selected for the study

The study focused on 3 main agricultural sectors in Armenia, which provides most of the agricultural output. The selected sectors and subsectors are provided below.

1. Crop production:
    - Solid-seeded crops (including wheat, barley, corn)
    - Fruit and vegetable cultivation, production of high value crops
    - Viticulture (including grapes for wine production and table varieties)
2. Animal husbandry:
    - Livestock (including dairy, small ruminants)
    - Piggery
    - Fishery
    - Beekeeping
    - Rabbits
3. Processing
    - Fruit processing
    - Herbal tea production

3.2 Needs Assessment Methodology

The research work included both primary and secondary data collection.

3.2.1 Desk Research

Secondary data was used in the study to assess the current situation of agriculture, challenges and needs so far identified in various literature sources including assessment reports of governmental bodies as well as international and local organizations, articles on specialized agriculture journals, interviews with representatives of the Ministry of Economy available on public media. In addition, for highlighting the sector activity, the data from the National Statistical Committee was analyzed and presented. The sources of data collection for desk review are listed in the Annex 1 of this paper.

3.2.2 Primary data collection

While collecting the primary data, the research team applied both qualitative and quantitative data collection techniques. The team conducted in-depth interviews with a wide range of stakeholders including government representatives, field experts, local and international organization representatives, farmers, women agripreneurs. Additionally, the focus groups discussions were conducted and online survey was organized.

The data collection tools were developed specifically for each group mentioned above. In addition to general questions, the interview and survey questionnaires included questions on specific capacity building and consulting needs of women and the access of female agripreneurs to the government/donor-funded support projects and to agricultural inputs and equipment. The analysis of survey responses included cross-tabulation of responses by respondents' sex, which allowed to identify needs and preferences of female agripreneurs and validate the findings from qualitative interviews.

Qualitative data collection

In-depth interviews with government representatives*:* The interviews on this level allowed to acquire information on the Government perspective on needs, gaps, priorities and possible solutions to existing agricultural problems. The government representatives also guided the research team on existing governmental projects for subsidizing the agricultural sector and innovative solutions. Overall, 14 government officials were interviewed for the purpose of this research.

In-depth key informant interviews with field experts: The research team interviewed agricultural experts from various sectors, who have extensive experience in their respective areas and deep understanding of the existing problems on the production level. Based on their opinion the possible innovative solutions applicable to Armenian agriculture sector were outlined. Overall, 22 experts were interviewed for the purpose of this research.

Interviews and focus group discussions with farmers and agripreneurs: The farm level information helped to understand the situation with production gaps and needs, farmers' understanding of and openness to innovations as well as their needs of and openness to new knowledge and information. The interviews were conducted involving both female and male farmers and agripreneurs. The interviewees and participants of focus group discussions were selected in a way to ensure representation of each geographical area, selected sector and subsector. In-depth interviews were conducted with 39 farmers and 32 farmers were involved in 5 focus group discussions on the following topics:

- Animal husbandry
- Fruits and vegetables
- Production of dried fruits
- Production of herbs and herbal tea
- Beekeeping

The summary on farmers interviewed and focus group participants is presented in the Annex 2 of this document.

Quantitative data collection

For research triangulation purposes, the quantitative data was collected as well through online survey with the help of google form. The survey was organized for collecting information from a wider network of agriculture sector experts, farmers, women agripreneurs, students, youth and other stakeholders involved in agriculture development.

Overall, 388 respondents participated in the online survey out of which 47% were women.

Respondents' Geography, Sector, Age and Gender Distribution is presented in the Charts 1, 2, 3 and 4 below.

Chart 1. Respondents' Geographic Distribution

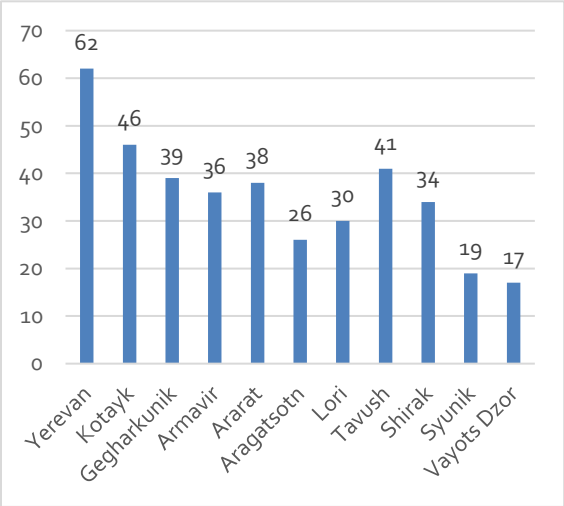


Chart 2. Respondents' Sector Distribution

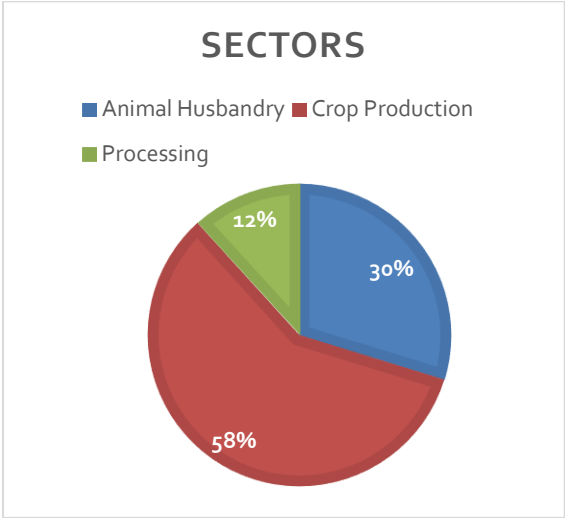


Chart 3. Respondents' Age Range

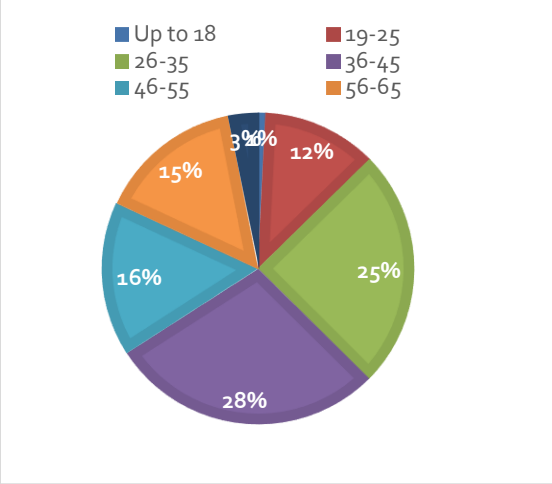
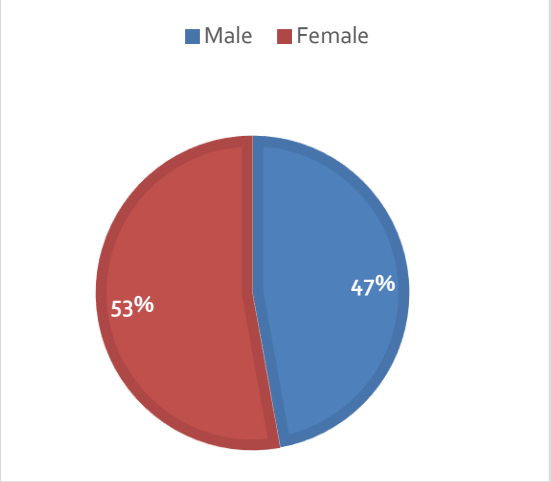


Chart 4. Respondents' Gender Distribution



3.2.3 Validation Workshop

Validation workshop was conducted to present the larger stakeholder groups the needs assessment results, to validate the content of the assessment and to discuss some of the key aspects of the content for improvements.

Validation workshop took place in ICARE premises. 29 participants from MoE, USAID, international and local organizations, agricultural sector experts, women agripreneurs and farmers from all studied subsectors were participating in the workshop.

During the workshop 2 workgroups were created to discuss important and disputable aspects of the assessment.

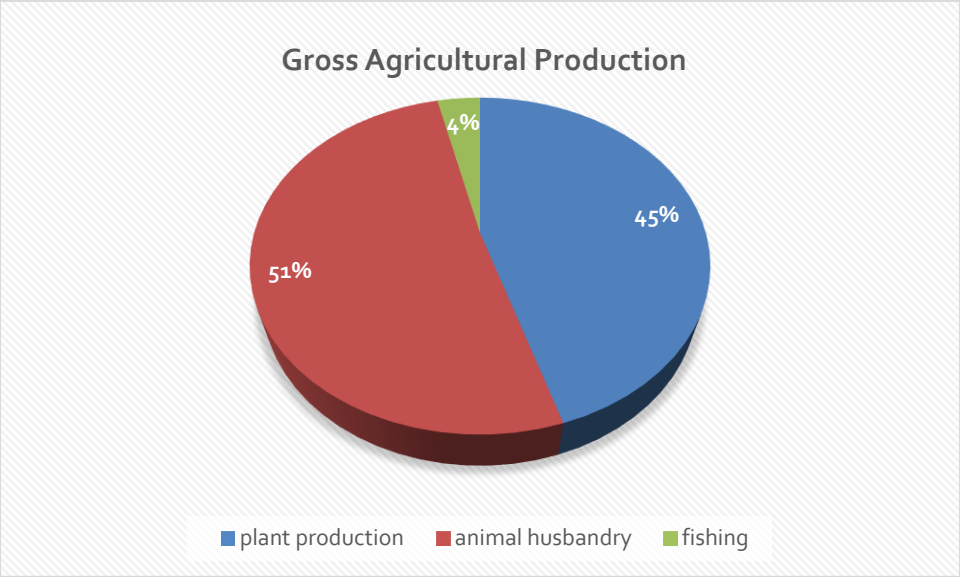
The work group discussions were facilitated based on Mesopartner “LED Café” Format which enables the workgroup to reveal the assets in the local areas on which the development of this or that subsector can be built.

4. AGRICULTURE IN ARMENIA

4.1.1 General overview

According to the data of Armenian Statistical Committee (2020) the gross agriculture produce comprised 850 096.2 mil. AMD, of which animal husbandry comprises 51%, plant production and fishing 45% and 4% respectively.

Chart 5. Gross Agricultural Production



The agricultural sector in Armenia employs around 22% of the population. Even though this percentage has decreased over the past decade due to the evolvement of the IT sector, according to the Armenian Statistical Committee and Ministry of Economy of RA, agriculture still remains the most strategic and major sector in the economy and in the year 2020, it has contributed around 11.7% of the country's GDP (https://www.mineconomy.am/en).

Due to the wide range of climatic conditions, various agricultural activities are spread all over the country with the biggest share (around 36,5%) of the overall agricultural output belonging to Ararat and Armavir. 22.7% of the agricultural output is provided by the three northern regions, which are Shirak, Lori and Tavush. 30.5% was contributed by the two central regions – Gegharkunik, Aragatsotn and Kotayk. 9.3% was contributed by the two southern regions, Vayots Dzor and Syunik. The major proportion of vegetable growing belongs to Ararat and Armavir Marzes. According to the Armenian Statistical Committee, as of 2020, 65% of all 21.005 lands cultivated under vegetable production belongs to these two Marzes. Ararat and Armavir Marzes are also the leading 2 Marzes in terms of fruit and berry orchard areas. 43.6% of fruit and berry orchards and 73.4% of vineyards are located in these two Marzes. 46.5% of the cereal fields are concentrated in Shirak and Gegharkunik Marzes (Sown areas of agricultural crops, planting area

of permanent crops, gross harvest and average crop capacity for 2020, Statistical Committee of Republic of Armenia, 2021)

Despite the fact, that agriculture is crucial for the economic development of the country, there are many challenges that need to be identified and overcome with integrated actions of enhancing the knowledge capacity and technological advancement. Particularly, the recent decade has seen an accelerating pace in the development of new and innovative technologies, which are having a positive impact on different people involved in various sectors. Therefore, the merge of those two distinct sectors, which are Agriculture and IT, can dramatically change the conventional forms of farming activities, hence increasing the productivity of agriculture and improving the standard of living of those people, who are involved in agriculture. It is noteworthy that 49.2% (Statistical Committee, 2019) of the rural population has an agriculture related occupation. Therefore, the social impact would also be significant, if innovative solutions were adopted and fastened the development of agriculture in Armenia. Not only is agricultural development dependent on the adoption of innovative solutions, but also whether they are properly applied by all of the parties involved in the sector. From this perspective, mitigation of the economic gender gap through providing female agripreneurs with access to innovative solutions and technology is the imperative of the day.

Overview of agricultural innovations used in Armenia:

According to the experts, even though some innovative technologies and best practices in agriculture are currently applied by farmers in the country, their use cannot be considered widely spread (e.g. drip irrigation, anti-hail nets, drones, smart barns, etc.).

As an effective, water saving measure drip irrigation system was introduced by different international, donor funded projects back in 2000s (i.e. USDA MAP, IFAD, Water to Market activity of MCA, OXFAM, etc.). Mentioned organizations mostly targeted smallholder producers and were establishing on-farm demonstration projects hoping that the practice would be adopted by other producers. First successful cases with installation of drip irrigation systems were registered among greenhouse producers, who generate relatively higher income (compared to field growers) and can afford investments to improve productivity.

One of the first installations of anti-hail nets were made by FAO support in the framework of ENPARD project on the collectible orchard for apricot located in Echmiadzin. Low level of investments in this technology is related to its high costs per hectare. Another reason is that there are mandatory requirements related to the orchards (dwarf saplings, even rows, flat landscape etc.) when installing the hail nets, which unfortunately cannot be met by most of the old orchards.

In recent years, establishment of fruit tree orchards (mostly “intensive”, with imported dwarf saplings, drip irrigation system, hail nets) on wider areas by investors or with the Government support programs are observed. Areas where drip irrigation systems and anti-hail nets are installed increased drastically in recent years.

Smart barns became popular after the government announced about the project to support their construction. These technologies also can be afforded only by bigger and sustainable farmers and agripreneurs. While these technologies required high investments the Government reimburses costs after completion of the construction. Recently from approved projects for the smart barns' construction only few in each Marz were completed, some of them stopped at different stages of construction.

Use of drones in agriculture is in the amateur stage. Even though, most people have heard about drones and their use in agriculture, few of them are aware of all the benefits that can be obtained from these technologies. There are just a few people/companies who are taking first steps in that direction.

4.1.2 Access to innovations, government strategy and support for innovations

When trying to promote innovations in the agriculture sector, it is important to clearly differentiate the concepts of "innovation" and "best practices". The purpose of introducing innovations or good practices is the same, i.e. increasing productivity in the sector, therefore the two concepts very often are mixed. These two concepts differ in their definitions provided in the dictionaries and professional literature "good practice" is defined as "the best and already tested way of doing a thing". While the best practice may be a tested idea, method or device, the term "innovation" is defined as "introduction of something new including a new idea, method or a device" (https://www.merriam-webster.com/). According to the definition of FAO, "Good Agricultural Practices (GAP), are a "collection of principles to apply for on-farm production and postproduction processes, resulting in safe and healthy food and non-food agriculture products, while taking into account economic, social and environmental sustainability" (http://www.fao.org/3/i6677e/i6677e.pdf). According to FAO definition, "agricultural innovation" is the process whereby individuals or organizations bring new or existing products, processes or ways of organization into use for the first time in a specific context in order to increase effectiveness, competitiveness, resilience to shocks or environmental sustainability and thereby contribute to food security and nutrition, economic development or sustainable natural resource management. According to the interviewed field experts, within the scope of this study, promotion of innovations and best practices should be carried out in parallel, as in the country the rate of commercialization of many known best practices most of the times is so low and replication is so slow, that they, as well, can be considered as an innovation.

Innovation in Agriculture as defined in the Methodology document of this task is presented below.

> Innovation in Agriculture refers to all the new concepts and ideas that can be applicable to switch to an alternative production and processing methods, which will be economically viable, environmentally friendly and socially equitable.

Not only agricultural development dependent on the adoption of innovative solutions, but also whether they are properly applied by all of the parties involved in the sector. From this perspective,

mitigation of the economic gender gap through providing female agripreneurs with access to innovative solutions and technology is the imperative of the day.

In order the efforts for promoting innovations in Agriculture sector in the country will be more efficient, it is important to coordinate the efforts with the government, as well as with other donor funded projects for synergy effect.

"The Strategy on the Main Directions Ensuring Economic Development in Agricultural Sector of the Republic of Armenia for 2020-2030" defines the priorities and objectives of the sector for 10-year period. These are:

- *Increasing competitiveness and enhancing efficiency* in the sector which requires measures like: improved access to modern agriculture technologies and equipment, quality seed and planting materials, new more productive breeds, improved irrigations system etc.,
- *Supporting sustainable rural development,* which assumes measures like rural agriculture infrastructure development, rural entrepreneurship promotion, maintaining good agriculture practices, biodiversity and environmental sustainability programs' implementation, etc.
- *Promoting digital agriculture and technology innovation,* which will require measures like investing in national digital agriculture platforms and digital initiatives, building farmer and education system capacity on digital agriculture and innovation etc.
- *Developing local markets and increasing export* possibilities for agriculture produce; which requires measures like development of well-organized agro-wholesale, retail and farmer markets, logistic centers, promotion of cooperation and aggregation, etc.
- *Improving food security and nutrition,* including measures like increased access to nutritionally diversified food, insuring minimum level of food availability for the country, etc.
- *Developing institutional and human capacity in agriculture, which include measures like* ensuring improved access to information of farmers, etc.

Armenia's Gender Policy Implementation Action Plan 2019-2023 includes a number of actions to tackle gender discrimination in the socio-economic sphere and expanding women's economic opportunities.[1] These actions include supporting women in the agriculture through promoting women's participation in value chain development programs, experience exchange and capacity building efforts targeting female farmers, increasing the proportion of credits provided to female agripreneurs, and other.

According to the Ministry of Economy of the RA ((https://mineconomy.am/)), within the scope of the government support programs for Agriculture development in Armenia, during the years 2018-2020 101 billion AMD was invested in the sector through ***subsidized loans*** program. Out of this invested amount 46.1 billion AMD were capital investments. More than 60% of the amount was

[1] RA Government Decision N 1334-L "On Approval of the Strategy for the Implementation of Gender Policy in the Republic of Armenia for 2019-2023 and Approval of the Action Plan," 19 September 2019, https://www.arlis.am/DocumentView.aspx?DocID=134904

invested in the sector in the year 2020 when due to state subsidies, 0% loan products were accessible. The aim of this support program was to enhance access of the farmers to financial resources, modern technologies and with that to ensure increased efficiency of farming activities and agribusinesses. Another state support program was to support farmers to purchase modern ***agro-machinery through subsidized leasing opportunities***. Within this program, in 2020 the leasing products were available to farmers with 0% rate. Only in 2020, 390 agribusinesses benefited from the project and overall 573 machinery and equipment were provided among which were 275 tractors and 3 combines. The state also has provided similar support to agribusinesses for processing initiatives through ***processing equipment leasing subsidies***. The leasing products are available for the processors with 0% rate since 2020. In the year 2020 186 beneficiaries have received 377 units of equipment through leasing with an amount of 6.3bilion AMD subsidized amount was 217.9 million AMD.

The government also have provided support to agribusinesses with the aim to:

- Improving collection and post-harvest infrastructures, including collection centers for fruits and vegetables, slaughtering services etc.
- Improving irrigation infrastructures- in 3-years modern irrigation systems were established on more than 600ha orchards.
- Establishment of vineyards and intensive fruit and berry orchards. 72 beneficiaries for more than 550ha of new orchards and 518ha berry plantations in 2020.
- Establishment of hail suppression systems /nets/ - in 3-years period more than 100 ha of fruit orchards were covered by hail nets.
- Establishment of small and medium greenhouses – over 57million AMD reimbursement
- Promotion of winter wheat production.
- Promotion of cattle breeding /improving breeds/ - in the years 2019-2020 more than 700 head of highly productive breeds were purchased/imported.
- Promotion of sheep breeding /improving breeds/ - in the years 2019-2020 more than 850 head of highly productive breeds were purchased/imported.
- Establishment of smart barns – overall 13 smart barns were established in the country.
- Agriculture insurance – more than 2500ha of agricultural areas around the country were insured. Corps included wheat, vineyards, apricot, peach and apple.

For of support from the government for the abovementioned purposes included subsidized loans, reimbursements and co-financing. 48% of total investments by the government were done in horticulture sector and 52% in animal husbandry.

Based on the data provided by international donors on their websites, since 2010 over $200mln worth of agricultural projects have been implemented in Armenia, which were overseen and implemented by both international agencies and the RA Ministry of Economy. These projects are mainly funded by USAID, EU, UN, ADA, SDC, etc., and have a key role in introducing innovations in agriculture sector.

4.1.3 Challenges of agriculture sector in Armenia

Despite the support provided by the government and donor funded projects to the development of agriculture sector in the country, there are still many challenges hampering the development of all its subsectors. These challenges as defined by the interviewed representatives of MoE, field experts and farmers are as follows:

A. Inputs:

Access to modern and high-quality inputs is one of the determining factors for ensuring efficiency and profitability in any agriculture subsector. The challenges related to agriculture inputs is discussed from two main point of views: buyers and suppliers.

- ***Limited access to agriculture inputs:*** Farmers in rural areas mostly state that even though all the needed agricultural inputs are available at country level, these inputs are not easy to purchase in remote communities due to the distance from larger cities. Farm Service Centers and small input supply shops do operate in more accessible places, but these input suppliers do not cover the whole country and in addition do not offer a full range of all inputs, especially when it comes to innovative and high value inputs. E.g. many farmers mentioned that there is a big potential for drip irrigation systems to be installed in the small homestead orchards in their communities, but because the materials of the system are not available in the agricultural shops operating nearby their communities, many of the farming households avoid installing this system as later its maintenance will be a problem.

  Another challenge related to access to input supplies, as stated by small and medium farmers, is the requirement of minimum order quantities. Eg. if a small farmer requires for example a mulching film for 200 sq.m. greenhouse, it will be impossible to purchase from a supplier, as mulching films are available for sales only with big packs. Another example is the pesticides being available only with large packages. These inputs are sold with smaller quantities from open large packages, which means the buyer may have no control over the quality, expiration dates and even the type of the pesticide purchased. .

  The farm size and area specialization are the key factors here that limiting access to agricultural inputs.
- ***Limited demand for agriculture inputs:*** The study also revealed the challenges of supplying innovative inputs from the point of view of input suppliers. For input suppliers, to import new more advanced pesticides, seed or sapling, fertilizers, hail-nets and other inputs there should be a permanent demand for that product. One-time import is never profitable business for a supplier. But because the market for many reasons /to include lack of information/ is very limited, importing each new input (even those with proven high demand in other countries), requires huge efforts and resources to be positioned in the local market.

  For the smaller agricultural shops in rural areas, with small shop and storage areas the decision whether to supply this or that input depends again on the permanent high demand

of that product. If the turnover for a certain input is permanently high, then they will choose supplying that input over any innovative inputs.

B. ***Machinery and equipment:***

Modern machinery and equipment are key for enhancing the competitiveness of the sector. Investing in upgrading modern machinery and equipment is a precondition for increasing the volume of agriculture produce and fully utilizing the production potential in the sector. Challenges shared by all agriculture subsectors related to access to modern machinery and equipment are the following:

- Worn out and highly inefficient machinery and equipment, requiring high maintenance costs are still commonly used in the sector.
- High costs of modern machinery and equipment as compared to small sizes of farms and low productivity.
- Lack of information on benefits of modern machinery and equipment vs. required investments in them.
- Lack of cooperation culture among small farmers in the communities.

C. ***Application of innovative technologies, solutions and practices***:

Another determining factor for ensuring efficiency of agricultural operations and enhancing competitiveness of agribusinesses and farms is surely high level of application of innovative technologies. The challenges related to wide application of these technologies include:

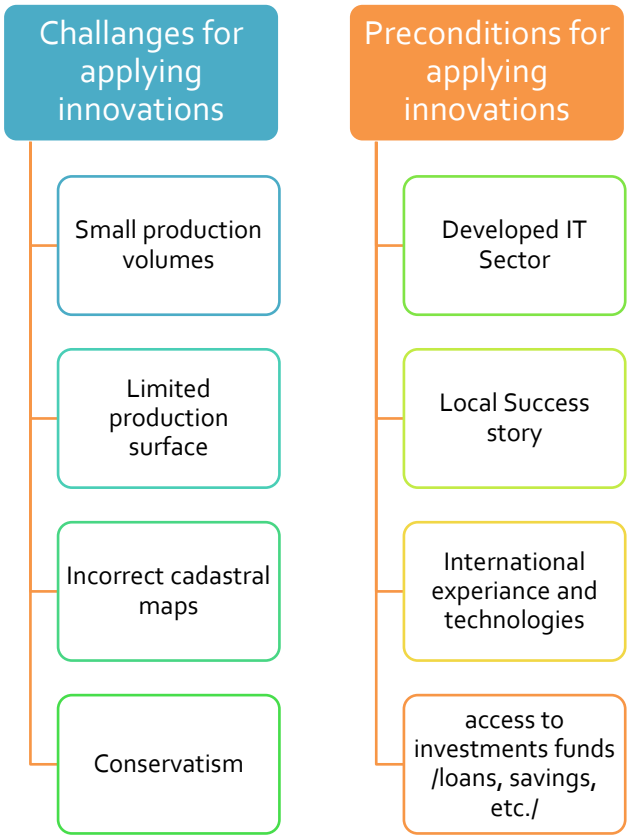
- ***Lack of understanding of innovative technologies:*** Around 90% of the farmers responding to the questions related to the innovative technologies, mentioned only those technologies which are already known best practices in the agriculture sector, but due to high investment costs associated with these technologies they are unable to invest in.
- ***Lack of access to information on modern technologies and insufficient promotion of those technologies***: Most of the time farmers, even if they heard about innovative technologies, do not know the whole possible impact and role of these technologies for their agribusiness. For example, few farmers only may know that the hail-nets are not only for hail suppression but also for protecting the crop from birds, sunburn, and in some cases, allow to be early in the market for a couple of days ensuring higher profitability. Just like drip irrigation is not only for saving costs on irrigation, but also for managing weeds, preventing certain diseases, decreasing labor, saving time and resources etc. First and most the farmers are interested in the amount of investments needed for having this or that modern technologies but very few are able to weigh these expenses against the "full package" of benefits from investing.
- ***Failed trials and demonstration efforts demotivating further replication of the technologies***: Lack of information on preconditions for using particular innovative technology as a result failed experiences and hence wrong feedback which prevents wider

use of those technologies. For example: farmers may have heard about using the drones in agriculture but few can make calculations of minimal required size of the farm for which it is feasible to use such technologies or donor funded projects supporting establishment of drip irrigation system as a demo plot in a remote area fails to communicate the required maintenance measures, and the system goes out of order in just a couple of years. Another example would be farmers receiving new highly productive cattle breed and failing to follow the guidelines on feeding ratio and gets low productivity and assume the problem is in the breed or local conditions which is out of their control.

- ***Slow replication of demonstrated Innovative technologies:*** Many larger companies invest in innovative technologies e.g. in 90s when these companies started to use drip irrigation, small and medium farmers were stating that these technologies will not be suitable for our water content, orchards, types of crops etc. Now the farmers mention this technology has wider use and each farmer keeps mentioning it as a desired innovation for their agribusiness. Innovative technologies, like artificial breeding and smart barns in animal husbandry, automated greenhouses, modern harvesting equipment etc. which are recently introduced to the farmers for now, meet high resistance by farmers and agripreneurs. They believe these initiatives will surely fail, and the big investments in these technologies will simply be lost. According to the experts' viewpoint however these innovations need certain technical preconditions for successful implementations, e.g. developed fodder production available in the country for replicability of smart barns technology, accessibility to proper greenhouse varieties of crops for automated systems etc. The learning from existing demo farms, in parallel with the improved infrastructures and ensured preconditions for each innovation will guarantee further wider use of innovative technologies.
- ***Lack of access to modern machinery and equipment:*** The small sizes of farms do not really allow the farmers to heavily invest in modern machinery and equipment which prevents application of innovative practices, e.g. even if everybody understands the importance of crop rotation for maintenance of soil quality, the farmers are limiting their choices of crops for each year to the available machinery and post-harvest equipment that they own rather than choosing the crops which based on crop rotation technology will be perfect to cultivate.

During the validation workshop of this study a working group discussed the preconditions and challenges for applying innovation in all sectors of agriculture. The results of this discussion are summarized in the chart below.

Figure 3. Challenges and Preconditions for applying innovations



D. ***Expertise and consulting services:***

To ensure the strategic development of agriculture, first and foremost it is necessary to equip the sector with professionals having quality agrarian education, skills and knowledge to share experience and encourage/motivate farmers to shift to more efficient production with implementation of modern and innovative solutions.

The knowledge of small and medium farmers in basic agriculture technologies mainly comes from their experience and cannot be considered sufficient for staying productive in rapidly changing technological and market realities. There is even a larger gap in business management and marketing skills of small and medium farmers. Proper farming business management planning will mean starting with selection of types and varieties, proper breeds for animals, planning of soil and pest management measures and ending with forecasting yield and defining target markets, financial planning, as well as planning for innovations. As the study revealed, none of these functions are implemented properly by most of the small and medium farmers from any agriculture sectors.

Access of farmers and processors to up-to-date information and stable consulting services is key for sustainable productivity increase in the sector. However, the role of information and expertise in the success of farming businesses is underestimated by farmers and agribusinesses in the country

for various objective and subjective reasons. Sources of information for farmers and limitations related to each of these sources are presented below:

- Regular farmers are not used to pay for consulting services. They rather refer ***to state funded consulting services***, lead farmers, internet and other free of charge sources for information. Overall feedback however from the state funded consulting service was that these services are not equally active in all communities of the country. Wherever they are active their consulting is mainly in basic agriculture technologies including soil management, pest management, managing of diseases in animal husbandry etc. However, these services are not much helpful when it comes to promoting innovations and, moreover, just like farmers, these services are also quite resistant to changes and prefer to advise on traditional technologies rather than promote the modern ones.
- ***Training from various donor funded projects*** are available for farmers and in almost all cases these trainings are promoting innovations. However, these trainings are mostly one-time events and cannot cover the permanent need for consulting services in the whole country. NGOs are also providing capacity building for farmers and surely topics and formats, as well as target audience largely depend on the project they are implementing. NGOs also cannot fill in the gap in consultancy services permanently and fully. The quality of consultancy service provided by NGOs will largely depend on the hired consultants in each case and so does the consulting provided by donor funded projects.
- Consultancy and information is also provided as ***embedded services*** at the specialized shops selling pesticides, medicines, agriculture machinery and equipment. This is a sustainable business model, through which the farmers receive consultancy almost free of charge. For farmers, it is practical and accessible information source, however there are problems associated with:
    1. The level of proficiency of the sales person in the agricultural shop.
    2. Biased information provision – promoting inputs available at that shop.
    3. Lack of information provided – sometimes the farmer does not even know what exact type of pesticide or fertilizer s/he bought. As a result, the farmers cannot later make an informed decision whether to purchase the same or to shift to another analogue product.
- ***Demo farm owners and lead farmers*** within each community remain one of the main sources of information for farmers and agripreneurs. When it comes to making decision on adopting modern technologies, the farmers, however, note that just the information is not enough. Because agriculture, in general, is a risky business and many innovations do not bring the expected results they need to see a real example of good practice to make decision on replication. At the same time, the demo projects do not always bring the expected impact in terms of replication, as in many cases there is no proper experience exchange programmers offered by this farm and the only useful information the farmers learn from these farms are the investments needed for establishing similar business.
- ***Internet:*** Around 73% of interviewed farmers mentioned sources of information being social media and in general internet websites. The survey results revealed that for farmers in both crop production and animal husbandry, Internet is the leading source of information

for innovations (see Charts # 5, 6, 7). There are 2 limitations related to this source however. Firstly, there is no control over the quality of this information. And secondly, there is a language barrier for farmers using this source of information. While the most part of information on innovative technologies are available in English the farmers can mainly read information available in Armenian and in some cases also Russian languages.

Chart 6: Main sources of information on innovations used by farmers in crop production

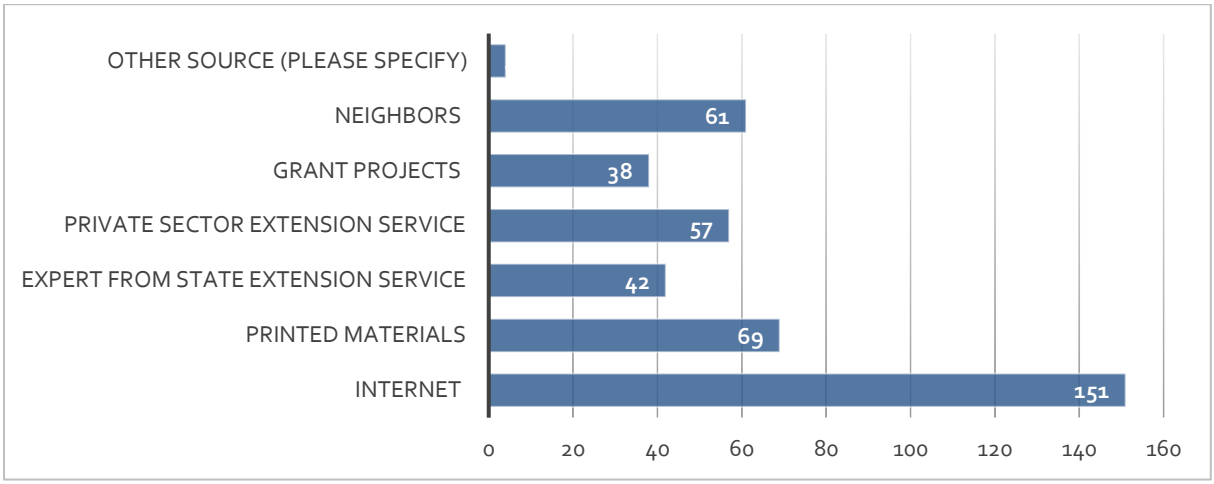


Chart 7: Main sources of information on innovations used by farmers in animal husbandry

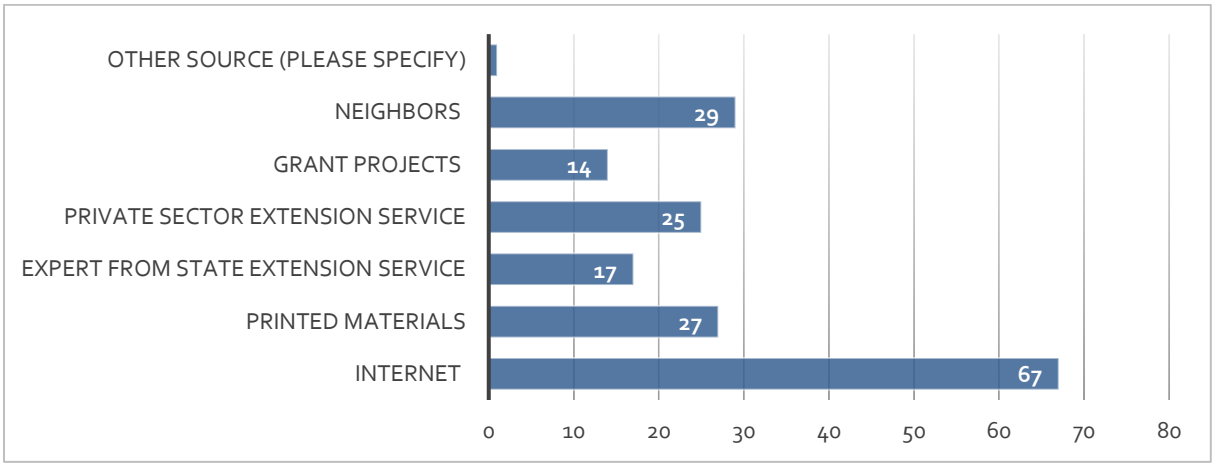
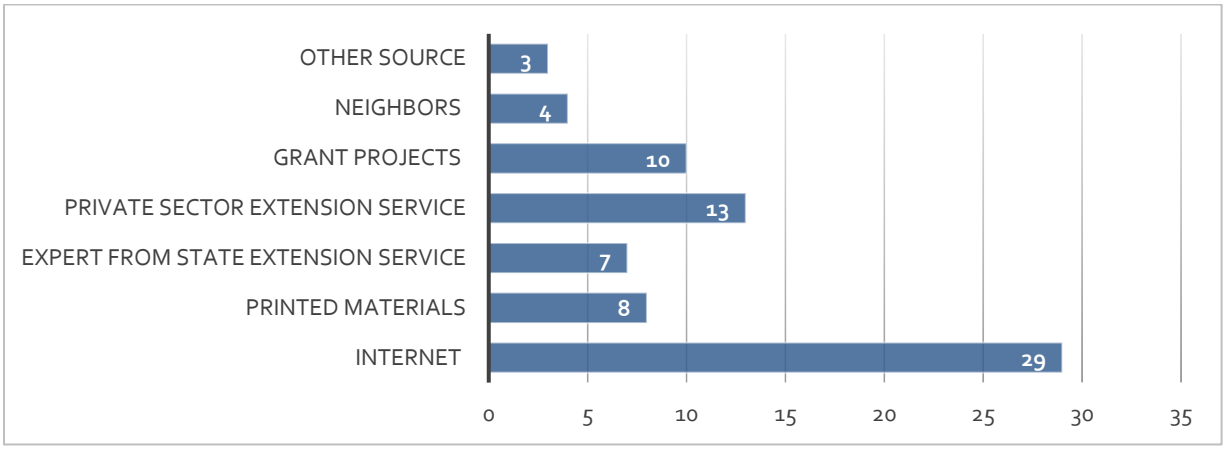


Chart 8: Main sources of information on innovations used by processors



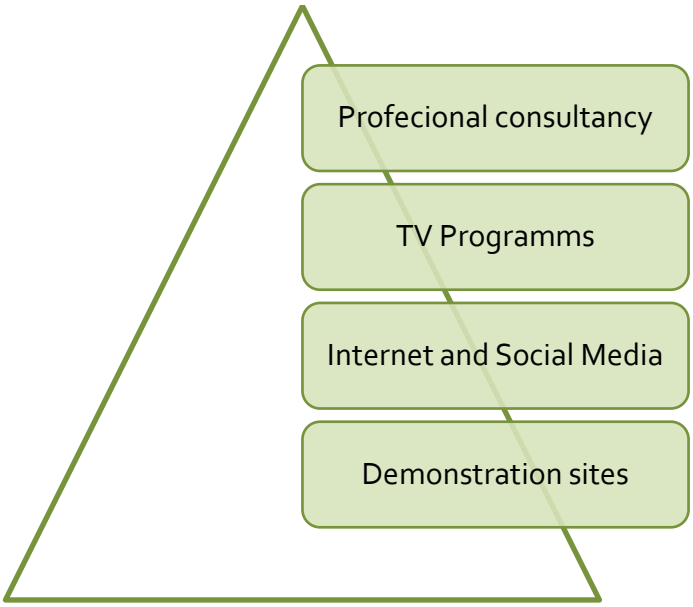
The lack of control is not only over the quality of information provided on internet, but also over the quality of any other information provided by consulting services. In addition, usually there is no official follow-up to assess the change and impact of the capacity building initiatives. Based on experts' opinion, the consulting services should not be free of charge and the government should spend not for providing a service but for controlling the quality of provided services. More control over the sales points of agriculture inputs should be carried out to ensure that the information provided by these shops is complete and true and that the farmers really get access to comprehensive information on the product bought.

Likewise, the training topics and content offered by NGOs periodically as part of their regular training agenda should be approved by respective government structures.

The proper channels for information dissemination were discussed during the validation workshop within the working group. During this group discussion, all the invited participants agreed on the importance and need for innovations in all the sectors of agricultural production, and the significance of proper information dissemination on innovations among farmers.

The work group defined the most suitable channels for the information on innovations, with the demonstration sites being the most commonly used and trusted source for a large number of farmers and professional consultancy being used mainly by few larger and professional farmers. All group members agreed that for the information to be accessible for farmers unrelated to the channel of dissemination should be in Armenian.

Figure 4. Channels for information on innovations suggested by the work group



E. ***Infrastructures:***

The level of relevant infrastructures' development simply defines the viability of the sector. Underdeveloped infrastructures can simply kill the sector, while the developed ones can create a fertile soil for increasingly growing investments in modern technologies and enhanced profitability. Worn out irrigation network, insufficient number of anti-hail nets and low efficiency of the existing ones; lack of agriculture product collection centers, poor condition of inter-village roads, issues related to storage and water stocks, low level of application of alternative energy sources, available of up-to- transportation network, etc. are all challenges hampering the development of agriculture sector in the country.

F. ***Markets:***

For accessing high-end markets the producers need to have high quality products. Very often however, it is the opposite. The markets targeted define the growing quality of the commodities. The more demanding is the market segments served, the more producers are motivated to invest in innovative practices which can enhance the quality, quantity and variety of their products. Armenian agriculture products are mainly oriented on domestic markets. The geography of exports for agriculture produce is quite low involving few post-soviet countries like Russian Federation, Georgia, Belarus, Ukraine, etc.

If the geography of the products will be expanded towards the EU and Middle Eastern countries, North America and Asia the demand towards the minimal requested quantities of the produce, diversification of the product and the quality of the products will be changed and the new market realities will put pressure on the producer to innovate and grow.

There are limitations related to accessing local markets as well. These limitations come from the fact that still many of the small and medium farmers, avoid working with collection units and individual middlemen. Cooperation in marketing and sales functions among farmers are also not a developed culture or business model in the country. Whereas both collection centers, middleman and cooperation models are key to solve the issues related to underdeveloped post-harvest infrastructures and access to markets.

4.1.4 Challenges and trends identified in relation to female farmers and agripreneurs

Generally, the experts mention that there are no barriers for females to access support programs implemented by the government and donors. Moreover, many experts emphasize that women are usually given preference and their participation in various programs is encouraged, with special programs designed specifically for women agripreneurs.

At the same time, experts note that the proportion of men in agriculture is higher thus they are more often engaged in capacity building and credit programs. Though the official statistics show that the proportion of men and women engaged in agriculture sector is almost equal (48% women and 52% men)[2], the perception of male dominance in agriculture might come from the dominant roles they play in agribusiness. In particular, men are registered as formal owners of businesses and assets, and they are the main applicants of credit programs. The male-dominant ownership issue is confirmed by the FAO study, according to which, most of the land is registered and managed by men and, as a result, women have limited access to decision-making on the use of the land and collateral for credit and entrepreneurship.[3]

The needs assessment study shows that there is a trend of labor division for "female" and "male" work. According to experts, women are more engaged in milking, processing, organic agriculture, greenhouses and producing dried fruit, while men manage the machinery and lead high volume production businesses.

Low level of participation of female agripreneurs in capacity building events is justified by the women's workload in household: "*Women are mostly busy with household chores, they do not attend classes, because they cannot leave their children, the household, and go to classes away from home. If the training course is not in the village, the number of female participants is very small*" (CSO representative, Shirak marz). The social-cultural issues were also mentioned by another CSO representative: *"…There are regions where women's rights are more limited. …We have female beneficiaries whose husband does not allow them to come to the meetings. Trainings are available to everyone, but there are stereotypes and traditions that restrict the participation of women*" (CSO representative, Yerevan).

[2] Women and Men in Armenia 2020, Statistical Committee of the Republic of Armenia, Yerevan, https://armstat.am/en/?nid=80&id=2322.
[3] Gender, Agriculture and Rural Development In Armenia, Food and Agriculture Organization of the United Nations, Budapest, 2017, http://www.fao.org/3/i6737en/I6737EN.pdf.

On the other hand, expert interviews highlight that in case women are involved in capacity building programs, they demonstrate high level of responsibility and team work, as well as openness to innovation and learning: "*Women are more enthusiastic, it is easier to work with them. For example, the topics of organic, sustainable agriculture are more interesting for women, they are interested to get harvest without the use of chemicals, use herbs to fight*" (CSO representative, Yerevan).

As to recommendations on capacity building measures for women in agriculture, experts mention the following:

- Offer small business modeling consulting services;
- Conduct soft skill trainings for women, such as leadership;
- Organize trainings on improving the condition of soils, obtaining and applying fertilizers biologically, proper operation of greenhouses.
- Create opportunities for cooperation between women in science and women farmers, which will increase the application of modern scientific achievements in agriculture.

The phenomenon of men dominating in large-scale business is confirmed by the results of the survey: 47% of men participated in the online survey manage land territory of two and more hectares, as opposed to 28% of women. Among the agripreneurs engaged in large-scale animal husbandry, men constitute the majority, especially in the bee-keeping economies where only two of 16 survey participants are women. As to the processing sector, the majority of women are involved in fruit processing, while men are engaged in a number of other activities such as production of combined feed, processing grain, potato and buckwheat, and production of vegetable oil.

The survey did not demonstrate significant discrepancies between the needs and preferences of women and men; however, some gender-specific differences are observed.

In the question on equal accessibility of agricultural inputs and machinery for men and women in the community, the average ratings of female and male farmers were similar, with higher level of agreement provided by men and women engaged in processing sector. The chart below represents the women's and men's responses to this question by sector.

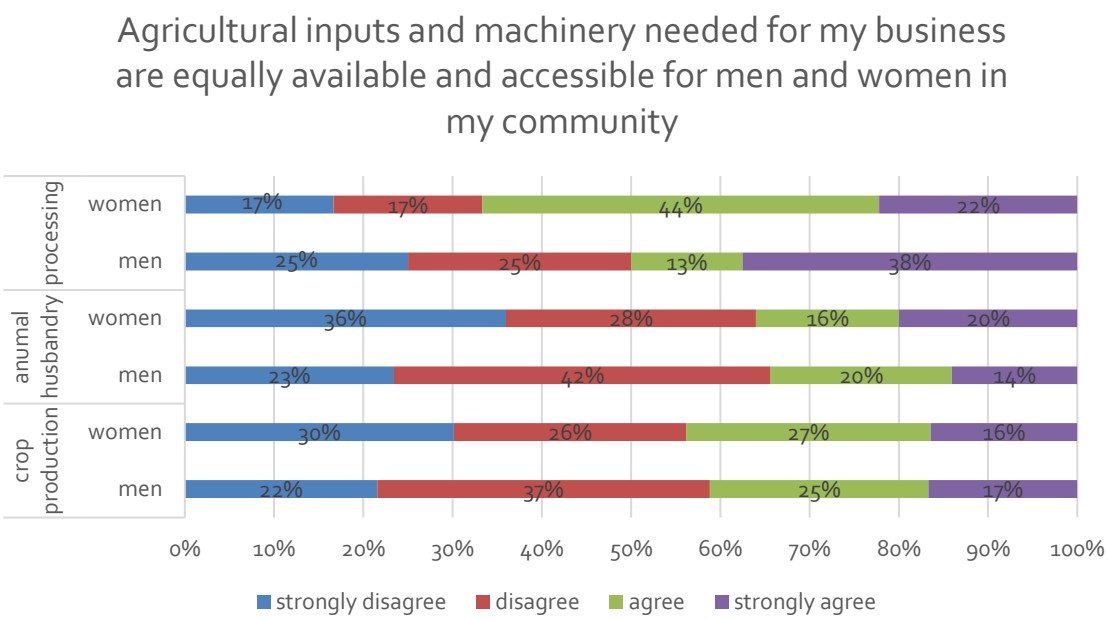


Chart 9. Level of agreement with the statement on equal accessibility of agricultural inputs and machinery by sex and sector

The women participated in the online survey were often less experienced: 53% of the female participants had 4 or more years' experience, as opposed to 76.9% of men which had long-term experience. This might be one of the reasons why women more often indicated the lack of knowledge of relevant management techniques and practices among the difficulties they face in agribusiness (21% of females vs. 12% of male participants). On the other hand, the concern on the lack of knowledge might be due to lower level of self-confidence highlighted in the FAO study referred above. Another difficulty that was more often mentioned by female participants was the lack of access to relevant technologies and equipment (mentioned by 40% of women vs. 27% of men). Apparently, technology and equipment has been traditionally linked with men, while their prevalent ownership status discussed above might be another reason for better accessibility to credits for buying new equipment.

The chart below represents the percentages of online survey responses on the common difficulties faced in all three agricultural sectors disaggregated by sex.

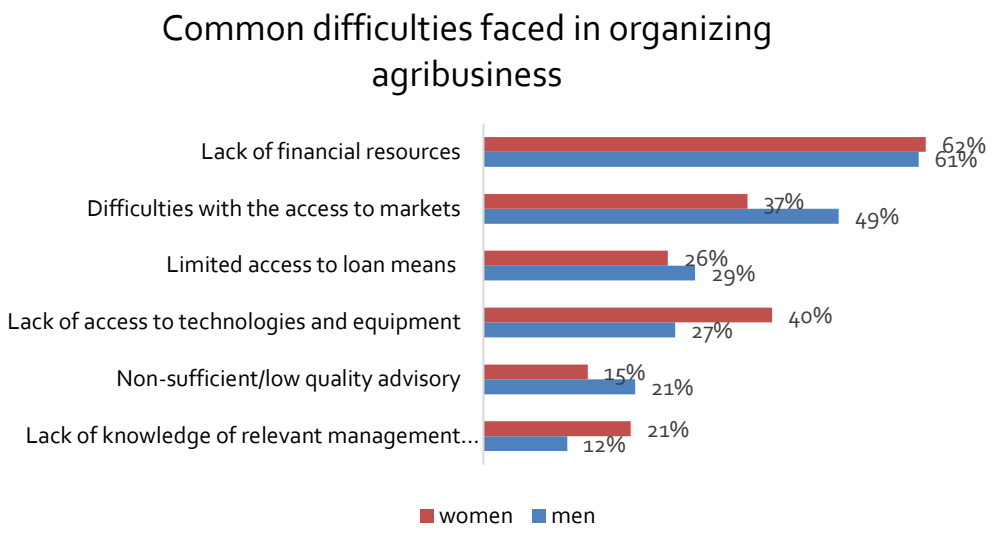


Chart 10. Difficulties faced in organizing their agribusiness by sex of respondents (multiple answers possible, common difficulties in all three sectors included only)

The specific difficulties indicated in each of the sector will be presented further in relevant sections.

Among the factors hampering access to innovation, the following were most often mentioned both by female and male agripreneurs: low quality of production, low income, limited access to loans and long payback period. At the same time, there are some subtle differences between the responses of men and women, with men more often mentioning low income, long payback period and lack of maintenance services as hindering factors for investing in innovations.

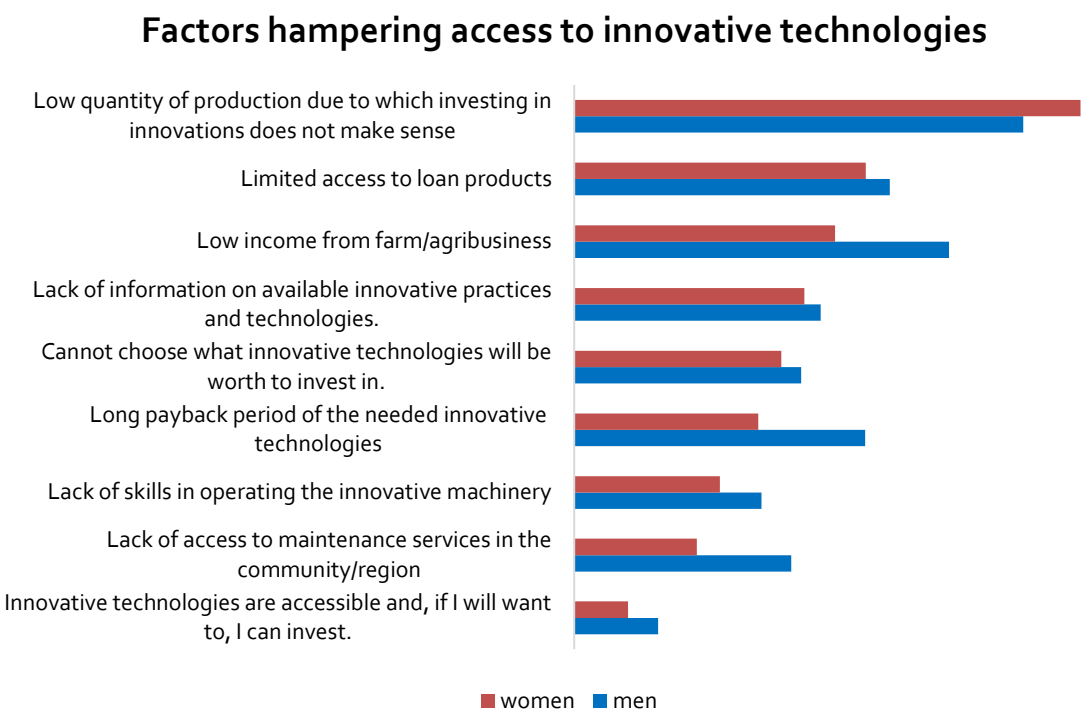


Chart 11. Factors hampering access to innovative technologies by sex of respondents (multiple answers possible)

In the question on the preferred capacity building topics, though the number of respondents per group was rather small to identify any statistical trends, the preference of women towards general business skills-related topics is observed. In particular, women more often mentioned the topics of financial management, budgeting, marketing and sales, while the specific topics on sector-related technologies and challenges were equally mentioned by men and women or more often preferred by male agripreneurs.

Less women had participated in the trainings organized by state extension service (31% women and 40.3% men of total positively answered the question) while the level of participation of women in private trainings is higher (40.7% of women vs. 35.4% of men).

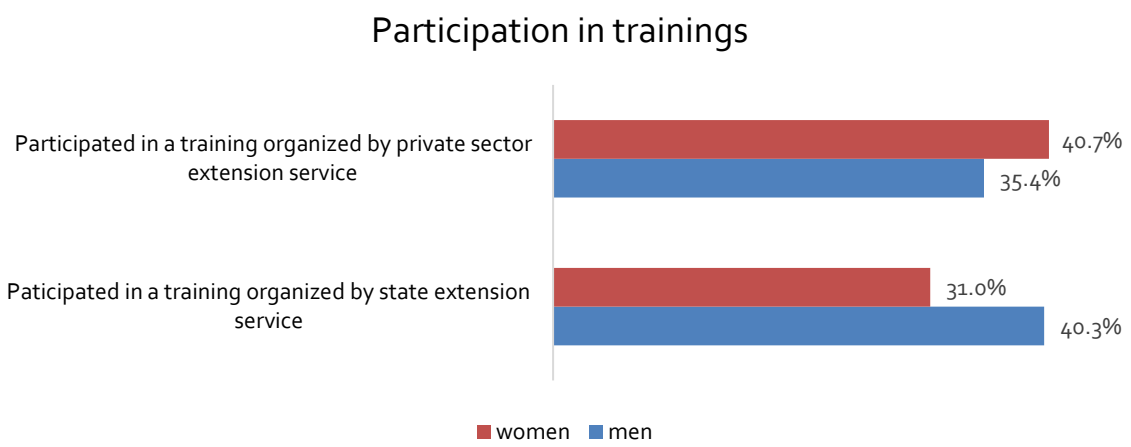


Chart 12. The percentage of respondents participated in a training organized by a state or private sector extension service (by sex)

These numbers to some extend reflect experts' statements about donors giving preference to capacity building of women. In addition, women more often indicate awareness on the donor-funded innovation programs and accessibility of private extension and consulting services. They are generally more positive on the availability and activity of various extension and consulting services, though the level of awareness on the government-administered trainings and programs is nearly the same among male and female survey participants. In addition, women more often mention that the information on innovations in agricultural sector is very accessible for producers and processors.

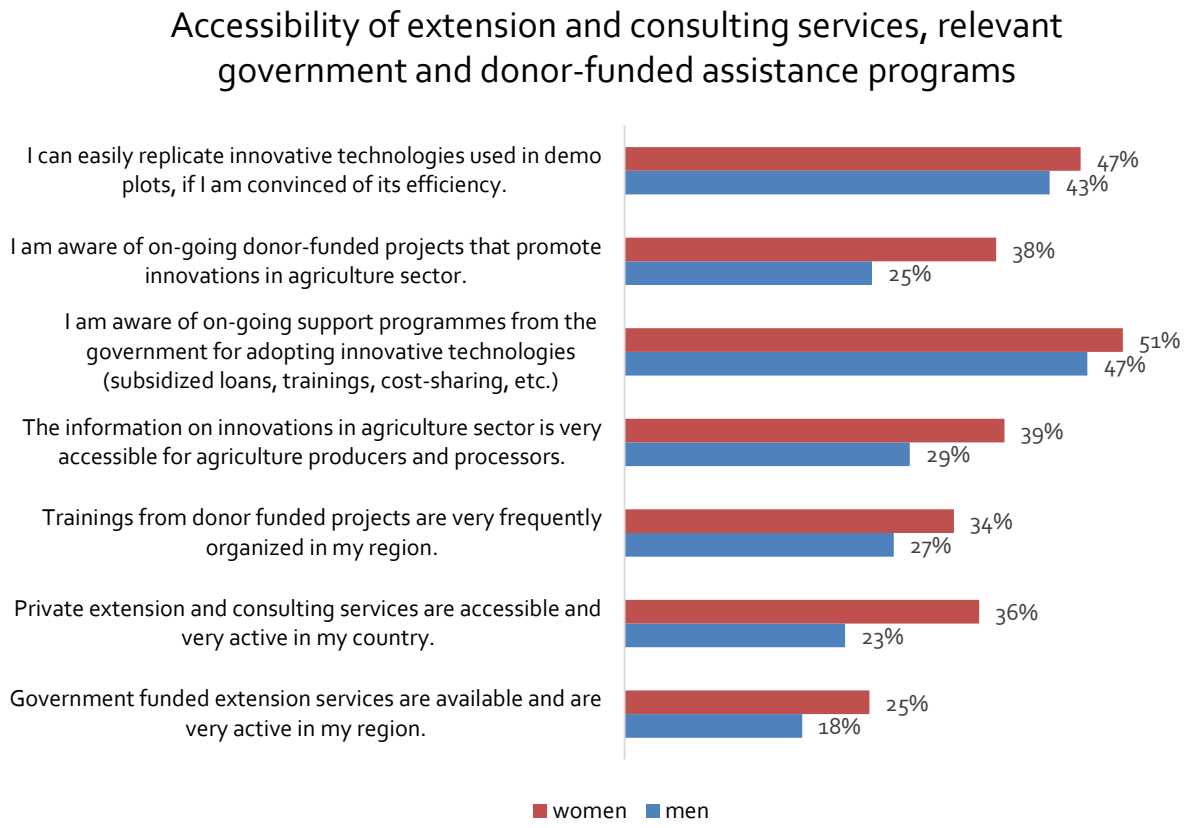


Chart 13. Percentage of respondents who agree or partly agree with the statements on accessibility of assistance programs

The information that describes in detail the research findings related to each sector of agriculture, reflecting the gender-related highlights identified in the online survey results is presented in Annex 3.

5. GOOD PRACTICES AND INNOVATIVE APPLICATIONS IN CROP PRODUCTION

Under the crop production sector, 3 main subsectors were analyzed:

- ✓ ***Solid-seeded crops (including wheat, barley, corn, etc.)***
- ✓ ***Fruit and Vegetable cultivation, production of high value crops***
- ✓ ***Viticulture (including grapes for wine production and table varieties)***

The interviewees have defined critical factors hampering the development of crop productions sector as follows:

- Non-Efficient functioning of Seed Selection Centers/Units –limited access to quality seeds and planting materials.

- Limited access to new and modern machinery and equipment.
- Limited access to consultancy services for improved agriculture practices.
- Non-Proper plant protection and fertilization knowledge and available inputs.
- Lack Access to water resources and proper water resource management system.
- Lack Access to proper quality and quantity workforce

The research results show that access to quality planting materials is one of the main factors that limit the possibility for increased productivity at farm level.

As already have been mentioned in the previous section of this document, the only selection centers supplying high quality seeds for cereals, beans, beetroot and carrot, are located in Echmiadzin and Akhuryan. The research results show that the quality of seeds produced in these centers is trustworthy but they are expensive and the production quantities are not enough to supply the whole country. Also, obviously, they do not cover the need for all varieties and types of crops.

With regard to the seedlings for vegetable production, there is one scientific center on vegetable and melon crop production in the country where only limited amounts of seeds and/or seedlings of local varieties of vegetables are possible to purchase. The research results show that mostly vegetable growers developed their own seedlings or bought seedlings with unknown origin from different sources (i.e. farmers' market, neighbor, friend, etc.).

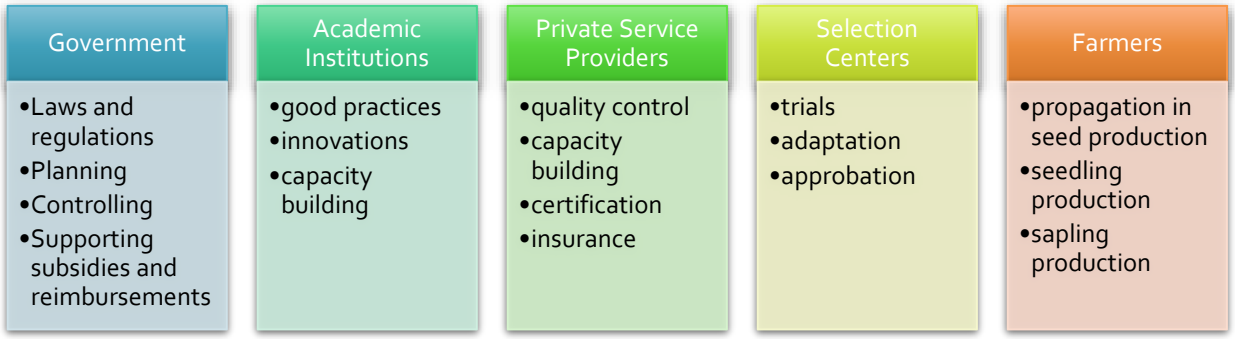
The situation with the saplings in the country is a bit better. E.g. professional and experienced nurseries are available in Ararat, Kotayk, Aragatsotn and Tavush, who import virus free certified rootstocks and propagate locally, even an organic certified nursery is available in the country Goris area, village Tegh supplying cherry, apple, pear, nuts, various berries and other types of saplings.

Availability of vine saplings is a challenge mostly in Tavush area where quarantine insect is developed and phylloxera-resistant, grafted planting material required. Farmers who plan to establish vineyard or fill-in existing ones always face difficulties in finding proper saplings. Some of them try to develop saplings themselves and mostly fail. Specialized nursery (with varieties of phylloxera-resistant mother nursery section) equipped with required tools and facilities required in the region to fulfill demand and boost sector development.

Picture is different in phylloxera free grape growing regions of the country (i.e. Ararat, Armavir, Vayots dzor marzes). Here specialized nurseries develop planting material for grape in case of orders. Mostly farmers easily develop required amounts of vine saplings themselves from the vine cuttings (no grafting require) and do plantings.

The gap of developing higher quality planting material for crops can only be addressed with the joint and coordinated efforts of the government, academic institutions, existing selection centers and farmers.

Figure 5. Role distribution in planting material development



The certification requirements for seed, seedling and sapling production should be enforced by state laws and regulations. The interviewees also see the role of the government in planning and controlling the types and varieties of planting materials. The interviewees also noted that the government support programmers should relate to all the above-mentioned players in the chain in accordance to their roles. E.g. academic institutions should get regular support in studying the need for innovations, studying international good practices and suggesting innovative solutions adapted to local realities. Academic institutions also should take the role of building capacities of private consultants for farmers, as well as for selection center professionals. Introduction of new insurance programs that would cover not only costs but also loss of harvest may also be supported by the government. While certain functions of selection centers can be on a commercial basis, they should receive permanent support from the government for trials and introduction of new types and varieties of seeds. Farmers who are producing sapling and seedlings, or who are also involved in certain functions of seed production in cooperation with selection centers, should have support from the government for ensuring standards in their fields required by the certification institutions.

Planting material development unit should consist of higher specialized and professional body/agency to develop and implement ***traceable system to control processes of development, testing, approbation and certification of planting material.*** Here would be developed higher quality planting material (i.e. super elite or elite type for field crops).

Developed higher quality seeds then could be propagated at farm level, to multiply and develop "A type" seeds that would be available for a wider range of producers to implement regular production in the farms. Farmers mostly could be involved in propagation/breeding and in the field production stages.

Here it should be mentioned that all of the three described levels (***starting from higher quality seed development, propagation processes up to the general cultivation***) requires specialization, certain professional knowledge, capacities and experience. Without implementation of combined crop management (or good agricultural practices), as well as innovative practices desirable results will not be achieved.

Relying only on improved genetic potential for high yield is not justified. It is well known that only up to 30% of productivity is caused by genetic potential of the farm animal, the implemented appropriate and the most suitable management practices, including housing, feeding etc., condition most part of productivity in animal husbandry. Planting material development as well as open field production for any crop is a certain process which requires improved capacities and skills to implement in all the stages and for all the practices.

Good agricultural practices for improved planting material production involves but is not limited to:

- Crop rotation
- Soil management (including "no-till" technology)
- Fertilization (based on results of agrochemical analyzes of the soil)
- Pest and weed control
- Approbation of varieties
- Sorting, grading, packing, labeling

Some innovative solutions also could be efficiently implemented in the production of planting materials:

- "Virus-free" planting material development
- Use of farm management platforms, IoT, weather stations, sensors or mobile applications for data collection, proper decision making, keeping traceability, real-time consultancy provision and wider information dissemination
- Use of modern soil and crop management machines and equipment, such as planting machinery for seedling and sapling production, sorting, grading, packing and labeling equipment for seeds, etc.
- Drone technologies
- Automated greenhouses,
- Etc.

Application of drones and other digital technologies in planting material production

Academic institutions, selection centers and large producers of seedlings and saplings development can widely apply digital technologies for:

- *Collection and analysis of data throughout the production process of planting materials and from the fields and orchards established where these materials were planted.*
- *Provision of embedded services for farmers on proper on farm interventions*
- *Accessing on-line data collection/determining critical points of production and developing improved decision-making system*

Drones: these technologies are not widely used by farmers even outside the country because of being expensive, the ability of farmers to analyze the captured data and ability of farmers to innovate in general. In the production of planting materials, however, the use of drone technologies is economically feasible because of its multilevel impact on the efficient operations of involved academic institutions, seed selection centers, large producers of planting materials and farmers, improving decision making processes of the mentioned players in business,

marketing and production levels. To enhance the productivity in planting material and in general in crop production, through drone technologies the following functions can be performed:

- ***Soil and field analysis in production areas of planting materials and the fields which are using these inputs*** **–** the 3D maps created with these technologies can improve the planning of the planting operations, managing irrigation and nitrogen levels.
- ***Crop monitoring, health assessment and spraying* –** The drones can carry devices which track changes in the plants and detect health problems at early stages. The players involved in planting material production can use these technologies not only in their production areas, but also for academic researches and for monitoring the situation in the farmers using the supplied planting materials for advising the farmers on proper measures, and later improving their operations.
- ***Planting processes* –** Drones can be used in planting as well. These technologies can shoot the pods with seeds and nutrients into the soil, providing all the nutrients necessary for growing crops. This can be an additional service provided to the farmers by the planting material producers. While these technologies can reduce the planting costs for farmers, they can be a source of additional income for the supplier companies.

    - *Determining demand for planting materials*

Data driven decision making – Modern digital technologies allow to collect, analyze and correlate huge data on weather, soil quality, probability of diseases, historical data, marketplace trends, and prices, demand for certain types of planting materials; as well as to apply digital platforms for orders. All of these contribute to informed decision making.

The lack of quality planting materials most of all has a visible negative impact ***on vegetable production*** in the country as seedling production, as mentioned above, is the only input among all other planting materials that is completely out of any kind of quality control. Therefore, most of all it is very important to support farmers either through awareness raising on how to choose quality seedlings, there is a need to establish a proper control and certification system and promote certain professional and innovative approach in the production process. As stated above, it is best if in production of any planting materials professional institutions and companies are involved, however seedling production at farm level always was and will remain in the country as a common practice for still a long period of time. Therefore, for mitigating the risks associated with this practice it is suggested to *promote sapling production in small and medium greenhouses as a form of small and highly profitable farming business in the communities with a heavy use of automated and digital systems. This approach will allow to attract youth in this business because of modern solutions and women (who required not so heavy types of work) in such greenhouse mainly associated with controlling the operations of the systems.*

Application of automated and specialized greenhouses for seedling production

Automated greenhouses are used around the world not only in seedling production but also in vegetable production, production of flowers etc. Despite the high costs of automated systems used in the greenhouses these systems allow ***decreasing labor costs, costs of treatments, overuse of expensive fertilizers***, as well as **increasing quality of produce and yield.** Automated and specialized greenhouses may have significant impact in seedling production as it maximizes the availability of data for accurate decision making thus minimizing the possibility of human error.

Even though some automated systems are used in most of the greenhouses in Armenia, majority of the farmers using these technologies still treat that as a covered landplot allowing them to start growing crops a bit early and end a bit late in the season for enhanced profits. Automated and specialized greenhouses are much more than that. They can let the farmer tailor an environment for the crops and offer proper solutions to outside influences that may risk the quality and quantity of the expected yield. A good automated greenhouse system will manage ***ventilation, temperature (heating and cooling), lighting, CO2, crop nutrition, humidity through irrigation system, roof etc***. Some greenhouses may also use automated system for seeding, early detection of pests and diseases and in most of the cases ensure treatments, harvesting etc.

Other factors that limit possibility for increased productivity, commercialization of good practices and application of innovative technologies for this sector as defined by the interviewees are ***lack of knowledge and information, high purchase and rental prices of machinery and equipment and lack of access to proper consulting services***. The areas under cultivation for ***solid seeded crops*** are small and fragmented, therefore renting or purchasing modern machinery and equipment for cultivation most of the time is economically not feasible. Investing in innovative technologies is not justified either.

The lack of access to modern machinery and equipment not only results in low productivity and loss during the seeding, harvesting and post-harvest stages of crop production, it also limits the possibility for the farmers to commercialize even the already existing innovations in the country. For example, for farmers in ***solid seeded crop production*** are able to apply crop rotation, they must have access to relevant machinery and equipment for each crop. ***Lack of knowledge and information, limited access to consultancy service for improved agriculture practices is also a key factor which limits possibilities for farmers to increase productivity and innovate:*** in some cases, the lack of access to modern machinery and equipment is a result of lack of access to knowledge and information of farmers and lack of their farm management, planning and forecasting skills. For example, proper planning and design of an orchard, as well as correctly chosen variety may allow ***the farmers in fruit and berry*** production to use ***automated harvesting technologies.*** Even if these technologies are expensive for a single farmer there is available private service for automated cultivation. Because the technologies are designed for a certain type of orchards, this equipment is not accessible for most part of the farmers who did not design their farms in accordance with the acceptable standards. The implementation of the technology though could solve the problem of limited access and high cost of quality manpower mentioned by almost 90% of the interviewed farmers and experts.

Lack of access to consultancy services was revealed to be an issue even for ***the viticulture*** sub-sector, which supplies wine and cognac production which in their turn are the leading export-oriented agriculture products for the country. Yerevan Brandy Factory even employs agronomists to provide consultancy to their contract famers. Even so, obviously this cannot covert the whole demand of consultancy services in the sector, therefore most of the interviewed farmers both in technical and table grape production mentioned during the interview that there is no access to professional consulting services in the sector which is the main reason for decreased productivity in these subsectors. ***Lack of plant protection and fertilization knowledge and limited availability of relevant diverse varieties of inputs are highlighted*** by the interviewees in all subsectors of crop

production. The pesticides are mainly purchased from local shops in small quantities and a number of issues arise, namely:

- The decision on which pesticide to purchase is based on the recommendation of the salesperson;
- The recommendation provided in the shops is mainly based on the available pesticide in the shop rather than the real need of the crop;
- The salesperson in the shops not always is qualified enough to provide proper recommendations;
- The pesticides are purchased mainly in small quantities without packaging and the farmers usually do not know what is the exact content of the pesticide purchased.

As a result of all of the issues mentioned above, the farmers very often use wrong treatment, overuse or underuse them facing all the possible negative impacts on the fields.

What concerns to fertilization, the farmers especially in the small and fragmented land plots usually use whatever is accessible in low costs, e.g. manure from their own farming activities, ammonium-nitrate subsidized by the government, etc. this approach obviously could not ensure efficient soil management, and therefore the farmers interviewed reported decreased soil productivity.

Revolutionary innovation in pest and disease management and fertilization.

It is estimated that roughly 60 percent of applied fertilizers are lost to the environment[4], causing pollution. The main issues voiced out by farmers in all subsectors of horticulture was about high costs of fertilizers.

Precision agriculture driven by nanotechnology: This revolution will see nanoparticles delivered to plants and advanced biosensors for precision farming. Nano encapsulated conventional fertilizers, pesticides, and herbicides will release nutrients and agrochemicals in a slow and sustained manner, resulting in precise dosage to the plants. Among the benefits of precision agriculture for farming include:

- Nano-fertilizers help in the slow, sustained release of agrochemicals, resulting in precise dosages
- Greater plant protection and treatment of diseases
- Biosensors can detect pesticides in crops, leading to more-informed decisions.

Access to efficient irrigation of agricultural lands is one of the most important issues of the agriculture sector in Armenia. Not only the accessibility of irrigation systems but also their management is a problem. In some cases, the problem is not so much the lack of water resources but the lack of the right water distribution mechanisms, such as application of more efficient and modern systems.

There are different types of irrigation systems. *Surface irrigation* is the application of water by gravity flow to the surface of the field. This is the typical way of irrigation in Armenia. *Farrow irrigation* used where water can be fed into small channels or strips of land. This method is the

[4] University of Delaware Cooperative Extension. 2009. "Urea and Nitrogen Volatilization." Available at: https://kentagextension.blogspot. com/2009/01/urea-and-nitrogen-volatilization.html.

easiest and least costly but inefficient one (in terms of water waste, labor need, etc.). *Sprinkler irrigation* systems imitate natural rainfall. Water is pumped through pipes and then sprayed onto the crops through rotating sprinkler heads. This system is rarely used in Armenia.

Drip irrigation delivers water through the use of pressurized pipes and drippers that run close to the plants. The system is costlier to install and operate. Mostly drip irrigation installed in orchards, berry plantations or greenhouses. It is one of the most efficient types of irrigation systems. Here are some advantages:

1. Only the immediate root zone of each plant is wetted, water saving is obvious;
2. Less weeds appear;
3. It improves fertilization (water soluble fertilizers delivered to the plants);
4. Number of harmful insects and diseases is decreasing;
5. Crop yield is increasing;
6. Less labor intensive.

In case of combining improved irrigation practices with innovative solutions it is possible to significantly improve efficiency of irrigation process. As innovation, it would include:

- Use of soil sensors (to detect humidity in the soil, as well as crop transpiration level to set proper timing of turning on and off irrigation system);
- Use of devices for automation each irrigation zone or even row;
- Use of mobile applications to manage remotely irrigation systems.

Application of Aeroponic and Aquaponics technologies for improved water and soil management in greenhouses

Innovations in some greenhouse technologies allow efficient use of water resources and proper soil management. For example:

Aeroponic means growing plants in midair. The system can reduce water usage by 98%, fertilizer usage by 60%, and pesticide usage by 100%. At the same time these greenhouses allow to maximize yield by 100%. Despite these benefits, according to the information provided by the field expert, there is only one greenhouse established based on aeroponic technology.

Aquaponics combines farming of fish and plant together. Aquaponics combines plants and fish in the same, closed ecosystems to sustainably grow crops. The nutrient-rich waste produced by the fish by filtering and purifying the wastewater, which gets recycled back to the fish ponds. There are only 2-3 farmers using this technology in the country. These farmers cooperate with a partner from the US, who is responsible for consulting on technologies and coaching the greenhouse management processes.

Lack of access to quality workforce is another increasingly growing constraint in the crop production sector. Here the problem may be solved on one hand through enhancing the motivation of youth to get engaged in the sector and in parallel through the promotion and use of proper modern technologies.

Application of robots in Agriculture[5]

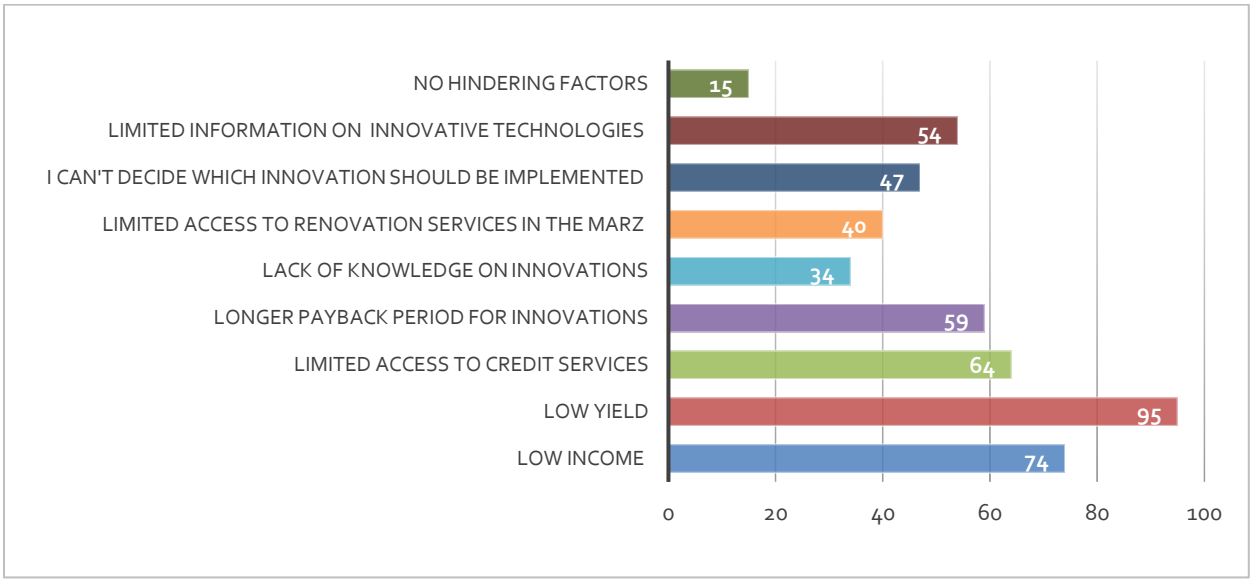
Per the UN projections, by 2050 two-thirds of the world's population will live in urban areas, significantly reducing the rural workforce. In Armenia, even now the farmers report having problems in hiring workforce during the heavy seasons in agriculture especially in planting and in harvesting. The new technologies will be needed to ease the workload on farmers allowing to operate the automated technologies remotely.

Agriculture robots are used to automate the slow, repetitive and dull tasks for farmers allowing them to focus more on improving overall production yields. Common uses of robots include:

- ***Harvesting and picking*** – accurate and fast picking of yield and reduce waste from crops being left in the field. These robots can only function in parallel with vision system to determine the location of the crop to be harvested, considering that the process can be disturbed by harsh conditions including: dust, varying light intensity, movements because of wind, etc. Despite the challenges the application of robots in harvesting and picking is becoming increasingly popular among farmers.
- ***Other application of robots for reduced labor:***
  - Weed control
  - Autonomous mowing, pruning, seeding, spraying and thinning
  - Phenotyping
  - Sorting and packing
  - Utility platforms

The survey results revealed main reasons why farmers resist using innovation in crop production and these reasons are presented in the chart 14 below.

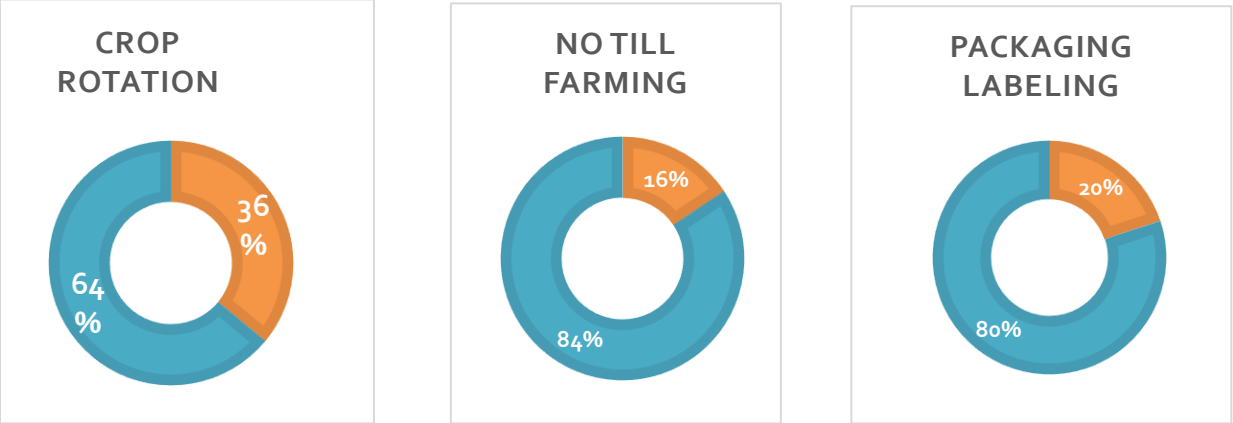
Chart 14. Factors hindering implementation of innovative technologies.



The survey also shows that the rate of implementation for even the known good practices is quite low. E.g. crop rotation is implemented by only 36%, no till by 16% and packaging/labeling by 20% of the interviewed farmers.

[5] https://www.automate.org/blogs/robotics-in-agriculture-types-and-applications

Charts 15. Implementation rate of best practices in crop production



Below are common best practices, which still need to be spread widely in the country for enhanced productivity in all subsectors of crop production in Armenia, suggested by the assessment team based on the information collected and analyzed through all survey tools.

Best practices in crop production to be promoted

Management Area	General Topic	Best Agricultural Practices/Innovations
Improved Soil Management	Reduction of mechanical influence on the soil through the soil managing machines and equipment	Reduced/low/zero tillage. No-till machinery. Small scale agro-machinery.
	Improving soil health, structure and quality. Improved management of agricultural by-products	Development and use of organic fertilizers (i.e. compost, bio-humus, etc.). Soil mulching. Green manure. Production and use of biomass briquets.
Improved Crop Production	Production diversification	Crop rotation (i.e. use of legumes). Inter-cropping/mixed cropping. Use of more suitable/better crop types/varieties (that have higher value and market demand, more resilient, have different ripening time, etc.)
	Implementation of climate smart technologies and practices	Improved irrigation practices/measures. Installation of anti-hail nets. Shift crop production timing (i.e. variety and technology change, production in high tunnels, etc.). Control environment in the greenhouses. Improved energy use at the farms (for agricultural purposes).

		Use of modern and effective agricultural equipment/machinery for crop management, Use of GMO varieties, etc.
	Implementation of precision agriculture technologies and practices	Use of unmanned aerial vehicles (i.e. drones). Use of mobile applications, sensors and other devices for more effective crop management. Implementation of precise soil cultivation, etc.
Integrated Pest Management	Encourage integrated approach for the pest management.	Promotion of preventive, mechanical, biological, physical pest control measures. Developing habitats for beneficial insects. Cultivating pest resistant varieties, etc.
	Decrease number of sprayings and application rates of pesticides.	Detection precise time of spraying (i.e. use of color traps, pheromone traps, sticky belts, etc.). Use of higher quality agricultural equipment and inputs with lower impact on environment.
Organic Agriculture	Application of the right methodologies and technologies (such as crop rotation, inter-cropping, cover crops, use of organic fertilizers, integrated pest management, etc.) that are beneficial for the environment and the ecosystem (i.e. protection and enhancement of natural resources as well as biodiversity), climate change adaptation and mitigation. Natural resource management and consideration of proper waste reduction/ management.	

Other applicable innovative technologies to be promoted in crop production subsectors

Usually the kitchen gardens and small homestead orchards are managed by women. Women, as mentioned above are open to innovations that are green and organic, are for high value crops and can be applicable on smaller areas. In addition, the smaller cities are sometimes even more vulnerable in Armenia than the rural communities as the inhabitants here mostly depend on paid jobs which are very limited and the existing ones are very low paid. The members of urban communities did not get any land-plots after the soviet collapse and hence most of them having no agricultural lands remained with no option for alternative income generation. In this situation, some of the agriculture experts have suggested promotion of vertical farming for smaller land plots and in urban areas of Marzes.

Vertical and organic farming application for smaller land-plots[6]

Vertical farming is the practice of growing crops in vertically stacked layers. It often incorporates controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics, and aeroponic. The main advantage of utilizing vertical farming technologies is the increased crop yield that comes with a smaller unit area of land requirement. The increased ability to cultivate a larger variety of crops at once because crops do not share the same plots of land while growing is another sought-after advantage.

[6] http://verticalfarminstitute.org/vertical-farming/
https://www.edengreen.com/
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/organic-farming

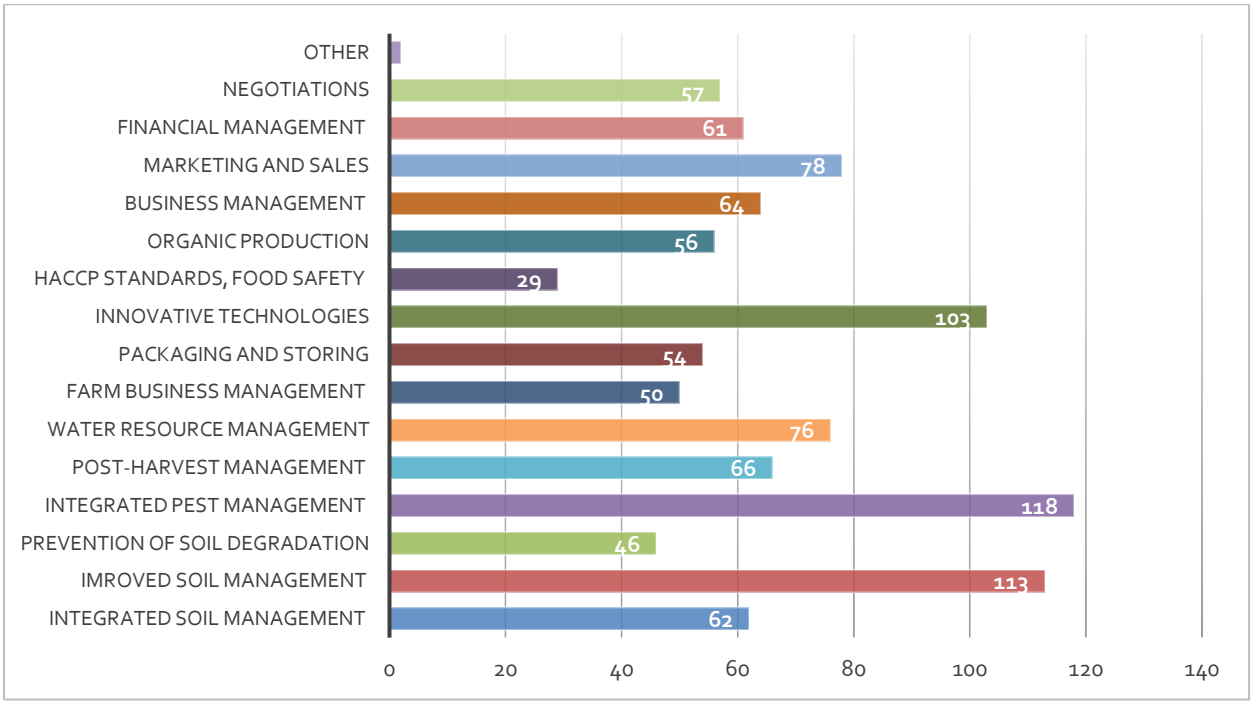
For Indoor vertical farming, an additional advantage is that the crops are resistant to weather disruptions. Because of its limited land usage, vertical farming is less disruptive to the native plants and animals, leading to further conservation of the local flora and fauna. Vertical farming technologies face economic challenges with large start-up costs compared to traditional farms. Despite their usual small size, the energy demand of such farms is much higher due to the use of supplementary light like LEDs. In addition, automated systems of drip irrigation, air humidity control etc. are heavily used in vertical farming. Therefore, these farms need to use renewable sources of energy (solar systems) for cost efficiency.

Organic farming offers great benefits and potential for key resource efficiency challenges of agricultural importance, such as climate, soil, biodiversity and nutrients. Organic agriculture takes a proactive approach to resource depletion and offers environmentally-sound solutions to the problems posed by resource use.
For instance, organic farming practices increase soil stability, organic matter content and there-with resilience to changing climate conditions. Organic farmland is rich in biodiversity; it bears on average 30% more species than conventional farmland. Organic farming is a pioneer in efficient use and recycling of nutrients through crop rotations, use of legume crops, lower stocking densities and sensible manure applications. It has the potential to use less energy due to the prohibition of synthetic fertilizers and pesticides.

Capacity building topics and recommended target Marzes for trainings in crop production

The in-depth interviews with farmers and field experts revealed the topics for trainings to be conducted for farmers in crop production. To verify the interest by farmers towards these training topics, the relevant question was included in the on-line survey tool. Thus, *the online survey* among farmers showed the interest levels for those mentioned topics, which are presented in Chart # 12 below.

Chart 16. Capacity building topics in crop production



Priority Marzes to be targeted for trainings in crop production can be chosen based on various factors including:

- Areas under cultivation for a certain crop
- The importance of the subsector in the overall economy of the Marz
- Natural conditions and other existing preconditions for promoting innovative technologies
- The readiness and openness of farmers to learn and invest in new technologies and potential for replication.
- Other criteria defined by the project team based on the project priorities.

The table 1 below present the areas under cultivation for fruits, vegetables and solid seeded crops. According to Statistical Committee of therepublic of Armenia, the 3 leading marzes for solid seeded crops are Shirak, Gegharkunik and Syunik. For vegetable production Armavir and Ararat are the leading 2 Marzes and for fruits and berries cultivation 4 Marzes can be chosen Armavir, Ararat, Aragatsotn and Kotayk. As for vineyards Armavir and Ararat Marzes have the largest areas under cultivation. While in this marzes cognac factories define the main demand for grapes, Vayots Dzor and Tavush Marzes also needs to be considered as being among leading provinces in Armenia in wine production and wine export. Moreover, Vayots Dzor Marz a large number of large and small wine producers, including "Getap Wine Factory", opened in 1938, "Maran Winery", "Areni Wine Factory", "Old Bridge Winery", "Getnatoun Winery", "Vayk Group Winery" (wine, vodka),"Hin Areni Vineyards", etc. The "Trinity Canyon Vineyards", opened in 2009 and was the first who actually is trying to make an organic wine in Armenia starting from certified vineyards in Aghavnadzor.

Largest area under seed production is Shirak. For solid-seeded crop production, it is also worth to consider the areas where animal husbandry is developed, i.e. Lori and Aragatsotn.

For capacity building and promoting innovations in fruit and berry production, Syunik Marz can also be considered. One reason for that is despite the small areas under cultivation of fruits, in Syunik Marz Meghri region grows subtropical fruits which can be found only in very few communities of Tavush Marz. Fruits like persimmon, pomegranate, fig, kiwi, loquat, and even bananas grow in this region and even though the fruits are highly priced in the market, the farmers producing these fruits have very big information gap on the cultivation, harvesting, post harvesting technologies. Moreover, there are no farmers within the country from whom it will be possible to learn or specialized consulting on these particular types.

Table 1. Areas under cultivation of various crops in hectares, year 2020[7]

Marz	*Areas under cultivation of fruits and berries*	*Areas under cultivation of vegetables*	*Included seed fields*	*Potatoes*	*Vineyards*	*Production area cereals /winter and spring sawn/ and legumes*
Ararat	8,661	5,110	8	508	4,849	4,371
Armavir	10,422	8,661	19	1182	7,401	7,524
Aragatsotn	6,232	557	-	1062	1,409	22,521
Gegharkunik	1,527	1,406	-	7995	-	33,509
Shirak	637	1,440	45	3536	-	48,085
Lori	2,317	1,296	-	3510	67	18,806
Kotayk	4,651	936	-	637	136	13,723
Vayots Dzor	2,517	319	-	125	1,202	1,907
Tavush	2,832	663	-	783	1,342	7,555
Syunik	2,627	604	-	1128	179	24,298

During organized validation workshop with the invited group of stakeholders 2 sub-sectors from crop production were discussed (i.e. solid seeded crops, viticulture) to identify the most specialized production regions, preconditions for the development of sector and key areas where improvements require (in terms of capacity building, or technologies).

Shirak, Syunik and Kotayk marzes were pointed as the leading marzes in production of solid seeded crops. Here proper soil-climatic conditions and massive areas exist for the sector (including seed production). For the mentioned areas, the key topics for capacity building and technologies that require improvement are:

- Use of crop rotation
- No-till production technology
- Introduction of higher effective equipment and machinery
- Introduction of higher yielding crop types and varieties (including drought resistant varieties/crops).

As for viticulture the group suggested Vayots Dzor, Armavir/Ararat, Aragatsotn and Tavush Marzes as these were traditionally vine growing and winemaking areas. For the mentioned Marzes the key challenges for the sector development were pointed:

- Development of traceability system for vine growers
- Exploring advantages of each production region and grape variety
- Lack of specialists or capacities/knowledge for grape growing, processing and marketing.

[7] https://armstat.am/en/
https://armstat.am/file/article/sv_12_20a_122.pdf?fbclid=IwAR26h7F--BZQMeCxf7ZgIrzeQ3kvvtZfhoNgHteOCQ9uxKLSNqpwcOGLZSc

6. GOOD PRACTICES AND INNOVATIVE APPLICATIONS IN ANIMAL HUSBANDRY

Under the animal husbandry sector, 4 main subsectors were analyzed:

- ✓ ***Large and small ruminants***
- ✓ ***Piggery***
- ✓ ***Fishery***
- ✓ ***Rabbit farms***
- ✓ ***Beekeeping***

The interviewees have defined critical factors hampering the development of the sector as follows:

- Improper feeding practices, including developing feeding ration based on animal type, growth stage
- Animal housing, disease prevention and control
- The need for improved productivity of local breeds
- Lack of access to slaughterhouses, storages, post-harvest and processing facilities
- Properly developed roads and infrastructures
- Lack of cooperation among producers
- Lack of access to proper consulting services and expertise

Feeding practices in animal husbandry

Farmers in the ***large and small ruminant, as well as the piggery*** subsectors, noted during the interviews several issues related to feeding of the animals, which includes:

- The distance of pastures from the communities and improper infrastructures /i.e. stock watering points, roads taking to the pastures, shelters, etc./
- Non-proper pasture management including reseeding, non-controlled grazing and fertilization.
- Lack of on-farm fodder production and hydroponic feed production,
- Lack of combined /nutrient rich / feeding.
- High prices of fodder.

Green fodder is essential to feed livestock and receive higher yields. During grazing season for that purpose pastures used. Availability of nutrient rich green mass is especially critical from October to April when the fodder (mostly hay) from grasslands and non-used arable lands is used (which is lower quality feed with insufficient contain of nutrients). The limited access to land and water resources, machinery, however, makes the production of even traditional fodder a challenging task for farmers.

Hydroponic Greenhouses for Fodder production[8]

Production of Hydroponic fodder involves growing of plants without soil, in water or nutrient rich solution in a greenhouse (hi-tech or low-cost devices). Usually the production cycle is 7 days. The benefits of producing fodder in a hydroponic greenhouse over the traditional fodder production are the following:

1. Hydroponic fodder contains ***higher nutrients***
2. Grows ***8 times faster***
3. Requires ***much less water resources*** - 3-4 liters of water is required to grow 1kg fodder vs. 70-100 liters.
4. ***Can be produced regularly irrelated to season.***
5. ***Requires no chemicals or pesticides***.
6. ***Required less workforce and transportation costs*** (usually the farmers grow hydroponic green fodder next to the livestock)

Hydroponic fodder production, unlike traditional ones, is a good opportunity to involve women workforce.

The issue of feeding in ***fish farming*** in the country is also far from being resolved. Larger fisheries use mainly imported artificial feeding and artificial or synthetic hormones to ensure rapid growth and reproduction of fish. Using such inputs in fish farming may not be healthy for consumers and expensive for producers. On the other hand, small fish producers rely mainly on natural feeding and therefore are non-feasible as business.

Algae as substitute for feedstock and fishmeal

Fisheries are the most important source of feedstock. However, only a small percentage of global fish production is used for human consumption, while the rest is used for fish feed and animal feed. The production of fish processed into fishmeal is unlikely to grow due to increasing demand for fish products.

Algae are at the base of the aquatic food chain, producing the food resources that fish are adapted to consume. Studies have proven that the inclusion of small amounts (<10% of the diet) of algae in fish feed (aquafeed) resulted in positive effects in growth performance and feed utilization efficiency.

Algae farmed in aquaculture sites tends to become a substitute for feedstock and fishmeal. The cost of farming algae is estimated to be around 60-70% cheaper compared to fishmeal. In addition, algae are more reliable source of feedstock, and its availability does not dependent on production or catching of fish. Algae-based feedstock is an effective and inexpensive substitute for the fishmeal and feedstock.

Other innovation related to feeding for increased productivity

Feeding automation

Feeding automation comprises complete systems including ***feed preparation, mixing equipment and the installations for distributing feed***, which is the best option for farmer to ration preparation. The Automation system consists of a control panel, a programmable command manager, a scale, a communication interface and finally all the needed equipment to organize the feeding process and feed provision to the animal. Computer-controlled calf feeders have many advantages over traditional ones. Calves learn to use the computer-controlled milk feeding system easily and the technology offers a significant reduction in labor cost.

These systems can be combined with automatic weighing and health observation system for calf welfare. Electronic Concentrate Feeding system ensures that each cow is supplied with the exact ration of feed at the exact right time.

[8] https://www.agrifarming.in/hydroponic-green-fodder-production-guide
http://www.fao.org/3/i4021e/i4021e.pdf

The Belt Feeder feed distributor is the ideal introduction to the concept of automatic feed supply systems. Small, flexible, economical – the combination of a conveyor belt and sliding scraper.

Precision feeding

For a livestock farmer, regardless of which species is being raised, the feed costs represent the greatest portion of the overall cost of production (reaching up to 70% of the overall production costs, especially for swine). Nowadays many livestock producers worldwide choose to manufacture all or large portions of the feed for their animals on farms with the goal of better controlling feed costs. Such practice requires knowledge, experience and above all, tools. The practice therefore is not much used in Armenia.

Animals need a diet that incorporates the four main nutrient groups: protein, carbohydrates, fibers, vitamins, and minerals. To provide the right number of nutrients to the animals, the rations are established per different criteria (e.g. the species, age, genetic potential, farming methods). Precision feeding is part of the precision livestock farming approach and consists of using different feeding techniques to feed the correct number of nutrients in a timely manner for each individual animal for enhanced profitability, efficiency, and sustainability.

In ***beekeeping, proper feeding*** is the honey harvested by bees. Approximately quarter of the harvest should be left in the beehive as winter feeding of bees, which increases the cost of production for beekeeping products. The main alternative feeding used by farmers is sugar, which is not healthy neither for honey consumers nor bees. In this subsector access to feeding is not an issue, but a matter of informed choice by the beekeeper.

Animal Breeding and Veterinary Issues

Improper animal disease prevention and control is another factor hampering the development of the sector. ***The lack of access to consulting services and expertise***, combined with the fact that the majority of farmers do not even have minimum required skills and techniques to detect whenever the animals have health and welfare problems significantly worsens the situation with disease prevention and control. While veterinary services are available in the country and some basic vaccinations for disease prevention are being performed for farm animals, most of other diseases need proper prevention, detection and control.

Improvement or change of breeds is another outstanding issue ***in large and small ruminant subsector***, as well as in ***fish farming***. In large ruminant subsector, even the breed Caucasian Brown which is so well adapted to the local conditions, has lost its former qualities. Even if artificial insemination service is available to ensure the maintenance of the breed qualities not all farmers are preferring this method and, as a result, year after year this breed is losing its qualities. The farmers are resistant to purchasing new breeds due to high investment costs both in purchasing those breeds and their care. Here surely plays a big role the fact that the farmers are unable to do proper farm planning and cost-benefit analysis. In addition, the consultancy in the communities is mainly from the local veterinarian who themselves trust only traditional breeds and technologies and cannot properly consult for best decision making. Objectively though, introduction of new breeds does require certain preconditions in the farm, starting from the proper feeding ending with proper barn conditions /preferably smart barns/ and knowledge.

In the case of fish farming, the new breeds/types are required to ensure export opportunities. According to the interviewed fish farmers, the local breeds have very limited market, which is only within Armenia. For accessing international markets, there is a need to introduce new types like

catfish, which have high demand in western countries. Together with introduction of new breeds however, there is a need to introduce also the technologies for proper care.

Innovations applied in reproductive performance[9]

Effective use of dairy cattle herd management programs has many advantages for consumers, farmers and animals. Till 1980s livestock products demands have been met by breed substitution, cross-breeding, and within-breed selection. Nowadays techniques such as artificial insemination and more specific selection techniques are used for the higher rate of genetic gain in the livestock sector.

Automatic estrus detection

While the techniques of artificial insemination is not an innovation in animal husbandry, even for Armenia, there are innovations that can be used to enhance the efficiency of the techniques. It is estimated that 5–30% of the cows were not in or near estrus when inseminated.

Traditionally, estrus detection is performed by visual observation of the dairy herd. Nowadays, as a result of technical progress in monitoring cows using computers, automatic estrus detection has become possible through the following systems:

- ***Electronic system:*** an electronic device that detects cows that stand to be mounted by herd mate and provides a continuous monitoring of activity, radio-telemetry is a computerized estrus detection device.
- ***The voice identification processing:*** pressure sensitive device to detect estrus with over 94% accurately using simple microphone. Mounting and standing activity are effective methods for estrus detection. ***Pressure sensitive device*** is programmed when a certain number of valid mounts have been recorded a light give signals. ***Marking device*** is for detected standing estrus, leaving marks on her back and rump.

Pregnancy check

Pregnancy diagnosis is one of the most important factors to get ideal calving interval. The most common methods are rectal and trans-rectal ultrasonography of the reproductive tract. Both procedures require training and time. An experienced practitioner using ultrasound can reliably diagnose pregnancy from 30days' gestation whilst an experienced veterinary is able to diagnose pregnancy from 35 days. Enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA) or latex agglutination (LA) tests use either blood or milk to detect a marker of pregnancy. Wireless system designed to measure many characteristics of cows is also developed to detect early stage of pregnancy in multiple cows.

The ***smart barns*** - an innovative technology highly promoted within the government and various donor funded projects cannot be replicated, if on farm animal feed production will not become a common practice for farmers. Smart barns however allow to create ideal controlled environment for animal growth, where the risks related to diseases are minimal and the conditions for improved breeding are sufficient.

9 https://uknowledge.uky.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1052&context=animalsci_etds
https://www.researchgate.net/publication/281744144_Estrus_detection_tools_and_their_applicability_in_cattle_Recent_and_perspectival_situation

Smart barns, description and benefits[10]

Smart barn *is a* new technology providing a self-regulating, micro-climate controlled environment for optimal animal growth and production. New technological tools can monitor nearly every aspect of animal barn indoor environment. Incorporating the environment-sensing capability of wireless sensor networks into mobile monitoring systems can provide convenient control of the barn microclimate anywhere, anytime for more productive animal production. Environmental sensors and other control facilities of the barn is the first component of *the barn automation*.

Sensors that can be used in smart barns include temperature and relative humidity sensors; wind and rain sensors, airspeed sensors, carbon dioxide sensors, ammonia sensors and light sensors etc. These sensors and automation systems planned as a capable of recording and adapting to environmental conditions inside the barn. E.g. rain sensors can close the curtain to a predetermined height when it rains to keep moisture off cows and stalls. Digitally controlled LEDs can extend the day, supplementing sun in autumn and winter. As the cows like bright illumination in barns the automated system for ensuring equally bright illumination in the barn can improve the milk yield. Milk yield can decrease by about 10 % when temperature gets warmer than 25°C. At the same time, if the environmental factors, for example air quality, are poor, milk production and quality can be affected adversely.

Milking automation is another automated technology that should be used in a smart barn. An automatic milking system requires a completely different management system for milking, feeding, cow traffic, cow behavior and grazing. This system is also for safeguarding milk quality and animal health. With the development of intelligent milking systems, the use of sensors in the milking systems has become widespread.

The milking robots equipped with sensors to detect signs of mastitis which measure the many characteristics of the abnormal milk pH, Somatic cell count, milk acidity, milk conductivity etc. systems also can be regarded milking specifications of the system such as parlor performances, milking efficiency etc. Simple automatic cup removal devices monitor the milk flow rate from individual cows and at a threshold, the milking vacuum is shut off and the system is activated to withdraw the cups from the cow.

The cow-behavior observations through ***behavior meters*** installed in milking systems, enable animal welfare assessment in different environmental conditions and stressful situations, as well as reproductive and health status. There are a lot of sensors which are used for good quality milk productions. Faster results have been achieved with the use of microchip technologies. With microchip technologies, it is possible to diagnose more successful mastitis with more effective tests and results with wider angle, more accurate results. Automatic milking systems give complete information about milk production, milking speed, milk acidity, milk conductivity etc. new sensor added some other new component such as milk progesterone level, milk temperature etc. But radio-frequency identification provides more possibilities for improving the reliability of collecting data.

Sensors for Health observation

An animal disease has serious economic implications on farm productivity. The right time detects disease three to 5 days' sooner, ***reduces treatment costs, reduces mortality rates, improves production efficiency***. The production, product quality and composition, body condition, and behavior provide a good indication for the health status of animals. By closely monitoring normal pattern changes, the farmers ensure animal health status. To monitor the health conditions of each cow the sensors are mounted on the cow. Sensor networks consist of several tiny, low price devices and are logically self-organizing ad hoc systems. The role of the sensor network is monitoring the health parameters of animals, gathering and conveying the information to other sink nodes. Sensors that collect data such as temperature, pH, etc.

[10] http://agromshakuyt.card.am/%D5%AD%D5%A5%D5%AC%D5%A1%D6%81%D5%AB-%D5%A1%D5%B6%D5%A1%D5%BD%D5%B6%D5%A1%D5%B7%D5%A5%D5%B6%D6%84%D5%A5%D6%80/?fbclid=IwAR2rvs6r10yHtuOAv1c-pFIX0UeH8P_1hCq55lxGHtvrx2PCdOh4H-KgrdU
http://agromshakuyt.card.am/%D5%AD%D5%A5%D5%AC%D5%A1%D6%81%D5%AB-%D5%A1%D5%B6%D5%A1%D5%BD%D5%B6%D5%A1%D5%B7%D5%A5%D5%B6%D6%84%D5%A5%D6%80/?fbclid=IwAR2rvs6r10yHtuOAv1c-pFIX0UeH8P_1hCq55lxGHtvrx2PCdOh4H-KgrdU

Furthermore, behavioral measures, such as the occurrence of aggression or stereotypic behavior, are important indicators of welfare problems. Including behavioral-based welfare criteria which is essential for an overall welfare assessment.

Livestock monitoring platforms

CattleEye is an Irish company that has created the world's first autonomous livestock monitoring platform improving the lives of farmers and their livestock and revolutionizing the Protein Supply Chain. Its deep learning AI platform is designed to interpret visual imagery of livestock from web cameras and extract valuable insights about those cows.

Other and newer technologies used to detect, prevent and control diseases in animals are presented below.

Animal Health Start-ups and Emerging Agriculture technologies[11]

Non-antibiotic treatment for bovine mastitis using acoustic pulse technology (APT). Mastitis causes annual losses of over $6 billion in the US and Europe. Infected cows treated with APT have shown 70% cure rates and consequently 10% increase in milk yield. Implementing APT increases farmer profitability, improving herd health and cow welfare.

Cellbots and antimicrobial probiotics eliminate harmful pathogens in livestock, enable the production of safe food, and reduce the current dependency on antibiotics. These advanced probiotics are engineered using synthetic biology and artificial intelligence.

A unique wireless IoT real-time water *control management system* is already in use in the Netherlands for dairy and beef cattle. The quality and quantity of the cattle drinking water is checked in real-time, 24/7, for pollution and possible malfunctions in the water supply. The data obtained by the system directly contributes to animal welfare, milk and meat production.

A smart monitoring system called Moonsyst is designed for progressive dairy and beef farmers. It collects different parameters of the livestock, helping farmers with real-time data to increase productivity and detect disease, stress and heat.

FarrPro company was founded to change the way the world rears pork. Its Haven platform ***reduces piglet mortality, saves energy and improves sow welfare*** by creating ***a microclimate environment*** for piglets to stay safe, warm and healthy. The Haven is the first milestone on FarrPro's roadmap to bring traceability and automation to the pork industry; providing the insight and control required to prevent disease outbreaks, rapidly develop vaccines and safeguard the pork supply chain.

SwineTech is an animal health company that leverages voice recognition and computer vision to assist in bringing ***automation and traceability to the pork industry***. Their product, SmartGuard, provides the automation necessary to more successfully ***prevent piglet deaths from crushing and starvation, track and facilitate obstetrical assistance, and record important biometric and production information***.

Lack of access to slaughterhouse services, have negative impact on Large and Small ruminant farms and piggeries. The inconveniences related to these services as defined by the interviewees, are the following:

- Service providers are very often located very far from the farms and transporting animals to these locations are risky due to the bad infrastructure;
- Some slaughterhouses are certified as "Halal" and therefore farmers who have to slaughter pigs and big or small ruminants (which very often is the case), can only get the service for the big or small ruminants and for pigs, they have to find another solution.

[11] https://moonsyst.com/home
https://www.thepoultrysite.com/news/2020/01/13-ag-tech-innovators-transforming-livestock-production

- Slaughterhouses are expensive as they charge not only the service fee, but also require to leave some parts of the slaughtered animal in the slaughterhouse (i.e. skin, head, internal organs, blood, etc.).
- The farmers cannot follow the slaughtering process so cannot be sure that the animal slaughtered is their own.

All the above-mentioned gaps in the subsectors are **hampering factors for the innovations** which are being promoted by various state and donor funded projects in the country. E.g., ***the livestock registration and marking system,*** which by itself is very important system to monitor and improve the efficiency in the sub-sector of large and small ruminants, cannot be fully implemented if the slaughterhouse services will not be fully available and accessible for farmers. In its turn if the livestock marking system will not be implemented then proper control over vaccinations, treatments cannot be effective. For the slaughterhouse services to become a widely-used practice, it will take investments from private service providers, awareness raising among farmers and strict control and legal enforcements.

Livestock Electronic Identification

Electronic Identification
There are numerous animal ID technologies available to livestock producers. Radio frequency identification (RFID) devices have an electronic number that is unique for an individual animal and link that animal to the database. Electronic ear tags, injectable transponders and boluses with a transponder, inside in the reticulum are the latest technology for animal identification technology. These systems work using radio frequency for sending data. These technologies (implants, ear tags, and rumen boluses) are available on the market for cattle farmers. All these devices have special chip system for sending data for the base computer for evaluation. Some electronic tags have reader which can receive and store the required data for evaluation. Some systems even use electronic scales, which may be justified to determine body condition score automatically. An easy and powerful electronic weighing system that accurately measures cattle weight, allows farmers to monitor cattle performance easily and continuously.

Beekeeping

Analysis of data received from interviews with beekeepers and experts as well as from focus group discussions revealed that there are some specific challenges related to this subsector. These challenges are:

1. ***Access to markets***: Most of the beekeepers traditionally sell their honey to their extended family members and friends, right after extraction. Few of them look for alternative sales opportunities, e.g. through specialized shops located in capital Yerevan, through exporters, etc. few of them even are aware of these opportunities. The exporters in their turn have difficulties in obtaining the amount of honey needed for exports. This is mainly because of the fact that the farmers keep as many beehives as they are sure they can sell with their own already established channels and do not increase the production volumes even if there are all necessary conditions for that.

2. ***Post-harvest management:*** Usual practice for beekeepers is to extract the honey, store that in proper 10kg stainless steel tanks and sell in 1-3kg tanks right after the extraction. Many of the beekeepers will not have any stored honey within 2-3 months after extraction. This does not mean that these beekeepers have no challenges in sales. The problem is that they are too dependent on their families and friends who purchase the produce and in years where there is extraordinary high yield, the honey remains stored for long. The honey is usually sold to local candy stores at a very low price or getting spoiled. In the non-sufficient for beekeeping year, the beekeeper might lose his loyal customers who will find alternative supplier and if the experience is good that the customer can be lost.
3. ***Cost of Production:*** Cost of production of honey in Armenia is very high as compared to the honey sold in the supermarkets of Europe, USA, Russia, etc. This is due to the fact, that unlike in other countries the beekeeping is not part of a farm specialized in a fruit production and the main reason for beekeeping is not pollination of the orchards but the honey production itself. The beekeepers transport the beehives during the year many times for the best harvesting areas for bees for the particular costs. The beekeepers sometimes even have to pay for the beehives to be put in a clean environment, unlike in many countries where the beekeepers are actually being paid for putting beehives in the orchard during pollination season.
4. ***Product specifications:*** The honey produced in Armenia is poliflower. It is a high-quality product, but its taste cannot be maintained from one year to another, and therefore, this honey is very hard to position in the market unlike monoflower honey.
5. ***Harvesting places for bees:*** The beekeepers, especially the organic ones, have challenges related to choosing proper place for bees to harvest safely, i.e. away from the sprayed orchards, away from mines and other polluted areas.
6. ***Lack of diversification of beekeeping products:*** Because of all abovementioned challenges, Armenian honey is very hard to position in the international markets. The interviewees also mention that many other beekeeping products are well demanded internationally there is no developed practice of producing other beekeeping products. These products can include pollen, propolis, bee poison, dead bee bodies, honey wine etc. Beekeeping is also rarely combined with service provision, such as tourism or apiculture, which actually could create an alternative market for selling the produced beekeeping products.
7. ***Availability of inputs:*** The inputs for beekeeping are mainly available and accessible for beekeepers as was stated during the focus group discussion. There are two main problems associated with inputs:
    a. The medications against diseases are not diverse, and when the bees become used to the preparate then controlling the diseases becomes challenging.
    b. Organic inputs, such as certified organic beeswax is not available in the country.

Traditionally women are not much involved in the subsector. If in case of cattle breeding and the crop production women have their defined roles especially in harvesting and processing, here processing of honey products is carried out only by few farmers and companies, and harvesting is a job requiring lifting heavy tanks etc. In beekeeping women are more in supporting roles.

Nevertheless, in many bee farms women take organizational roles, are active in selling the products, and are open to learn new technologies in beekeeping and processing of beekeeping products.

The focus group discussion on beekeeping also revealed the following tendency in the sector: with the increase of number of companies which are ready to purchase honey from farmers for processing and for exports, as well as the existence of newly opened specialized shops in the capital city, motivates youth to be involved in honey production. Women also are increasingly more interested to get involved and develop practices like provision of apitherapy services in tourists as a form of agrotourism, implementing organic and green technologies, modernizing the beekeeping practices to make it a pleasant business.

One innovation, which is introduced with young women in beekeeping in the country, is using lightweight beehives. This did not become a common practice in Armenia yet, therefore can be considered as an innovative solution for simplification of the hard work associated with heavy weight of wooden beehives.

Application of lightweight beehives[12]

Polystyrene hives
These are lightweight beehive is a result of 35-year beekeeping experience of the biggest honey producer in Scandinavia, Finland.
The beehive of food grade, extra hardened, expanded polystyrene (EPS) with a density over 100 kg/m3 which can survive winter colder than -35 C and in summer heat over + 30 C and in case of proper use and service is made can serve for decades. The insulation provided by the **polystyrene** keeps the internal hive temperature far more constant than with wood. It shields the bees from the worst of the heat during the summer, so the bees spend less time and energy keeping the hive cool, and more time collecting honey.

Another innovation that is introduced in Armenia as a form of diversifying the beekeeping products is production of venom without actually harming the bees. This is the first trial in the country and the technology however is being used already in other countries.

Introduction of new beekeeping products[13]

Extracting bee venom without harming the bees.
Bee venom is extracted through a unique and patented method developed by New Zealand scientists. Bee venom is produced in the venom gland of the bee, and is stored in an adjacent sac in the bee's abdomen. The amount of venom a bee has depends on age. Newly hatched bees don't have any venom at all, but the amount increases rapidly for the first two weeks of a worker bee's life, reaching a plateau of about 0.3 mg (dry weight).
New Zealand scientists have invented a collection device for venom that doesn't kill the bees. The device consists of a glass sheet placed on the bottom of the beehive. The glass sheet conducts a gentle electric current. When the current is turned on, bees that are on the sheet automatically stick out their stingers, and the action of the muscles pushing the stinger also pumps a small amount of venom out the end of the sting. This venom falls on the glass where it is collected and purified for storage, and freeze-dried to ensure that the venom's bioactive materials are not degraded. It takes one million sting deposits on a collector board to make 1 gram of dry venom.

[12] https://www.blueskybeesupply.com/polystyrene-hives-components/
[13] https://www.korunaturals.com/blog/extracting-bee-venom-without-harming-bees/

Some other innovations in beekeeping sector used by beekeeping companies worldwide are provided below.

Other innovative technologies in beekeeping[14]

Physical sensors that track within the hive. It collects and stores data such as weight and temperature on a preset schedule. This data then is sent to consultants who can generate reports and aid the beekeeper in tracking progress. Another ***sensor product*** attached to the side of the beehives can monitor the sounds in the hives. It uses ***artificial intelligence*** to detect issues like missing queens, swarming and parasites. The sensor also monitors temperature, humidity and barometric pressure around the beehive.
Macedonian Honey (North Macedonia) creates its own technologies to fight against pests, diseases and bee mortality. It developed a new beehive Elle-Hive, which keeps the smell and warmth. The bees grown in Elle Hive, become stronger and their genetic material allows future generations to combat predators better.

Rabbit Farms

Investments in ***rabbit farms*** according to the interviewed specialists have a very short payback period, it is a very pro-poor value chain, does not require much investments and does not depend much on community assets like pastures, irrigation infrastructures etc. one can build rabbit farm in most remote area right next to their house or in a garage, or even build a small moveable construction in the backyard of the house. It is highly recommended to target remote areas for promoting innovative technologies. Women, men, youth, vulnerable families and all those who want can be involved and benefit from this economic opportunity. For rabbit farms to succeed the farmer needs to create the ***right microclimate*** in the cages, which is easy as rabbit does not require big space and the cages are really small, and to make sure that the ***vaccinations*** are carried out on a timely manner. Rabbit farms are just becoming popular in the country and the use of rabbit manure is not in practice yet. Few knows about the benefits or rabbit manure and its use. Therefore, in rabbit farming, as innovative technology the use of rabbit manure is suggested by the field experts.

Rabbit manure benefits and use[15]

Facts about rabbit manure:

1. Rabbit manure has four times more nutrients than cow or horse manure and is twice as rich as chicken manure. Cow, horse and chicken manure are considered “hot” and need to be composted (well-rotted) to use as fertilizers while rabbit manure doesn’t need to be composted.
2. Rabbit manure is organic matter and improves poor soil structure, drainage and moisture retention.
3. It improves the life cycle of microorganisms in the soil.
4. It is not as smelly as other manures and is easy to handle.
5. Rabbit manure is packed with nitrogen, phosphorus, potassium, minerals and micronutrients. It contains beneficial trace elements such as calcium, magnesium, boron, zinc, manganese, sulfur, copper and cobalt, just to name a few.

[14] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7248914/
[15] https://www.finegardening.com/article/rabbit-manure-in-the-garden

- ***Nitrogen (N).*** Rabbit manure is higher in nitrogen than sheep, goat, chicken, cow or horse manure.
- ***Phosphorus (P).*** Rabbit manure is also higher in phosphorus than the other manures.
- ***Potassium (K).*** Potassium helps with fruit quality and reduces disease; plants will not grow without it.

6. One doe and her offspring can produce a ton of manure in one year.

The use of rabbit manure:

- ***Without any treatment*** – Rabbit manure is dry, odorless, and in pellet form which makes it suitable for direct use in an orchard. Because it is considered a cold manure there is no threat of burning plants and roots.
- ***Composted*** - Composting rabbit manure is an easy process and the end result will be ideal fertilizer for garden plants and crops. In the compost bin or pile manure, dry straw or shaving should be mixed in equal amounts. It can also be mixed in usually composted materials such as grass clippings, leaves, kitchen scraps etc. Also, the poop/urine/shaving mix is the best compost activator.
- ***Manure Tea*** - Rabbit manure tea is the colored water that manure has been steeped in and is full of nutrients making a concentrated liquid organic fertilizer.
- ***Growing worms***- The worms can be grown and raised directly in the rabbit droppings under cages, or hutches. Rabbit manure along with wasted feed makes some of the best worm feed. Although fresh rabbit manure is considered one of the best organic garden fertilizers it is also the best worm feed and bedding.
- ***Making Methane*** - Biogas plant from rabbit manure is another innovative technology that can be considered by larger rabbit farms.

Livestock production needs to be more sustainable and productive at the same time being profitable. Modern and innovative animal equipment and technologies are key components of the solution for livestock farmers to overcome existing challenges in the sector.

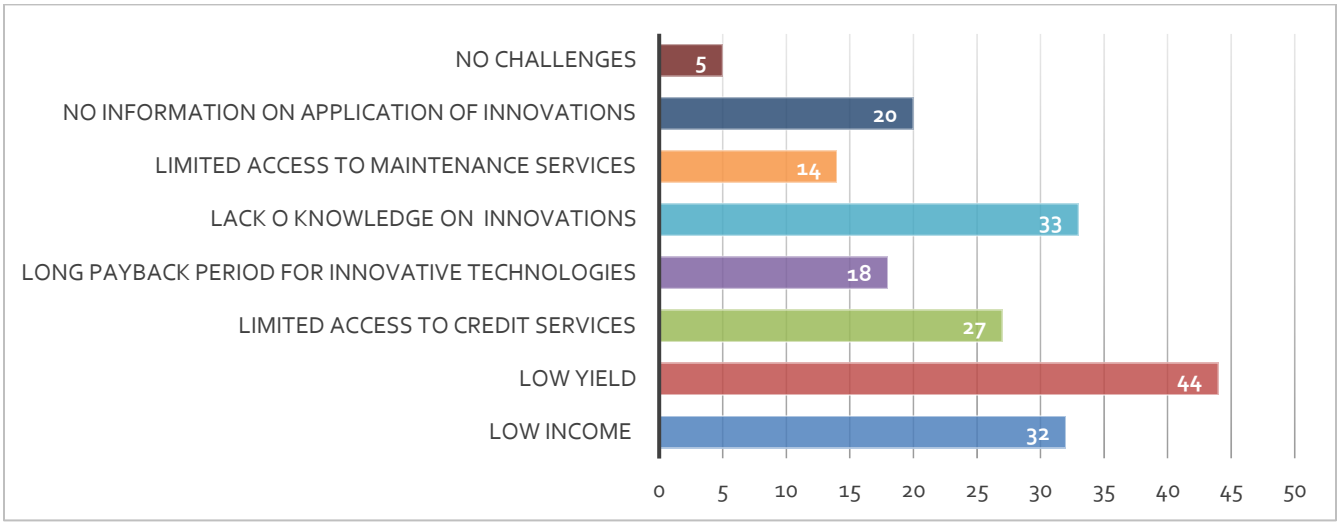
Technology is developing rapidly. Many technologic equipment and tools have made animal husbandry easier and comfortable worldwide leading to increased animal production, efficiency and profitability. To be successful in the livestock sector farmers should rapidly adapt their infrastructures to exploit changes in technology for better production. Today livestock farmers increasingly use robots on production, algorithms and sensors to optimize their farm management decisions. The main technologies are electronic recording, milking, heat detection auto-weighing, auto-drafting, genetic improvement, feeding, barn optimization, and health monitoring, livestock housing and equipment designs. The new technology especially in livestock means producers can work easier and improve cattle welfare, production efficiency, and profitability. The use of such advanced technological solutions goes in parallel with increased number of cattle per farm and enhanced productivity of breeds. Usually small-scale farmers bypassed the computer and internet use technology because of its cost and their lack of knowledge. Meanwhile there are several reasons that limit using computer and internet:

- high financial cost,
- difficulties to use technology,
- loss of knowledge to economic benefits,
- hesitate to use new technologies,
- lack of education,

- strict personality,
- poor infrastructure,
- lack of personal experience and not enough time to spend.

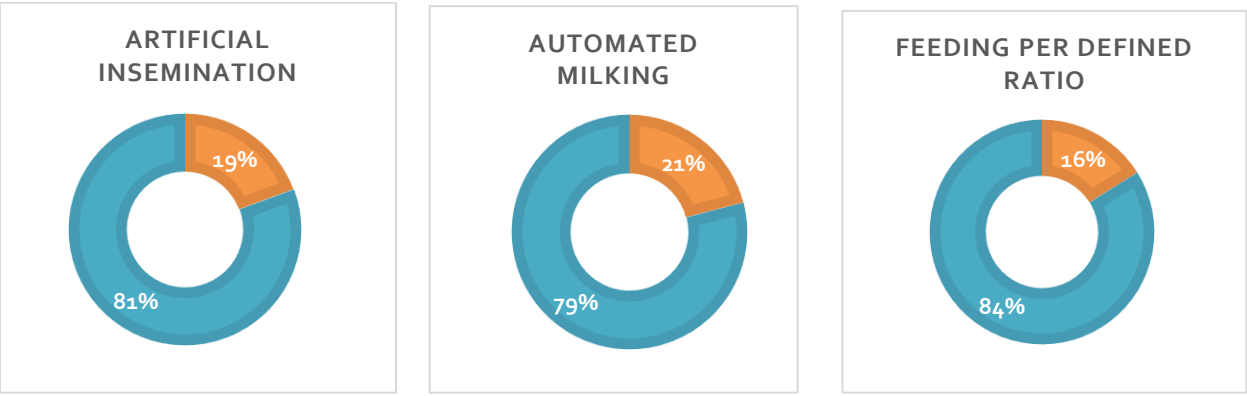
The survey results reveal the main challenges hampering the application of innovative technologies in Animal husbandry. The results are summarized in the chart 17 below.

Chart 17. Challenges for application of innovative technologies



The survey results revealed that the rate of implementation for even the known good practices in the animal husbandry is quite low. E.g. automated milking is used by only 21% of farmers, 16% use feeding per defined ratio (non-automated), 19% stated to be using artificial insemination.

Chart 18. Application rate for good practices in animal husbandry



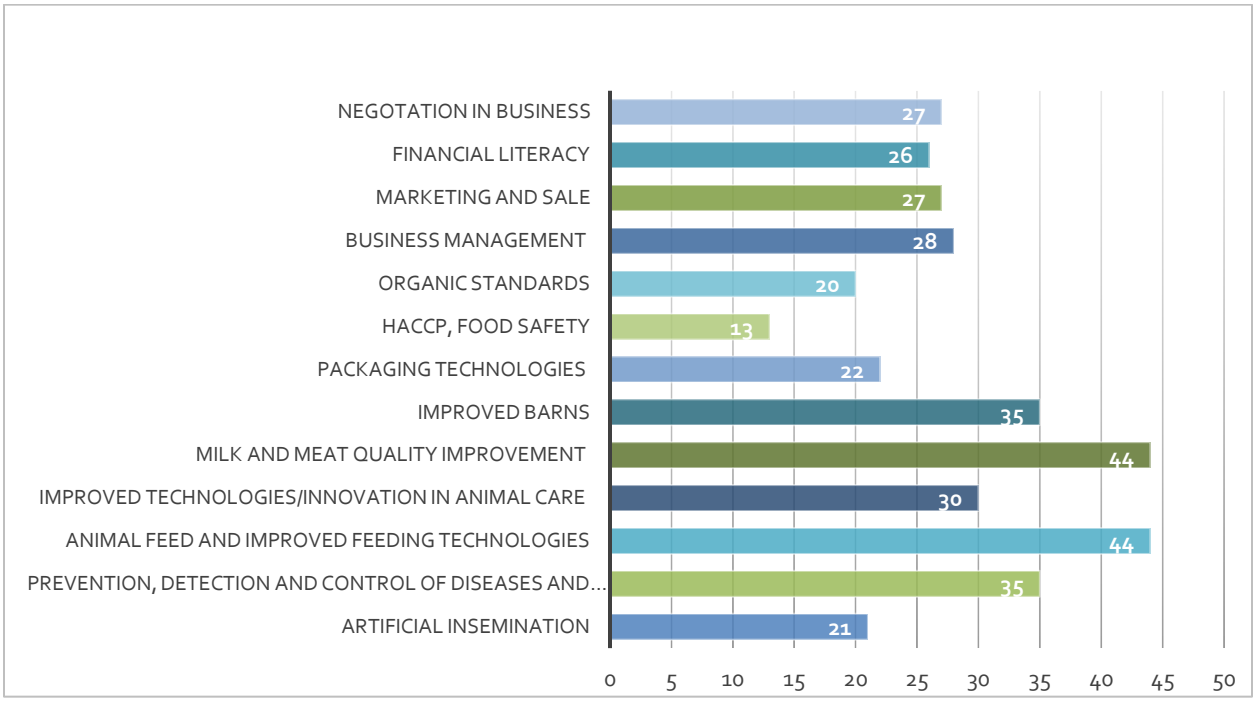
Best practices in animal husbandry to be promoted

Management Area	Good Agricultural Practices/Innovations
Modern and animal-friendly stables	Housing systems for different animal types depending on their stage of life Proper stable dimensions/sizes for different animal types depending on their stage of life Improvement of air movement/conditioning in the stables Improvement of lightning in the stables Types of underlay in the stables Improvement of manure-removing system in the stables Proper equipment and technique to improve milk quality (i.e. milking machines, development milking parlors, milk collection points, etc.) Use of Artificial insemination IT solutions for improved animal care (i.e. to collect info on health status, grazing location, productivity measures, tracking health care treatment activities, etc.)
Animal Feeding	Developing balanced feed ratios for different animal types depending on their stage of life Production of forages and silage Implementation of rotational grazing Improvement quality of natural feeding landscapes Hydroponic fodder production

Capacity building topics and recommended geographical coverage for trainings in animal husbandry

The in-depth interviews with farmers and field experts revealed the topics for trainings to be conducted for farmers in animal husbandry. To verify the interest of farmers towards the training topics defined by the interviewees, the relevant question was included in the on-line survey tool. The results are summarized in the Chart # 17 below.

Chart 19. Training topics for farmers in animal husbandry



Target Marzes for trainings in animal husbandry

When recommending on target marzes for conducting capacity building and promoting innovations in selected subsectors of animal husbandry, first of all the production volumes are considered. Other factors that can influence the choice of the target Marz may include but not limited to: number of farmers involved in animal husbandry, openness of farmers for change and innovations, replication potential, market demand and opportunities etc. Table 2 below summarizes the number of animals in small and large ruminants and pig building subsectors.

Table 2. Animal head in Marzes for each subsector, year 2020[16]

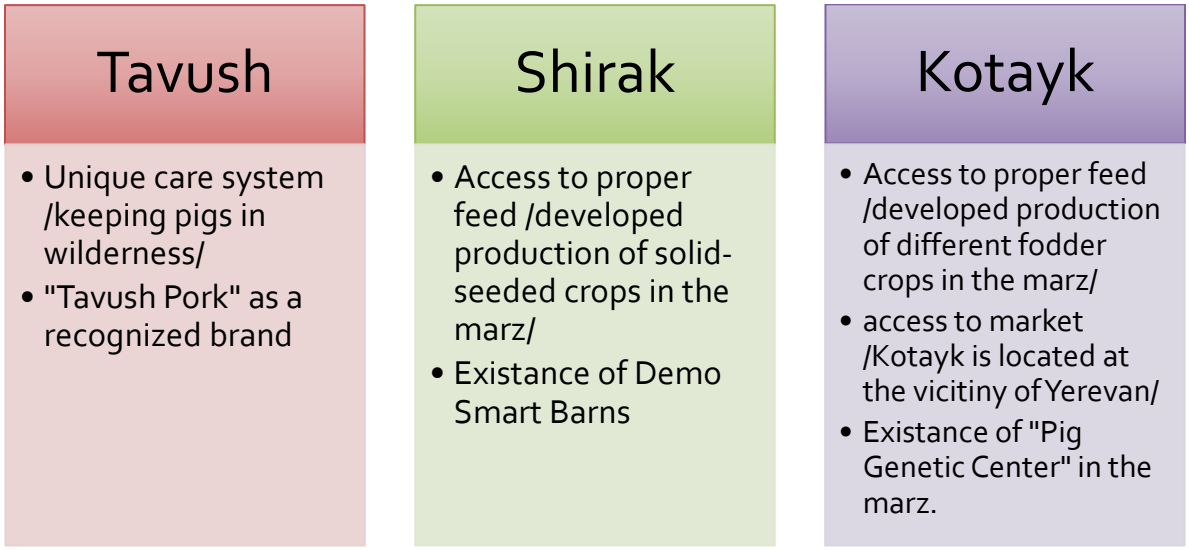
Marz	Large ruminants	Small ruminants	Pigs
1. Ararat	45,367	100,480	21,650
2. Armavir	57,583	140,245	21,367
3. Aragatsotn	71,554	87,761	15,557
4. Gegharkunik	103,019	110,276	17,009
5. Shirak	90,879	74,986	18,904
6. Lori	78,168	29,252	13,738
7. Kotayk	54,292	44,403	28,446
8. Vayots Dzor	21,247	15,913	4,008
9. Tavush	35,427	15,921	19,118
10. Syunik	52,350	93,023	11,429

Gegharkunik, Shirak, Lori and Aragatsotn Marzes are leading in Large ruminants' subsector of animal husbandry. For small ruminants, the leading Marzes are Armavir, Gegharkunik and Ararat. In pig building Kotayk, Ararat, Armavir and Tavush Marzes are mostly advanced. While Tavush marz is only the 4th in the list in terms of number of pig heads in the area, this Marz is worth to be considered for capacity building and promotion of innovative technologies as this area is a recognized geographical brand on pig-breeding in the country. The same way Lori Marz is not leading in the number of cattle, but the area is very famous with its processors which do create a demand for milk, therefore the cattle farmers are very motivated to enhance the size and productivity of their cattle business.

During the validation workshop the work group discussed pig sub-sector and defined the Marzes where this sub-sector has the most potential for growth. Existing preconditions for the sector development for each Marz were identified. The results are summarized in the chart below.

[16] www.armstat.am

Figure 6. Recommended Marzes for promotion of piggeries



As for the capacity building in rabbit farms, beekeeping and fisheries it is worth to target the whole country. The justification for that is rabbit farms and beekeeping are both pro-poor subsectors and there are no strict natural-climatic conditions as a precondition for development of these subsectors. Anyone can be involved. Both of the subsectors if managed well can contribute to the developments of crop production sectors in the country.

7. GOOD PRACTICES AND INNOVATIVE APPLICATIONS IN PROCESSING

Under the agriculture processing sector, 2 main subsectors were analyzed:

- ✓ ***Fruit processing***
- ✓ ***Production of Herbal Tea***

In Armenia, particularly in the areas where fruit growing well developed (i.e. Armavir, Ararat marzes, Meghry sub-region, etc.) drying industry is one of the promising and stably developing sectors of agriculture. In recent years, number of fruit driers are increasing and entire communities are specializing in this activity. Mostly drying facilities located in the areas where the raw material is available. It significantly contributes to the increase of orchard areas and the farmers are increasingly choosing varieties suitable for drying. Fruit drying industry is quite profitable and "zero-waste" production, where everything is processed (including fruit skin, stone, etc.). In Armenia, at the initial stages, this business is non-registered family business (where all the family members are involved) but after 2-3 year, when the production reaches to commercial levels, the agribusiness is usually registered as a legal entity with permit of involving workers. In parallel with the increase of number of processors, number of middlemen and buyers, exporters, sellers are increasing.

Drying process is taken care in warm and windy natural conditions or in the fruit dryer machines. These machines help to diversify assortment of dried fruits. Farmers start drying apple and pear which when ripen to an extent suitable for drying rainy and cold season start, and the drying naturally becomes close to impossible.

Gradually processing facilities are developing and even the small and medium producers are investing in new facilities for collecting, sorting, washing, drying, cold storing and packing. Availability of storing capacities (cold storages) are essential for collection raw material and storage of final product.

In general, agripreneurs start drying business/process in their own areas with the limited amount of money and with the advisory support from their relatives, neighbors or other lead processors. Internet and donor funded projects are the only sources for information. Support provided by donor organizations is quite helpful in terms of implementation of innovative equipment and technologies, as well as participation in fairs, exhibitions and experience exchange visits are useful to improve capacities and skills on improved production and processing, to develop contacts, increase orders, understand gaps/weaknesses of the product.

Despite the developments in this subsector, the interviewees have defined the following critical factors hampering the development of the small-scale processing as follows:

- Limited access to raw materials
- Challenges in finding quality labor force
- Almost no access to consulting services

- Limited access to post-harvest infrastructures
- Lack of food safety standards in the production sites
- Barriers in linking with markets

Limited access to raw materials is hampering factor in both fruit and herb processing. The mechanization level of the fruit production is low which influences the cost of raw material. Better quality yield farmers prefer to sell fresh in the market. Processors are readily paying higher price for the better-quality raw material, which is the key to get the best final product; but even in this case the availability of fruit varieties suitable for drying is very limited. Another challenge is due to the fact that the dried fruit producers are unable to find standard quality raw material with required quantities, which would ensure standard quality of produced dried fruits and thus manage the expectations of the customers. The problems are similar to herb supplies. Most part of the herbs for herb tea production comes from wild collection. There are very few farmers who actually produce herbs for tea production. While the aromatic herbs from wilderness are very suitable for high value tea production with very small quantities for niche markets, for larger quantities and for serving larger international markets with standard high-quality products the tea producers need to find farmers who actually cultivate herbs for tea.

Challenges in finding quality labor force: Drying industry is labor intensive, most of the activities are carried out by hand. Labor is quite expensive in the country and despite high unemployment in the rural areas, most of the processors´ state that access to qualified and required number of workers is a serious issue during the drying season. It is worth to mention though that processing of fruits and herbs mostly requires women workforce and any capacity building related to technical skills to be used in these sub-sectors can be directed mostly on women and will have direct positive impact both on economic benefits of women and for the development of the sub-sectors in general.

Almost no access to consulting service: Drying is a process which requires continuous experimenting, especially in Armenia where there are no consulting services available in fruit or herb drying. Most processors learn based on their own experience and very often bear losses. Lack of information on drying technologies and appropriate equipment hampering application of new technologies. Each fruit type or variety requires different approach and technology for drying, which processors and their staff need to learn from other producers or based on their experience. New and innovative equipment/machinery are expensive for start-ups and small processors. And even if accessible, each new equipment also needs testing for all types of fruits and herbs. There is always a need for trainings, capacity improvement for the dried fruit and herb tea producers. In herb tea production the training is also crucial for wild collectors. First of all, this is needed for wild collectors will not destroy the population of the herbs during the industrial collection. Secondly it is crucial both for consumers' rights protection and producers' economic benefits that the wild collectors learn to recognize the types and verities of the herbs to be collected. Unfortunately, even these trainings are carried out mainly by the producers of herb tea, as there are no high-class experts that can be involved as consultants in the process.

Lack of food safety standards in the production sites: There is no strict control over production processes in the country. None of the processors set and are following the standards like ISSO, HACCP. At the same time, it is costly and requires additional investments from the processors,

while not in all the export markets require adoption of these standards. The main market for the dried fruit exporters is Russia, where there is no request for the quality standards. At the same time, in case of shift to another market or if the use of these food safety standards would be obligatory in current target markets probably only few processors will survive.

Limited access to post-harvest infrastructures is another problem in the country for this sector. Even if proper production conditions are ensured and all agro technologies are kept for producing fruits for drying and herbs for tea production, lack of cold storing and packaging infrastructures can really result in reduced shelf life and loss of huge amounts of ready products. Even though investment in these facilities is increasing the situation is still far from ideal. Many start-ups and small processors bear losses because of limited access to post harvest infrastructures.

Barriers in linking with markets: This challenge has 2 aspects:

1. ***Ability to serve markets:*** Very often, larger producers which have good links in Russia, Europe, US or in another foreign country get order for large quantities of produce which these producers cannot serve due to the absence of required quantities of standard quality raw material to produce required minimum quantities. This statement is true both for dried fruit and herb tea production.
2. ***Language barriers and lack of business and marketing skills of producers.*** Because of the language barriers the producers cannot even understand the request of an international buyer which finds the producer in a business directory and wants to place an order. Lack of business and marketing skills is a very common issue as the producers mostly do not know where to look for business opportunities and how to create business links or how to serve these links, etc.

In the fruit drying industry use of innovative technologies are important to improve product quality, reduce dependence on labor and decrease production costs. The interviewees mainly mentioned very simple technologies that are widespread in other countries but are rarely used in Armenia due to the absence of the readily available equipment in the shops, high costs of those equipment and also simply because of the lack of such information on the modern equipment. The innovative technologies as suggested by the interviewed processors and experts are listed below:

- **Use of appropriate equipment and machinery** (for washing, pealing of raw material, stone removing, juice squeezing, ventilators for sun drying, packing equipment etc.) is essential to decrease production costs and labor use. The equipment helps to increase efficiency, save labor and get better quality product in terms of cleanliness, shape, laboratory parameters.
- **Use of solar panels** will significantly decrease production costs (especially in the communities with no gas supply). Main operations consuming electricity are drying machines, cold store as well as heating (during winter time). In Ararat valley **drying machines** used to dry apple and pear (when rains are frequent and sunny days are scarce) or other fruits in non-favorable weather conditions.
- ***Products' diversification.*** In a market, there is a high demand for **sublimated fruits** (it is shock freezing process followed by quick drying in vacuum). But the proper equipment is

quite expensive and non-reachable for the small processors. Another alternative option could be considered production of ***fruit and vegetable chips***. Especially this solution is important for the kids to improve their feed ratio.

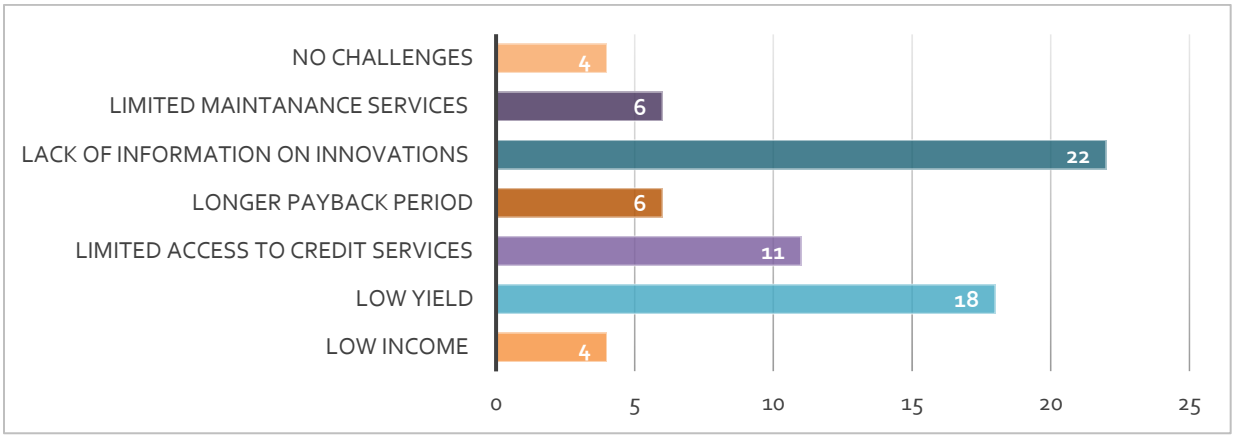
Advanced technologies in fruit processing and herb tea production[17]

Artificial intelligence (AI) technologies have been widely used to solve problems of nonlinear function approximation, pattern detection, data interpretation, optimization, simulation, diagnosis, control, data sorting, clustering, and noise reduction in different food drying technologies due to the advantages of self-learning ability, adaptive ability, strong fault tolerance and high degree robustness to map the nonlinear structures of arbitrarily complex and dynamic phenomena. The application of high-efficiency physical fields such as microwave, radio frequency, infrared radiation and ultrasonic fields can result in efficient production of dried fruit and vegetable products with high quality. The application of high efficiency physical field in the drying process of fruits and vegetables can solve the problems of large energy consumption, uneven drying, poor sensory evaluation, and large nutrient loss. The drying process and the corresponding drying model of fruits and vegetables can be detected and controlled online, and the optimum drying scheme can be determined using artificial intelligence technology. The most important thing is to make up for the shortcomings of highly efficient physical field drying of fruits and vegetables. The artificial intelligence technology has a promising application prospect to assist the efficient physical field drying of fruits and vegetables.

Smart packaging of fresh produce is an emerging technology toward reduction of waste and preservation of consumer health and safety. Smart packaging systems also help to prolong the shelf life of perishable foods during transport and mass storage, which are difficult to regulate otherwise. The use of these ever-progressing technologies in the packaging of fruits has the potential to result in many positive consequences, including improved fruit quality, reduced waste, and associated improved public health. In smart packaging ***Freshness sensors or indicators*** are used that can sense and inform about the quality of fruits in terms of their freshness level, ripeness, or firmness. Therefore, fruit freshness sensors are on-package indicators that monitors the environment inside or outside the package and allow consumers to make informed decisions about the quality of the fruits.

The survey revealed main challenges for producers in adopting innovative technologies in processing of fruits and herbs. Challenges as defined by the respondents are summarized in the chart below.

Chart 20. Factors hindering implementation of innovative technologies in processing



[17] https://www.intellias.com/artificial-intelligence-in-agriculture/
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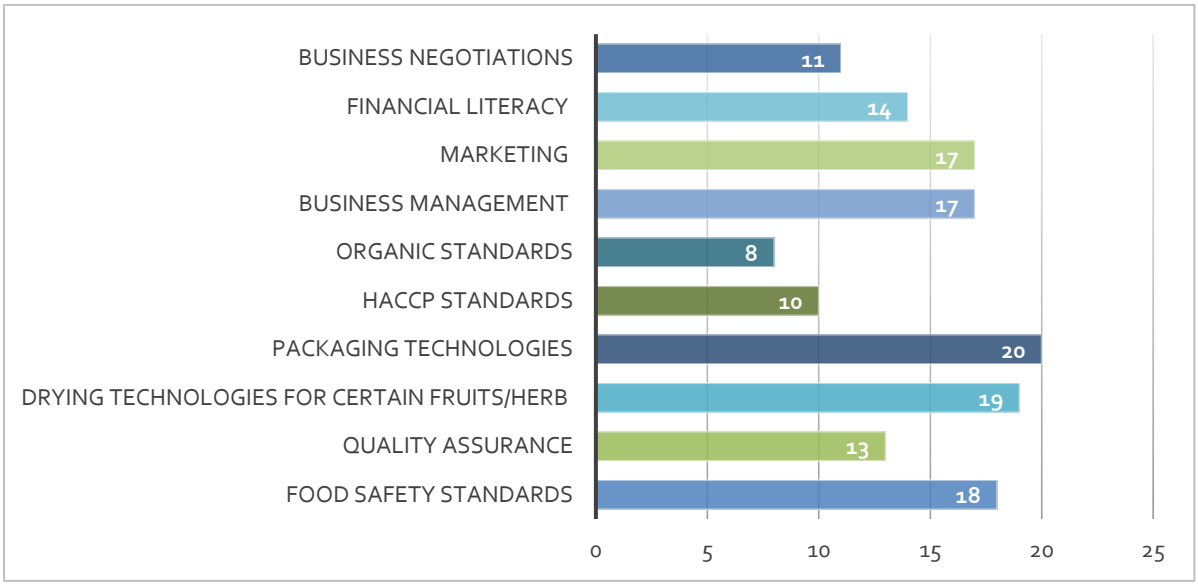
Capacity building topics and recommended geographical coverage for trainings in processing

The in-depth interviews with farmers and field experts revealed the topics for trainings to be conducted for agribusinesses in dried fruits and herb tea. To verify the interest of farmers towards the training topics defined by the interviewees, the relevant question was included in the on-line survey tool. The results are summarized in the Chart # 19 below.

Chart 21. Training topics for agribusinesses in fruit and herb processing



Naturally the fruit and herb drying agribusinesses are mostly being established in those Marzes where there is available raw material. For fruits, the leading Marzes are Armavir, Ararat, Aragatsotn and Kotayk and for herbs the usually mountainous and forest areas are considered perfect for wild collection, i.e. Syunik, Vayots Dzor Tavush and Lori. For dried fruit production it is also worth to consider Meghri sub-region of Syunik Marz together with low altitude areas of Marz, from where comes fig and persimmon dried fruit varieties. Because in Tavush Marz persimmon ripens in a rain season, there is an established cooperation between Meghri and Tavush Marzes where the processing agribusinesses purchase persimmon from Tavush and process in Meghri. Despite the distance between the Marzes the cooperation is beneficial as this dried fruit variety is quite highly priced in the market.

8. SUMMARY - FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The assessment looked at pre-selected sub-sectors in 3 main agriculture sectors: crop production, animal husbandry and processing. The gaps and challenges of agriculture sector as well as sector specific challenges for each mentioned sector were revealed and innovative solutions to the identified issues were suggested. Particular attention was given to revealing the needs of women

in ensuring better access to agricultural innovations and identifying the solutions which could enhance women economic roles in the pre-selected sub-sectors. Based on the research results, the application of new context-relevant technologies and innovations to increase agricultural productivity with a focus on female entrepreneurs and farmers were highlighted and topics for capacity building initiatives were suggested to support adoption of the innovative technologies throughout the country.

Below are the summary challenges in agriculture sector as defined by the interviewed agriculture experts and state officials.

1. **Limited access to inputs:** on one hand farmers from the remote areas have limited access to agricultural inputs because he specialized shops are either in capital city Yerevan or in Marz centers which can sometimes be hundreds of kilometers away from the community through bumpy roads; on the other hands the limited demand of agriculture inputs in remote communities make the input supply business unprofitable and therefore the input suppliers prefer to establish their shops in the Matz centers or in Yerevan where there can be high turnover.

2. **Limited access to modern machinery and equipment:** worn out, and highly inefficient machinery and equipment, requiring high maintenance costs are still commonly used in the sector and there are challenges for farmers to modernize those
   - High costs of modern machinery and equipment as compared to small sizes of farms and low productivity.
   - Lack of information on benefits of modern machinery and equipment vs. required investments in them.
   - Lack of cooperation culture among small farmers in the communities which could solve the issue of access to modern technologies.

3. **Resistance for application of innovative technologies, solutions and practices**
   - Lack of understanding of innovative technologies.
   - Lack of access to information on modern technologies and insufficient promotion of those technologies.
   - Failed trials and demonstration efforts demotivating further replication of the technologies
   - Slow replication of demonstrated innovative technologies
   - Lack of access to modern machinery and equipment, which in some cases is a key precondition for application of innovative technologies.

4. **Expertise and Consulting Services:** On one hand the farmers and small agribusinesses are not used to pay for consulting services, on the other hand in many agriculture subsectors professional expertise is simply not available. Internet sources, demo plots and embedded consulting services from input sully shops are the channels where the farmers are usually

seeking consulting services. All of these channels, however, have their serious limitations, especially when it comes to necessity in investing in expensive innovative technologies.

5. **Infrastructures:** The level of relevant infrastructures' development simply defines the viability of the sector. Worn out irrigation network, insufficient number of anti-hail nets and low efficiency of the existing ones; lack of agriculture product collection centers, poor condition of inter-village roads, issues related to storage and water stocks, low level of application of alternative energy sources, available of up-to- transportation network, etc. are all challenges hampering the development of agriculture sector in the country.

6. **Markets:** In almost all subsectors of agriculture the farmers and agribusinesses target either local or Russian Markets. Very often the markets targeted defined the quality of the supplied produce. These markets are less demanding than the European and USA markets, therefore the farmers and agribusinesses are not much motivated in adopting innovative technologies in the process and improving the quality of the produce.

The below sections present specific challenges revealed in each mentioned sector (crop production, animal husbandry and processing) and suggested innovative solutions to the identified issues. Particular attention was given to revealing the needs of women in ensuring better access to agricultural innovations and identifying the solutions which could enhance women economic roles in the pre-selected sub-sectors and increase productive in agriculture.

In ***crop production*** 3 main sub-sectors analyzed were:

- ✓ Solid-seeded crops (including wheat, barley, corn, etc.)
- ✓ Fruit and Vegetable cultivation, production of high value crops
- ✓ Viticulture (including grapes for wine production and table varieties)

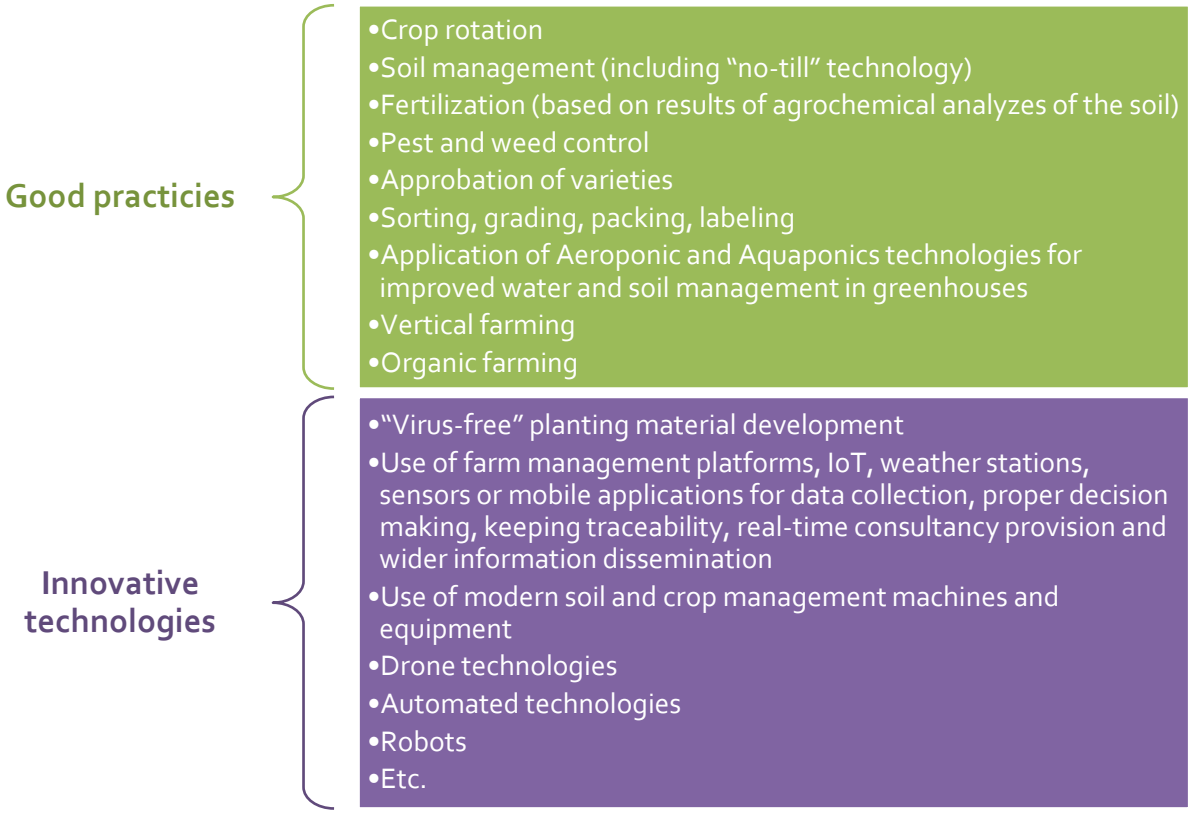
Specific challenges identified in the analyzed subsectors were:

- Non-Efficient functioning of Seed Selection Centers/Units –limited access to quality seeds and planting materials.
- Limited access to new and modern machinery and equipment.
- Limited access to consultancy services for improved agriculture practices.
- Non-Proper plant protection and fertilization knowledge and available inputs.
- Lack Access to water resources and proper water resource management system.
- Lack Access to proper quality and quantity workforce
- Lack of Access to efficient irrigation infrastructure
- Etc.

The solutions to the challenges should be found in the innovative technologies which are efficient and feasible for the given agribusiness. In this sense, the size of the agribusiness, the cost of the innovative technology vs. its impact on the profitability and other factors should be considered. The innovations in agribusiness can be considered both the technologies and good practices which

are known but are not being used because of various objective and subjective reasons and technologies which are new in Agriculture in the country as well as beyond its borders. The innovative solutions and good practices for the selected subsectors in crop production are summarized in the chart below.

Figure 7. Good practices and innovative technologies to be promoted in crop production



In animal husbandry 5 main subsectors were analyzed:

- ✓ Large and small ruminants
- ✓ Piggery
- ✓ Fishery
- ✓ Rabbit farms
- ✓ Beekeeping

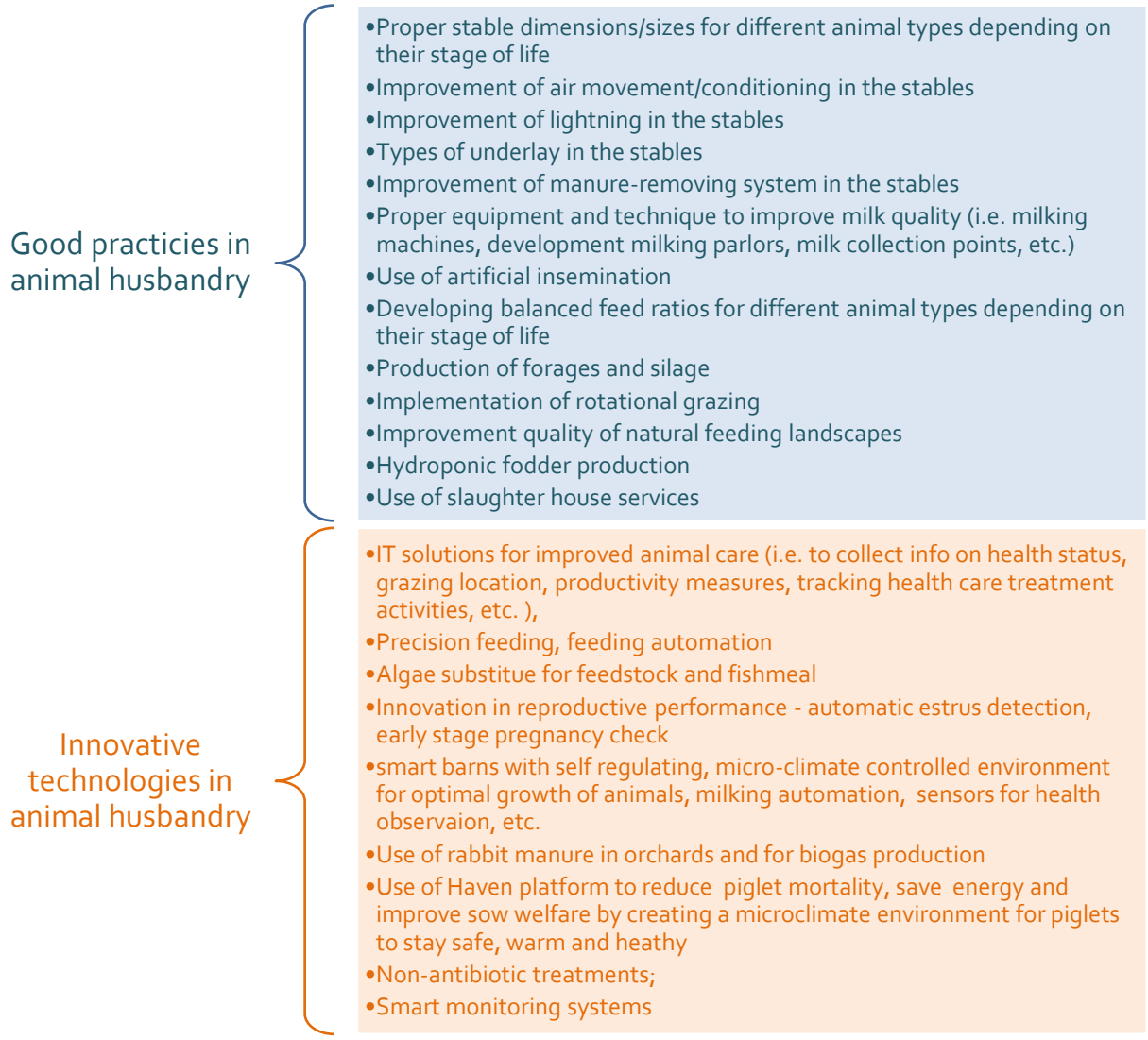
The specific challenges for the selected subsectors in animal husbandry are:

- The distance of pastures from the communities and improper infrastructures /i.e. stock watering points, roads taking to the pastures, shelters, etc./
- Non-proper pasture management including reseeding, non-controlled grazing and fertilization.

- Lack of on-farm fodder production.
- Lack of combined /nutrient rich / feeding.
- Lack of hydroponic feed production.
- High prices of fodder.

The Innovative solutions as well as good practices in the subsectors of animal husbandry are summarized in the chart below.

Figure 8. Good practices and innovative technologies to be promoted in animal husbandry



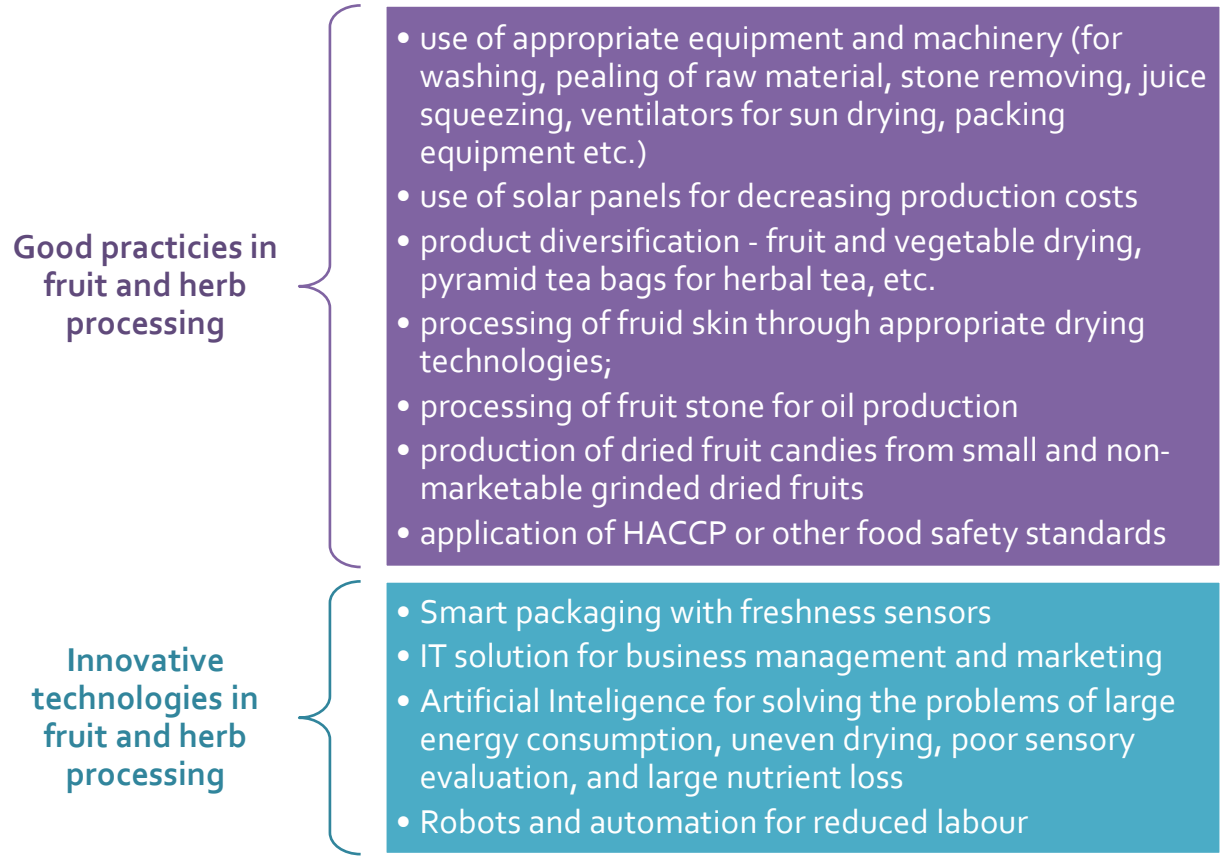
Under the agriculture processing sector, 2 main subsectors were analyzed:

- ✓ Fruit processing
- ✓ Production of Herbal Tea

The main challenges revealed in the selected subsectors were the following:

- Limited access to raw materials
- Challenges in finding quality labor force
- Almost no access to consulting services
- Limited access to post-harvest infrastructures
- Lack of food safety standards in the production sites
- Barriers in linking with markets

Figure 9. Good practices and innovative technologies to be promoted in crop production



Additional Conclusions and Recommendations

Conclusion 1.

The application of good practices by a large number of farmers is not happening due to various interrelated challenges hampering the process. Among the main reasons for this situation is the fact that the farmers are not really able to estimate the real impact of the good practice of their farm.

Recommendation 1

There is a need in not only capacity building of farmers on the particular technology and its application, but also in training them in basics of business decision making processes and financial management.

Conclusion 2

The efficiency of the innovative technology and a good practice highly depends on the location, size, specialization and many other factors related to the farm or agribusiness. Assessing the applicability of a given technology for the farm or agribusiness is crucial for the success of increasing efficiency in agriculture sector through innovative practices.

Recommendation 2

Introduction and promotion of good practices and innovative technologies in the agriculture subsectors should be carried out considering the efficiency of the particular practice in the given local natural climatic conditions and other factors such as the farm size, market potential of the given agriculture produce, replicability of the given practice in the local area, openness of the farmer in learning and applying innovative technology or good practices and in sharing the experience with other farmers and many more.

Conclusion 3

The research revealed that women and men have different roles in each agriculture sectors. In some subsectors women are more involved in processing, in other they have their agribusinesses in production. Preferences of women and men in agribusiness concepts differ. Women prefer to deal with small and high value agriculture practices, small scale processing, introducing to markets final packaged products under their own individual brand, introducing organic and green practices in their agribusinesses, while men mostly look for high volume production, introduction of modern machinery and equipment. While young women are good at using social media in marketing and sales function, young men are interested in IT technologies, Robotics and automated systems. The challenges identified through the study is dominance of men in business ownership and large-scale production, consequently in decision-making and access to credits, and socio-cultural aspects restricting women's participation in capacity building events. At the same time, women are

considered to have higher level of responsibility and openness to innovation, and indicate more demand towards development of their business and management skills.

Recommendation 3.

Promotion strategy and capacity building plan on good practices and innovative technologies for enhanced productivity in agriculture sector should be developed considering the various roles and preferences of women and men agripreneurs, for ensuring the inclusive growth of the sector. Trainings on general business and management skills targeted at women will help to meet the needs and demands of women agripreneurs. Along with the capacity building, such trainings will contribute to the enhanced self-confidence of women in managing their agribusiness. In addition, the ownership rights of women should be promoted through awareness-raising measures and encouraging co-ownership registration.

Conclusion 4

The research revealed that the lack of professional consulting is one of the main challenges hampering the application of innovative technologies and good practices. Moreover, the lack of access to information and consulting is the main reason why in many cases even the basic required agro technologies are not followed by the farmers risking not only the existence of their farm and agribusiness but also the health of consumers. On the other hand, the research revealed Internet being one of the main sources of information for farmers despite its limitations /like language barriers, trustworthiness of the sources etc./.

Recommendation 4.

It is highly recommended that the materials to be developed by the project for capacity building of farmers on innovative technologies and good practices in the selected sub-sectors are made available in an on-line platform in Armenia language.

Conclusion 5

It is obvious, that innovations in all subsectors of agriculture cannot be promoted by the project in all Marzes of the country. The research used certain logic in recommending the target Marzes for each sub-sector where the project should support the application of good practices and innovative solutions. It should be noted however that within all Marzes of the country there are communities where there is potential for developing all subsectors of Agriculture.

Recommendation 5.

It is highly recommended that the trainings and capacity building events are kept open for all the farmers around the country who will want to take part unrelated to the location where the event is taking place.

Conclusion 6

One of the findings of the research is that the limited access of farmers to modern machinery and equipment is one of the reasons hampering the application of innovative technologies. The high price of these machinery and equipment vs. the small-scale agribusinesses is the main cause of limited access.

Recommendation 6

Obviously one solution to the above-mentioned finding can be promotion of cooperation among farmers. Therefore, it is highly recommended that along with promotion of the innovative technologies as a solution for profitability increase the projects also build capacities of farmers in various forms of cooperation and their benefits.

Conclusion 7

Most of the farmers and field experts pointed out that youth are more open to innovative technologies than older farmers and agripreneurs. Youth however are gradually migrating from rural areas, as they find the agriculture sector not enough rewarding in terms of profitability as well as opportunities for professional growth.

Recommendation 7

Introduction and promotion of good practices and innovative technologies in the agriculture subsectors will create a demand for various new professions and with that will attract youth to be actively involved in the sector.

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Annex 2. Summary information on farmers and agripreneurs interviewed and focus groups participants

Marzes	Animal husbandry	Crop production	Beekeeping	Herb & tea production	Fruit processing	Total by marzes
Yerevan				2		**2**
Ararat	2	2		1	1	**6**
Armavir		5			8	**13**
Vayots dzor	1	3				**4**
Lori	4	3	2			**9**
Shirak		3				**3**
Tavush	2	2				**4**
Gegharkunik	2	3		1		**6**
Kotayk		4	3	3		**10**
Aragatsotn	7	1	1			**9**
Syunik	2	3				**5**
Total	**20**	**29**	**6**	**7**	**9**	**71**

Annex 3. Sectoral findings and charts reflecting the gender-related highlights identified in the online survey results

The information below describes in detail the research findings related to each sector of agriculture, reflecting the gender-related highlights identified in the online survey results.

CROP PRODUCTION

The largest group of the survey participants is from crop production sector, including 102 male and 73 female agripreneurs.

Difficulties faced in organizing business

As mentioned in the previous section on general trends, women in agribusiness more often face lack of access to technologies and equipment as compared to men. This is especially visible in the survey responses provided by female and male agripreneurs engaged crop production sector. Another challenge often faced by women is the lack of financial resources, though this problem is the top one mentioned by both female and male respondents.

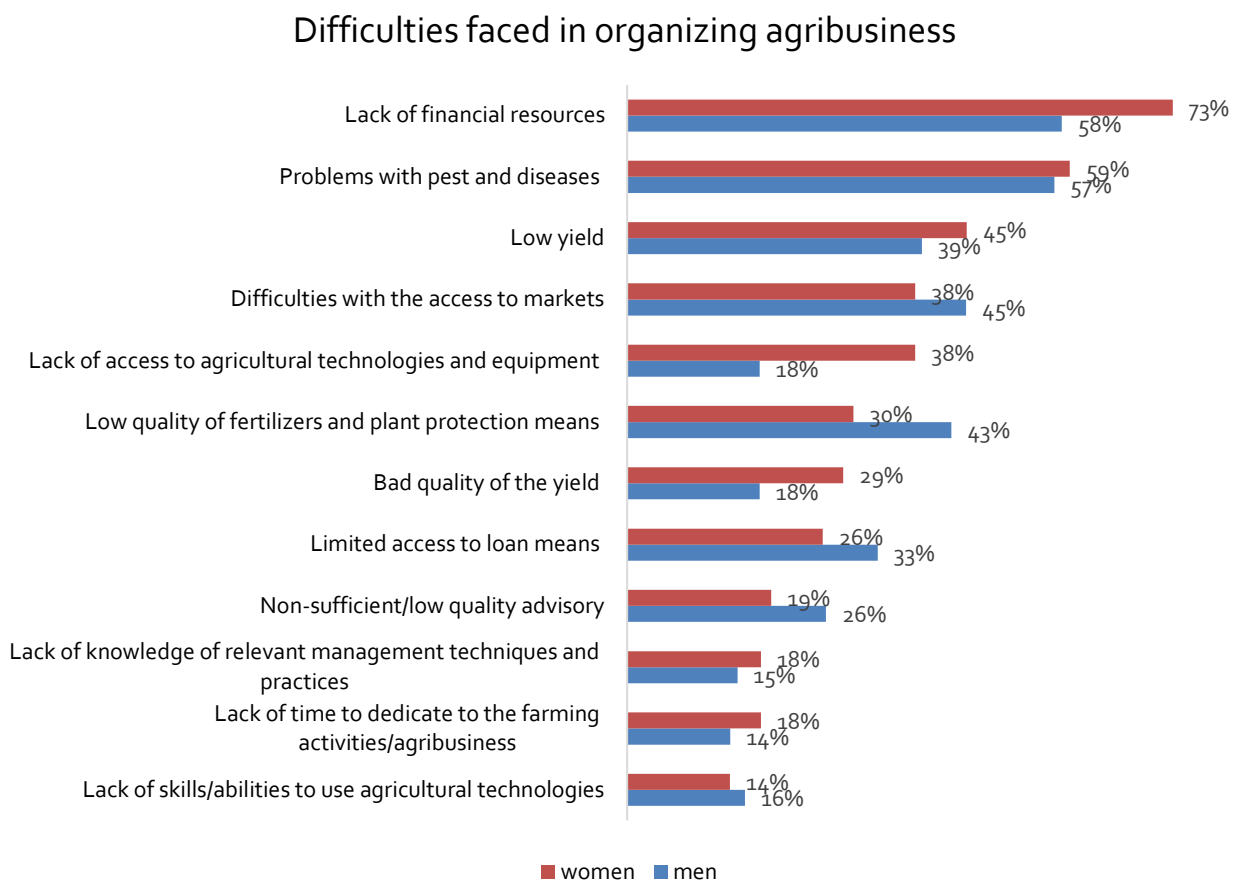

Chart 1. The percentage of female and male respondents engaged in crop production who indicated specific difficulties faced in organizing agribusiness (multiple answers possible)

Among the sector-specific problems, problems with pest and diseases, low yield, low quality of fertilizers and protection means, and bad quality of the yield are mentioned as main difficulties in organizing the business. At the same time, few farmers identify lack of won skills and knowledge as a hindering factor of their business.

Need for innovations

The chart below presents the distribution of responses on the innovative technologies that, according to the respondents engaged in crop production, would result in increased productivity of their farm or agribusiness. The preferences of female and male agripreneurs generally show same trends, with exception of organic fertilizers that are among the three top priorities for male respondents but less prioritized by women in comparison to drop irrigation system.

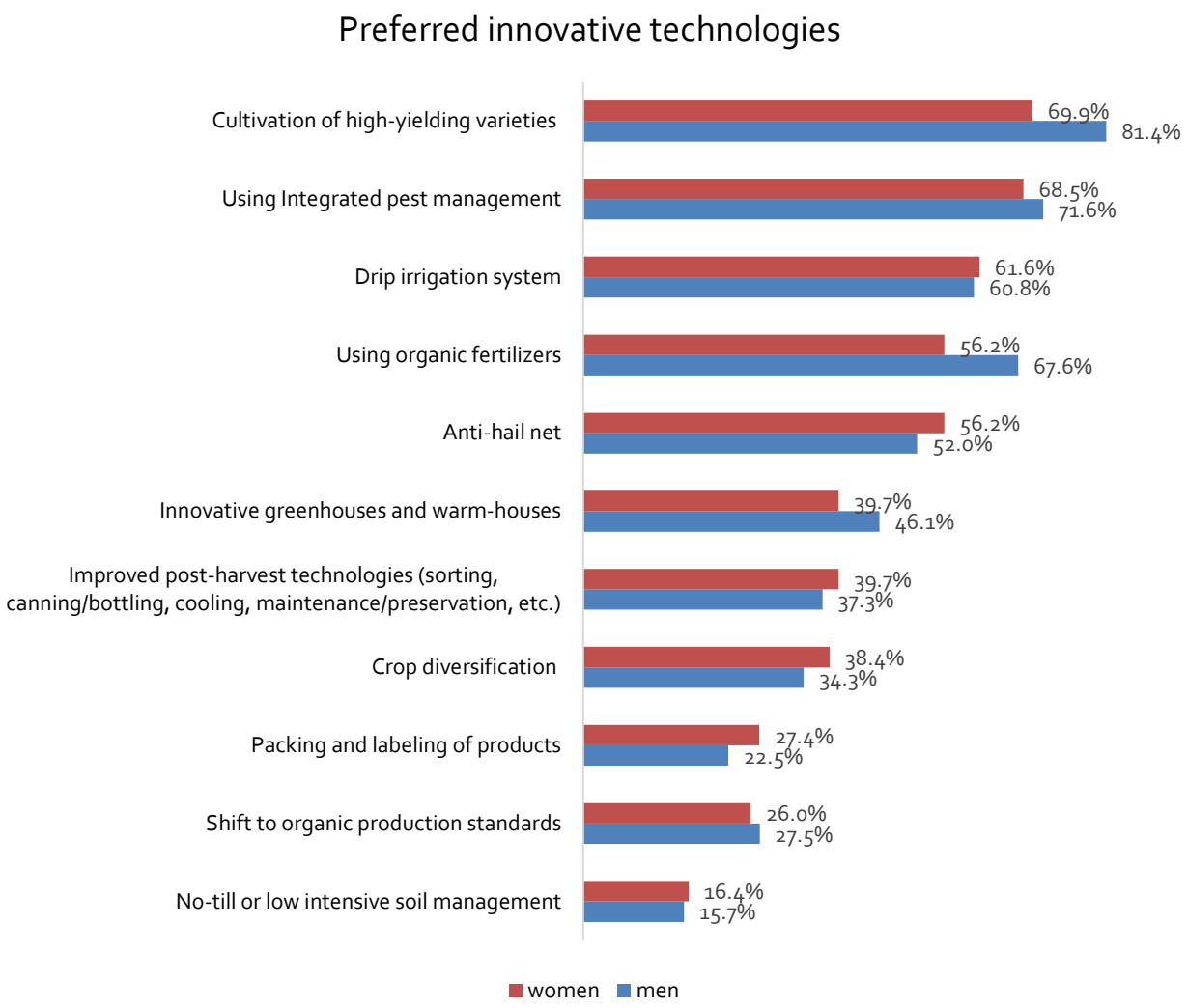

Chart 2. The innovative technologies/practices implementation selected by the female and male respondents engaged in crop production (multiple answers possible)

It can be visible that technologies and practices focused on increasing yield and escaping possible damages are more often selected, thus reflecting the priority of getting more income with less expenses.

As to the factors hindering access to innovative technologies, female respondents most often mentioned low quantity of production (60.3%) and low access to loans (37%), followed by low income from agribusiness (31.5%). At the same time, men indicated first of all low income (50%), low quantity of production (50%) and long payback period of innovative technologies (41.2%) as top three factors hindering usage of innovative technologies. Lack of information on the available technologies was mentioned by 28.8% of female and 32.4% of male respondents involved in crop production.

Capacity-building topics

Looking at the responses of female and male agripreneurs, it can be seen that they mostly prefer the same topics for capacity-building. Main differences are noticed in the preference of soft skills-related trainings, such as marketing and sales, business management, budgeting and financial management, which are more preferred by women.

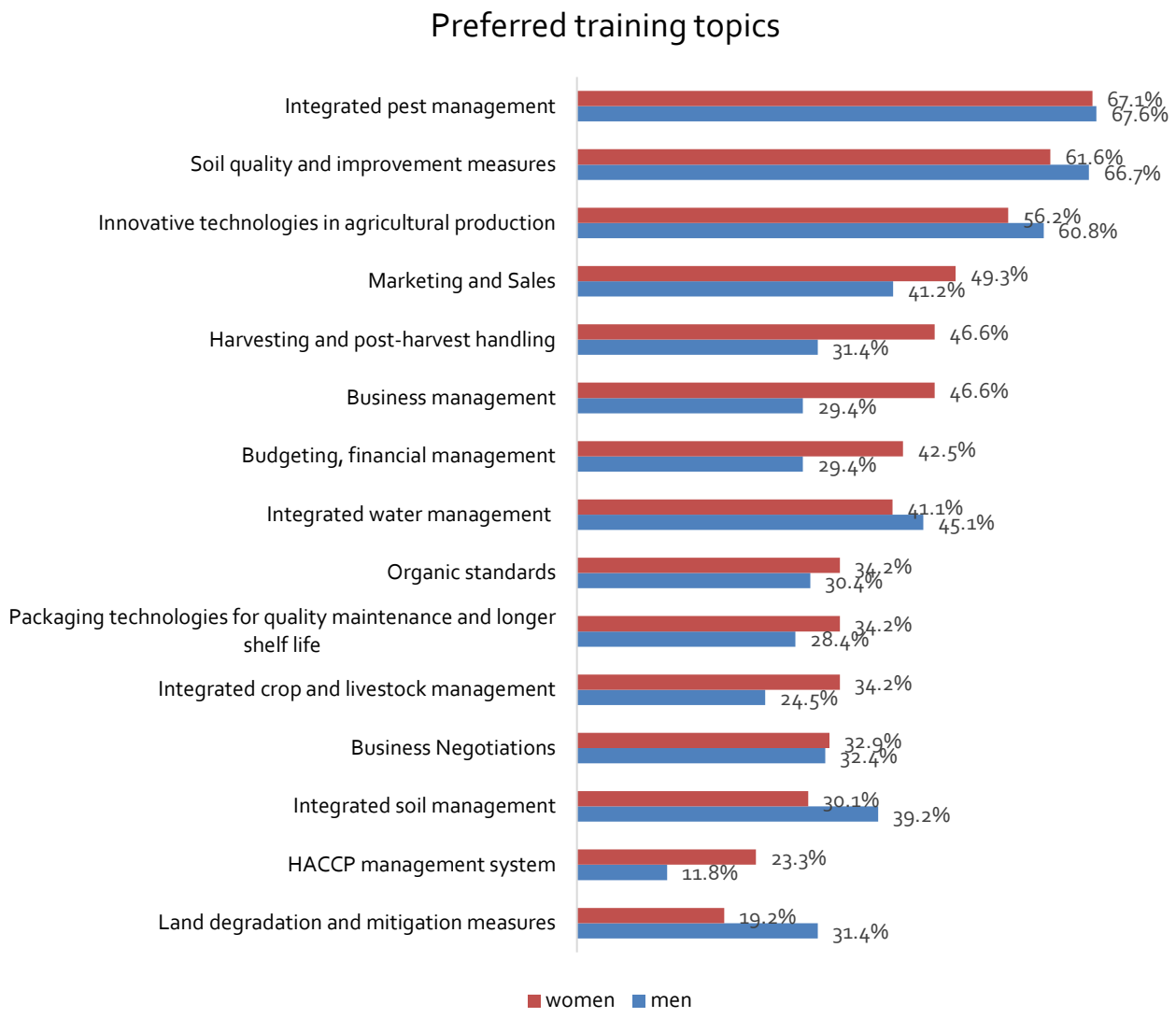

Chart 3. The training topics indicated by the female and male respondents involved in crop production (multiple answers possible)

As to the sector-specific themes, women more often indicated topics related to harvesting and post-harvesting handling, organic standards and packaging technologies, as well as integrated crop and livestock management and HACCP management system.

ANIMAL HUSBANDRY

The share of women respondents engaged in the animal husbandry is relatively low (25 women vs. 64 men respondents).

Difficulties faced in organizing business

As in the case of crop production sector, lack of access to technologies and equipment is again among the priorities of female agripreneurs participated in the survey. Low productivity is highlighted as a major difficulty by both men and women, while lack of financial resources and challenges with access to markets are male respondents' most mentioned problems.

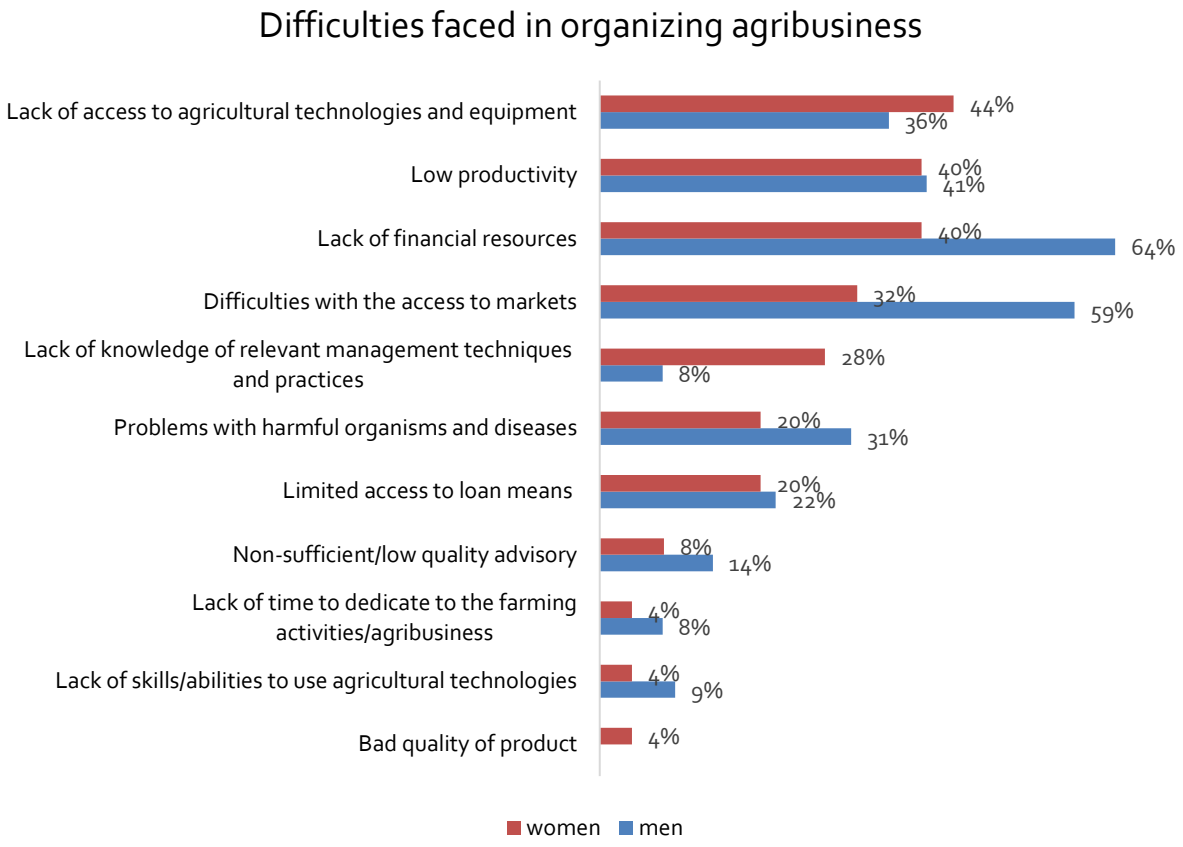

Chart 4. The percentage of female and male respondents engaged in animal husbandry who indicated specific difficulties faced in organizing agribusiness (multiple answers possible)

Unlike the crop production sector farmers, female respondents involved in animal husbandry often mention lack of knowledge of management technics as a challenge in their work. Other problems mentioned by both female and male respondents in this sector are harmful organisms and diseases and limited access to loans.

Need for innovations

Unlike the crop production sector, where the responses of female and male agripreneurs on this question were nearly the same, the needs of men and women engaged in animal husbandry in regard to innovative technologies and practices are quite different. The top priority need mentioned by women is automated milking machines, followed by shift to organic processing and adoption of HACCP management system. In contrast, male respondents most often indicated contemporary barns and fish farms, followed by milking machines, artificial insemination, packaging, specialized feeding ration and slaughterhouses.

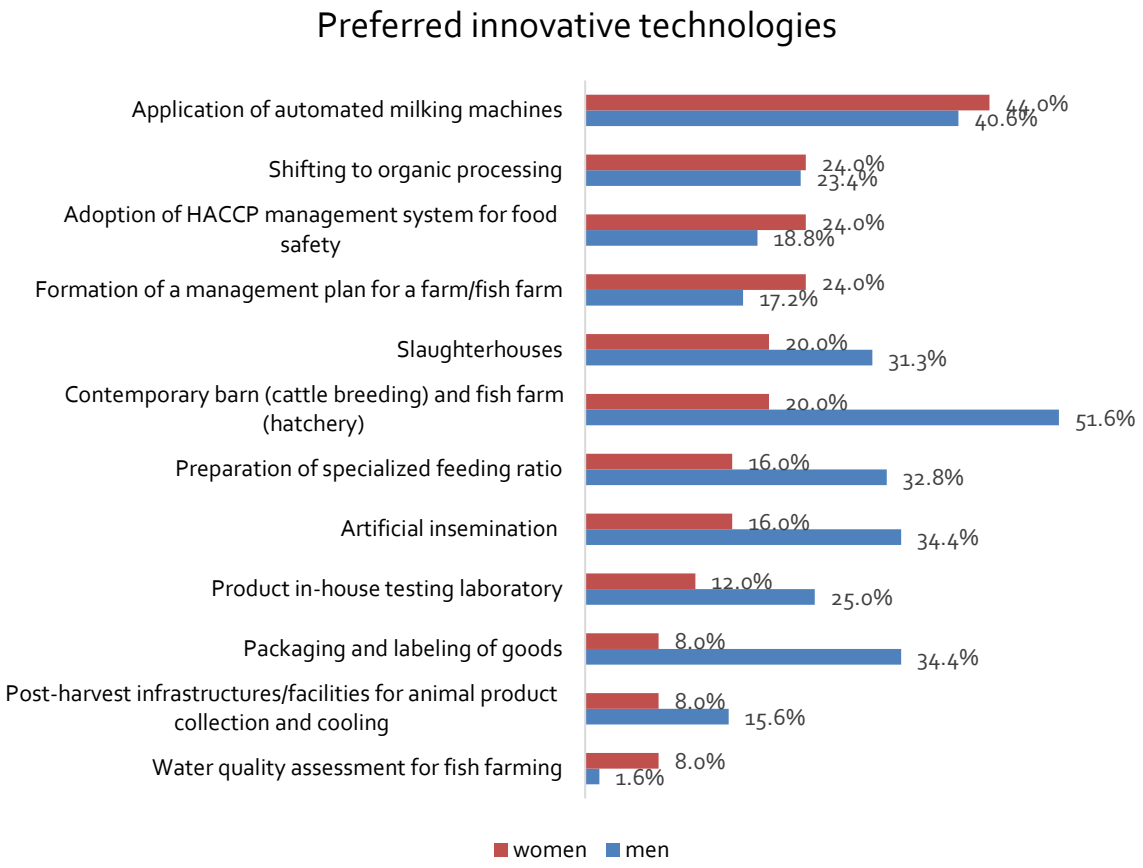

Chart 5. The innovative technologies/practices implementation selected by the female and male respondents engaged in animal husbandry (multiple answers possible)

Among the challenges hampering access to innovative technologies, as was the case in crop production sector, low quantity of production and low income from farm were mentioned among top issues disturbing both female and male respondents: 53% of men and 40% of women indicated the first issue, and 36% in both groups indicated the second. These problems are followed by limited access to loan products (indicated by 34.4% of men and 20% of women) and difficulty to choose among the innovative technologies (23.4 and 20% respectively).

Capacity-building topics

The female respondents in the animal husbandry sector are generally less interested in trainings as compared to men and to women engaged in crop production and processing. The most often indicated topic both by female and male respondents in this sector is milk and meat quality improvement, followed by the animal feed and feeding technologies. Also, women are relatively more interested in innovations and good practices in animal care.

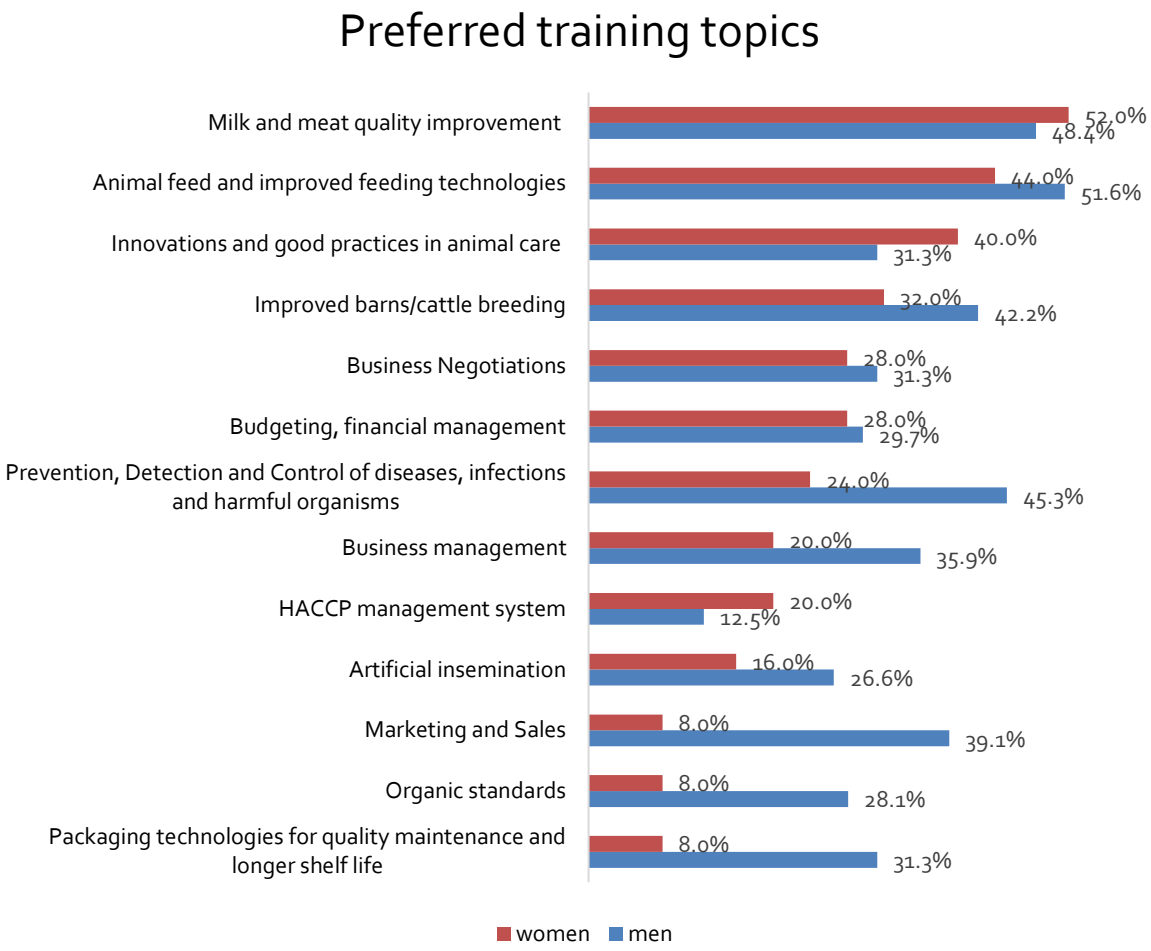

Chart 6. The training topics indicated by the female and male respondents involved in animal husbandry (multiple answers possible)

In contrast, male respondents are more concerned with diseases and infection, barns and breeding, as well as interested in business development topics.

It should be noted, however, that the distribution among response categories is small, ranging from 2 to 13 responses among women respondents, thus these responses simply reflect the preferences of survey respondents and cannot be considered as statistically significant.

PROCESSING

It should be taken into account that the number of respondents in the processing sector is rather small: 16 men, 19 women from this sector participated in the survey. Thus, the data below can be interpreted only as presenting the needs and preferences of survey participants without making any conclusion on general trends and preferences.

Difficulties faced in organizing business

As in the other sectors of agriculture, lack of financial resources, limited access to equipment and difficulties with access to markets were most often mentioned both by female and male respondents engaged in processing. At the same time, men more often than women highlighted the problems of lack of specialists and lack of raw material.

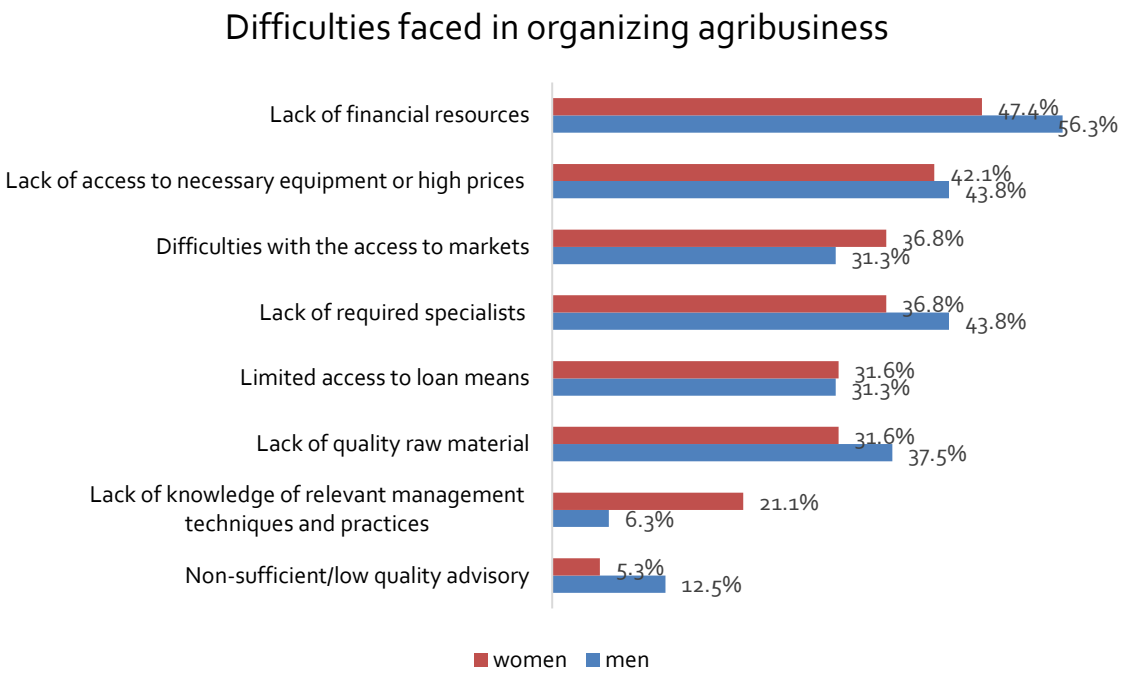

Chart 7. The percentage of female and male respondents engaged in processing who indicated specific difficulties faced in organizing agribusiness (multiple answers possible)

As mentioned in general trends, lack of knowledge of relevant management technologies and practices was more often indicated by women which shows more critical assessment to their own skills and need for training.

Need for innovations

The needs for innovative technologies and practices in processing sector indicated by both male and female respondents are most often related to adding new production lines, adoption of HACCP and ISO systems, ongoing improvement of employees' capacities. The usage of alternative energy sources is also prioritized, though men showed more interest towards this topic. On the other hand,

women are more oriented towards improving drying capacities and tools, as well as shift to organic processing. These differences might be due to the fact that most of the female respondents in processing sector are involved in fruit processing.

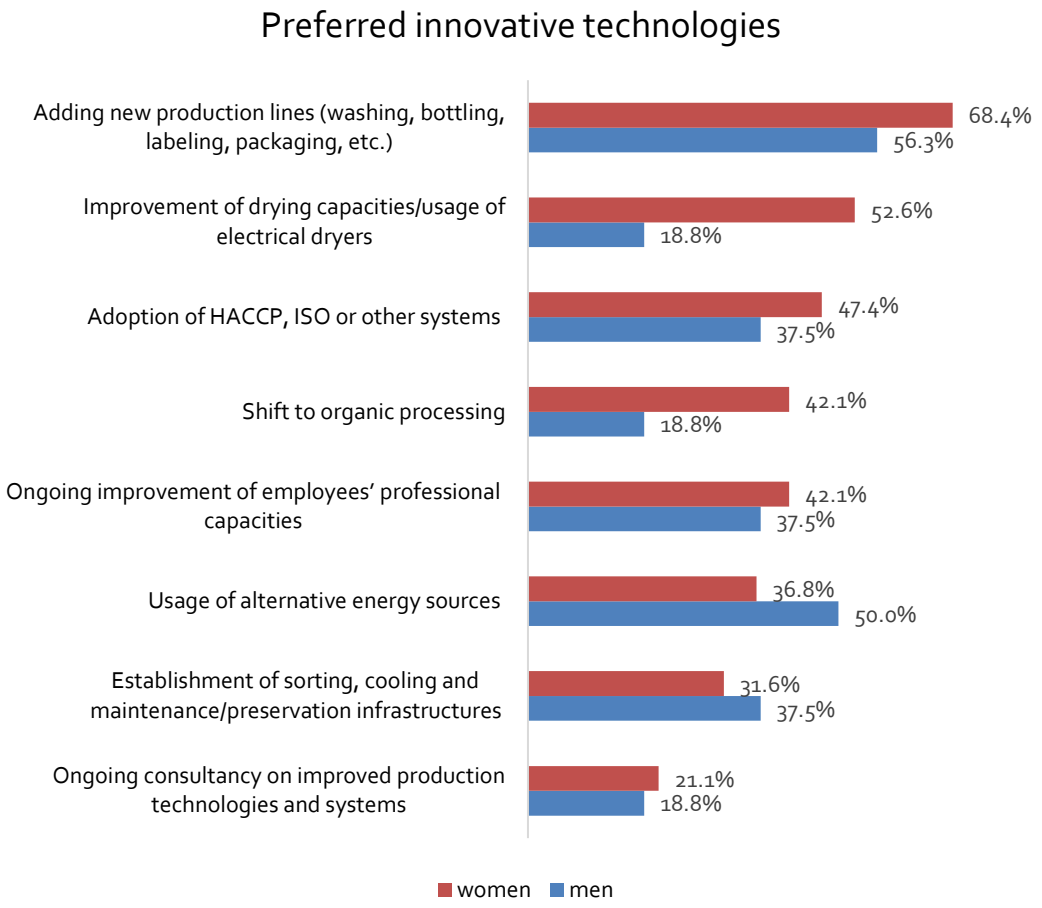

Chart 8. The innovative technologies/practices implementation selected by the female and male respondents engaged in processing (multiple answers possible)

The factors hindering innovation most often mentioned by the respondents involved in this sector are low quantity of production (mentioned by 63.2% of women and 37.5% of men), limited access to loans (31.6 and 31.3% respectively), and lack of information on available innovation practices and technologies (31.6 and 25%). At the same time, male respondents also highlighted lack of skills in operating innovative machinery (31.3%) and lack of access to maintenance services (25%), which were mentioned by only 1-2 women (comprising respectively 5.3 and 10.5% of female respondents involved in this sector).

Capacity-building topics

The female survey respondents engaged in processing, in the same way as men, are interested in trainings on packaging technologies, processing of certain fruits/herb types, and food safety

standards. Women are also interested in budgeting, financial management and business management topics.

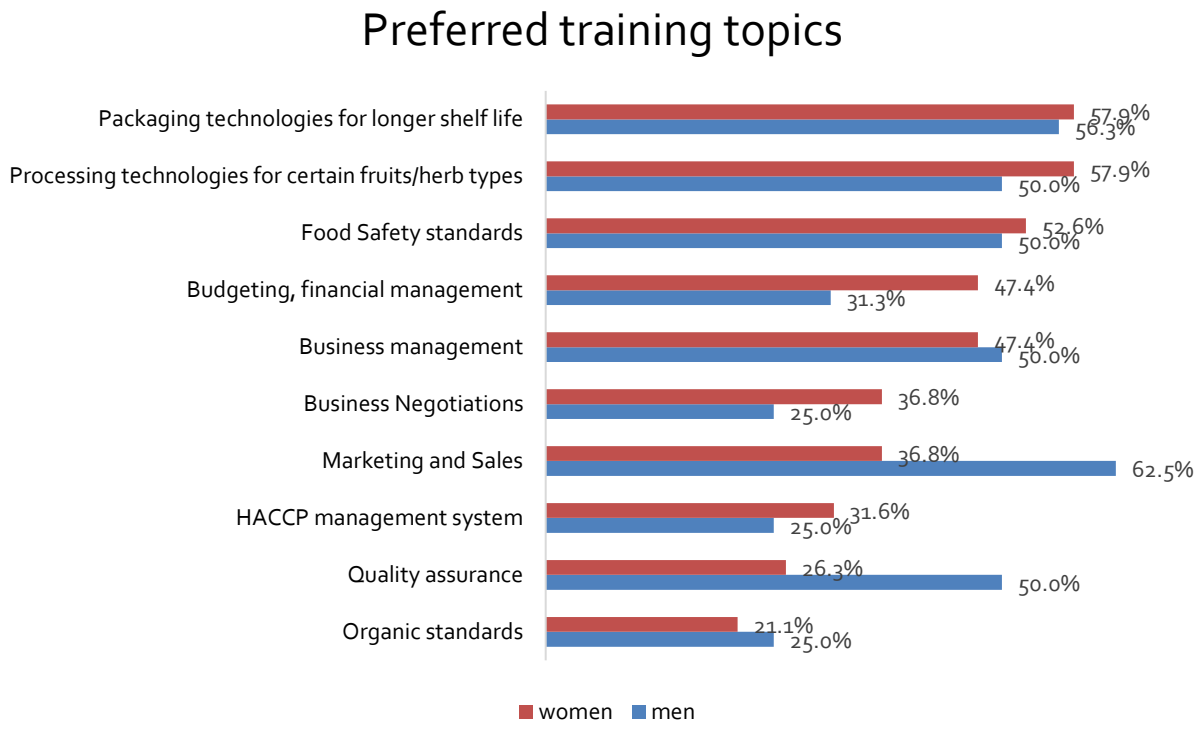

Chart 9. The training topics indicated by the respondents involved in processing (multiple answers possible)

The topics where female and male training preferences significantly vary are marketing & sales and quality assurance, as male respondents indicated more interest in these categories.

AGRI CAMP

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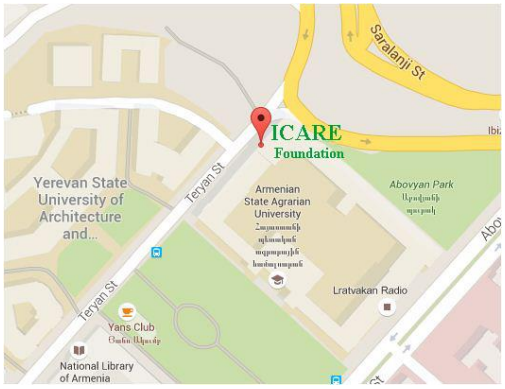
Innovative Agriculture Training and Learning Camp



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