Government of the Islamic Republic of Afghanistan

National Environmental Protection Agency

Technology Needs Assessment for Climate Change Adaptation

Barrier Analysis and Enabling Framework Report

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FOREWORD

Afghanistan is inherently one of the most climate vulnerable countries and is likely to become even more vulnerable to climate change impacts on one hand, and the lack of sustainable socio-economic opportunities on the other. A range of factors (drought, floods, landslides, mining, deforestation and avalanche) drives vulnerability to climate change; Country need innovative adaptation technologies.

Luckily, Technology Needs Assessment (TNA) project executed by the National Environmental Protection Agency (NEPA) in collaboration with the United Nations Environment Program and Technical University of Denmark (UNEP-DTU) Partnership, and Climate Technology Centre & Network (CTCN) will play an effective role in the process significantly. Agriculture and Water both vulnerable sectors in light of climate change tendencies, existing barriers create obstacles and hinder the transfer and diffusion of prioritized adaption technologies.

I am pleased to record that the entire process to set preliminary targets for transfer and diffusion of technologies, identify barriers and suggest an enabling framework for overcoming the barriers in the phase-II of the TNA project has been country-driven. Being consultative, it involved a number of stakeholders and experts from the government, private sector and civil society. I strongly believe that the implementation of adaptation technologies prioritized in TNA Adaptation Report will help the country in building resilience to the impacts of climate change.

I have the pleasure to express my deep and profound sense of gratitude and heartfelt thanks to the members of the TNA National Team and my colleagues in NEPA and experts from the Adaptation Working Group for their invaluable contributions to the preparation of this report.

I express my immense pleasure to thank the contributions of Dr. Mohammad Gulab Omari, Lead-Expert and other experts of Global Environment Facility (GEF), United Nations Environment Program (UNEP), UNEP-DTU Partnership and the Asian Institute for Technology (AIT) for their constant support and guidance for implementation of the TNA project into an acceptable documentary proof.

Shah Zaman Maiwandi
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PREFACE

Climate change is a global phenomenon; Afghanistan amongst the most vulnerable countries to the impact of climate change. The world adaptation index ranks it the most vulnerable country in the world taking into account the country's exposure, sensitivity and ability to cope with climate related hazards it is a dire need to achieve its sustainable development goals without compromising on its socio-economic development needs.

Enhancing the development transfer and uptake of technology is a key pillar of the international response to climate change. Technology Needs Assessment (TNA) is one of the critical steps towards identifying and assessing climate change adaptation challenges for Afghanistan in order to align its adaptation needs and opportunities with goals and objectives of its sustainable development. As a climate change adaptation tool this TNA would help the country identify the needs for new equipment, techniques, practical knowledge and skills, which are necessary to pursue climate resilient development successfully.

This report on 'Barrier Analysis & Enabling Framework' of technology needs assessment is the part of TNA project outputs, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Program (UNEP) and the UNEP DTU Partnership in collaboration with Asian Institute of Technology (AIT). The TNA process in Afghanistan is being undertaken since July 2020, with the National Environmental Protection Agency (NEPA) in the lead.

This report identifies and provides a list of barriers and enabling measures for adoption of prioritized adaptation technologies for water and agriculture sectors of Afghanistan. The report is the result of a fully country driven, participatory process. Views and information in this report is the product of extensive discussions with technology expert team and stakeholders.

I accorded with gratitude the great suggestion unabated help and detailed guidance rendered by all stakeholders for their constant support and valuable comments throughout the development of this report. I hope that this assessment will go a long way in mitigating the country's climate change vulnerabilities, respectively.

Dr. Mohammad Gulab Omari
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ABBREVIATIONS

ADB	Asian Development Bank
AIT	Asian Institute of Technology
AREU	Afghanistan Research and Evaluation Unit
ASA	Agriculture Seed Agency
BAEF	Barrier Analysis and Enabling Framework
BCM	Billion Cubic Metter
CBEA	Community Based Extension Agents
CBO	Community Based Organization
CC	Climate Change
CTCN	Climate Technology Center and Network
DoA	Department of Agriculture
FAO	Food and Agriculture Organization
FoF	Faculty of Forestry
GCF	Green Climate Fund
GDP	Gross Domestic Product
GoA	Government of Afghanistan
HRD	Human Resource Development
HYV	High Yielding Varieties
IAs	Irrigation Associations
ICARDA	International Centre for Agricultural Research in Dry Areas
IFAD	International Fund for Agricultural Development
IWRM	Integrated Water Resource Management
M&E	Monitoring and Evaluation
MAIL	Ministry of Agriculture, Irrigation and livestock
ME	Ministry of Economic
MENR	Ministry of Ecology and Natural Resources
MEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoMP	Ministry of Mining and Petroleum
MPI	Ministry of Planning and Investment
MRRD	Ministry of Rural Rehabilitation and Development
NGOs	Non-Governmental Organizations
PVC	Polyvinyl Chloride
R&D	Research and Development
RAE	Responsive Agricultural Extension
RBM	River Basin Management
RDC	Research and Development center
RWC	Rain Water Collection
SCWAM	Supreme Council for Water Affairs and Management

SLM	Sustainable Land Management
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UNEP-DTU	United Nations Environment Programme-Denmark Technical University
UNFCCC	United Nations framework Convention on Climate Change
US	United States
USAID	United Nation Agency for International Development
WB	World Bank
WUA	Water User Association

Table of Contents

List of Tables

List of Figure

Executive summary

The National Environmental Protection Agency (NEPA) takes great pleasure in presenting Afghanistan's second phase of the TNA, Barrier Analysis and Enabling Framework (BA & EF), during the TNA process in Afghanistan, water and agriculture were selected as priority sectors — as they are both vulnerable sectors in light of climate change tendencies. Existing barriers create obstacles and hinder the transfer and diffusion of prioritized adaptation technologies. This report aims to outline the analysis of existing barriers and enabling framework for prioritized technologies in water and agricultural sectors. Identifying barriers is the process of determining the reasons that hinder the transfer and diffusion of technologies. These include the identification of any missing measures that could have sustained the diffusion. As an initial step in the process of barrier analysis, a desk study of policy papers and other pertinent documents was conducted in order to identify the primary reasons why the technology is not currently applied widely, and why neither the private nor public sectors have invested significantly in it. Next, a consultation process was conducted with stakeholders through Skype call and Mobile communication. For the organization of the barrier analysis process, a sectoral/technology-working group representing relevant stakeholders was formed. National consultants have applied a participatory approach for barrier analysis and identification of enabling measures in agricultural and water sectors. Barriers related to technology implementation have been identified in two categories:

i) economic/financial barriers;
ii) Noun financial

After compiling a long list of barriers, a Skype call and Mobile communication was organized in order to screen barriers and group them under different categories economic/financial and non-financial (information, social, technological, capacity building, policy/regulatory). In addition, the enabling framework and measures for overcoming barriers are addressed. For each of the ten technologies identified for the water and agriculture sectors, a systematic approach of describing and analyzing technology barriers, and identification of measures and enabling framework was adopted. The process included:

1. Identify preliminary targets for technology development and diffusion at the sectoral scale.
2. Describe technology properties and its potential adaptation benefits, categorize technology as either a market or a public good and briefly elaborate on its current status in the country.
3. Identify important barriers to the diffusion of technologies through expert opinion, literature review and brainstorming sessions with important stakeholders; development of barrier analysis tools including problem and objective trees and market mapping tool; categorize the barriers into financial and non-financial barriers.
4. Identify measures for overcoming the barriers, the possible linkage between different technology barriers within a sector and outline a technology enabling framework that would help to overcome barriers and create a supportive environment for the development and successful diffusion of the selected technologies.

This whole process of technology barrier identification was drawn from the literature review, meetings with stakeholders, Adaptation Expert Working Group and technology experts

through Skype due to the COVID-19 outbreak. It also included full use of TNA barrier analyses guidelines (Boldt *et al*., 2012), resources, information and templates provided by specialists of UNEP-DTU (United Nations Environment Programme-Denmark Technical University) Partnership during and after regional capacity building workshops.

The technology barrier analysis process identified crucial economic and financial barriers and non-financial barriers. The latter was further broken down into many other sub-barrier categories including policy, legal and regulatory, institutional and organizational capacity, technical, information and awareness, social, cultural and behavioral and market imperfection.

Technology barriers and measures in the water sector

Each of the four adaptation technologies in water sector, namely integrated water resource management, small dams and micro catchment, rainwater collection from ground surface and micro irrigation system for efficient water use and management, were categorized as a public good which requires public sector support for its deployment and successful replication at different implementation scales. The review of barriers recognized that economic and financial barriers were associated with a high initial cost of development of the technologies which were due to the lack of incentives like subsidies or soft loans offered to individuals or communities, high cost of construction material and available technical expertise, and labor at the local levels. The non-financial barriers included lack of an approved water sector policy, which exists in a draft form for more than a decade. Moreover, absence or weak coordination between relevant line departments due to weak integrated policies (draft water policy and agriculture policy etc.) further aggravates the situation. The legal and regulatory frameworks concerned with the development and management of the four adaptation technologies have failed to adopt an integrated water resource management approach and thus face a weak monitoring and implementation regime in the country. Other barriers included absence of a strong resource management authority, lack of information and awareness on potential benefits of technologies in the face of climate change. The barriers in water sector can be overcome by putting in place appropriate financial and technical resources for the development and diffusion of these technologies at local level. The non-financial barriers can be tackled through formulating and approving a water policy with consensus from all the important stakeholders, devising a regulatory framework that would take care of conflicting natural resource rights in the realm of integrated water resource management, small dams and micro catchment, rain water collection from ground surface and micro-irrigation system for efficient water use and management at the community levels.

Technology barriers and measures in the agriculture sector

Similarly, in case of the agriculture sector, the primary focus in the face of climate change is the adoption of technologies that help and increase the resilience of communities through adopting crop diversification and new varieties, responsive agricultural extension, introduction of plant varieties resistant to climate change, land use planning, conservative agriculture and agro-forestry were selected with the help of stakeholders. During the consultation, the farmers and communities identified processes with various stakeholder groups, high initial cost of installation and maintenance for agroforestry systems and land use

planning as the key financial barrier in the widespread adoption of technology. The main element of this barrier identified was the lack of trained technical staff locally available for the design, implementation and maintenance of the technologies, high rate of taxes and custom duty imposed on import of technology parts, and a small, underdeveloped market for technology importers and suppliers in the country. In case of introduction of plant varieties resistant to climate change, the obstacles recognized were inadequate Research and Development (R&D) facilities, non-availability of sufficient financial resources and market barriers to the adoption of newly developed seeds by farming community. The stakeholders agreed that by allocating necessary financial resources for research and training of scientist and field staff can provide an enabling framework for technology diffusion.

To help in achieving diffusion of these six technologies in the country, several enabling measures have been suggested *viz.*, access to appropriate subsidy, grants, or soft loans to the farmers besides training and capacity building of relevant field staff.

Chapter1: Background & Introduction

1.1. Background

Technology Needs Assessment (TNA) is one of the foremost critical steps towards identifying and assessing climate change adaptation challenges within the United Nations Framework Convention on Climate Change's (UNFCCC) technology mechanism on technology development and transfer. For a climate-vulnerable country such as Afghanistan, TNA has an added significance for aligning its adaptation needs and opportunities with goals and objectives of its sustainable development programs. In Afghanistan, the project on Technology Needs Assessment (TNA) was initiated in June 2019 in collaboration with UNEP-DTU Partnership, Asian Institute of Technology (AIT) and Climate Technology Centre & Network (CTCN) as a part of the South Asia regional program. The purpose of the TNA project is to assist Afghanistan in identification of its priority adaptation sectors, followed by prioritization of technologies in these sectors. This will form the basis for development of environmentally sound technology projects and programs to facilitate transfer and diffusion of these priority technologies in accordance with Article 4.5 of UNFCCC. The main objectives of the project are to:

1. Identify and prioritize, through country driven participatory processes, the technologies that can contribute to mitigation and adaptation goals of the participating countries while meeting their national sustainable development goals and priorities;
2. Identify barriers hindering the acquisition, deployment and diffusion of prioritized technologies; and
3. Develop Technology Action Plans (TAP) specifying activities and enabling framework to overcome the barriers and facilitate the transfer, adoption and diffusion of selected technologies in the priority areas with national relevance.

This TNA project also aims to build capacity of Afghanistan to effectively meet the obligations under the UNFCCC to adapt and protect livelihoods of the communities, and to reduce vulnerability of priority sectors exposed to the adverse impacts of climate change. TNA project's implementation is phased out in three stages as indicated below in Figure 1.1. In the first stage two sectors—water resources and agriculture—were identified as economically important and vulnerable sectors to climate change. Later, after extensive consultation with experts and other stakeholders, following technologies were prioritized in these two sectors.

The prioritized technologies identified through TNA process for water sector of Afghanistan are:

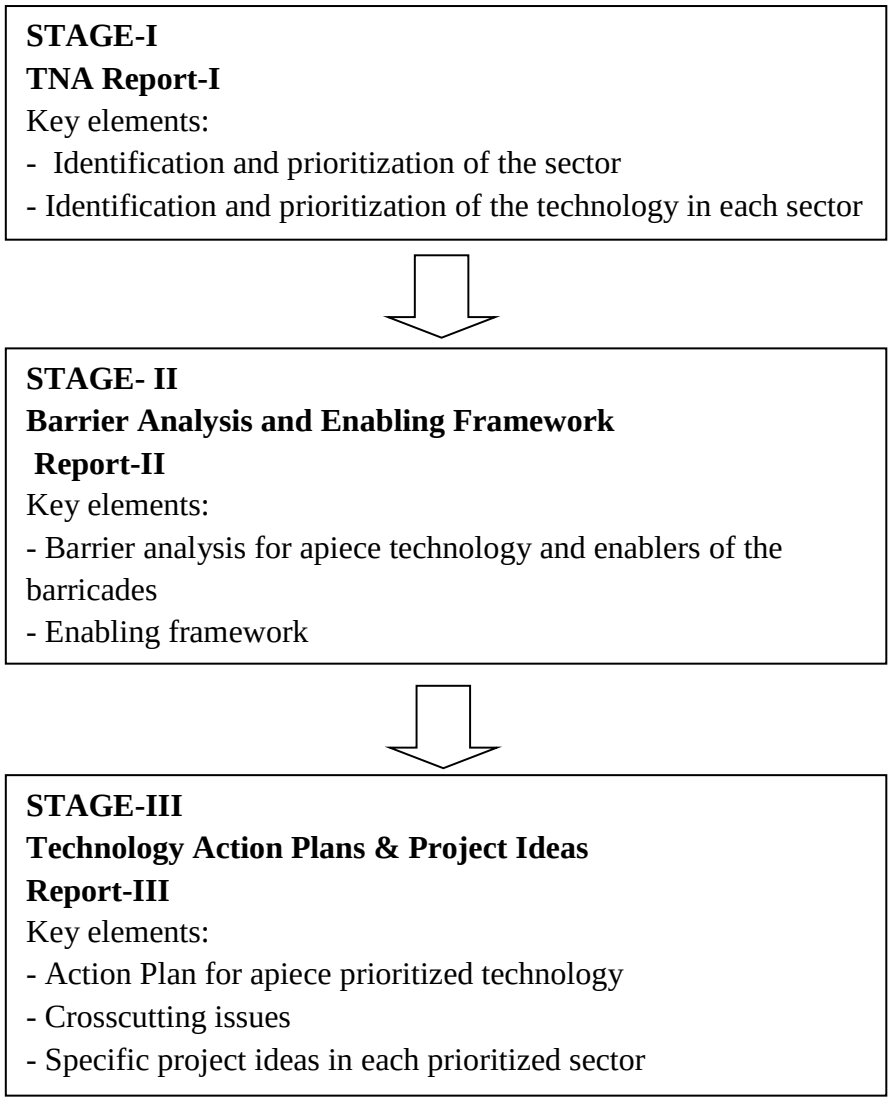
- Rain water collection from ground surface
- Small dams and micro catchment
- Micro irrigation system for efficient water use and management
- Integrated water resource management

Likewise, priority adaptation technologies identified for agriculture sector of Afghanistan are:

- Introduction of plant varieties resistant to climate change
- Agro-forestry
- Conservative agriculture

- Crop diversification and new varieties
- Land use planning
- Responsive agricultural extension

Figure: 1.1 Different stages of TNA project implementation followed in Afghanistan



Source: Adapted from UNEP Riso Centre Flyer. March 2014: What are the technology needs of developing countries?.

1.2 Methodology

This report is the output of the second stage of the TNA process that covers barrier analysis on transfer, and diffusion of the prioritized adaptation technologies in the selected sectors. In addition, the enabling framework and measures for overcoming barriers are discussed and addressed. For each of the selected technologies identified for the water and agriculture sectors, a systematic approach of describing and analyzing technology barriers, and identification of measures and enabling framework was adopted. The process included:

1. Identify preliminary targets for the technology development and diffusion at sectoral scale.

2. Describe technology properties and its potential adaptation benefits, categorize technology as either a market or a public good and briefly elaborate on its status in the country.
3. Identify measures for overcoming the barriers, possible linkage between different technology barriers within a sector and outline a technology enabling framework that
4. Afghanistan TNA BAEF Adaptation Report-II July 2020 would help to overcome barriers and create a supporting environment for the development and successful diffusion of the selected technologies.

   Brief account of methodology followed in this second stage of TNA process, "Barrier Analysis and Enabling Framework", is given in Table.1.1 and explained as under:

Table: 1.1. Methodology followed in conducting TNA barrier analysis and enabling framework

Steps	Focal analysis stages	Methods and tools used
STEP1	Identification of stakeholders	A small committee of NEPA performed this task.
STEP2	Identification of potential barriers	Extensive literature review, brainstorming and meeting with experts through Mobile and Skype.
STEP3	Analysis of barriers	Detailed analysis using logical problem tree in stakeholder/expert's consultation through Mobile and Skype communication due to COVID 19 outbreak.
STEP4	Measures development to overcome barriers	Translating barriers into measures using logical solution tree through Mobile and Skype communication due to COVID 19 outbreak.
STEP5	Screening and validation of important barriers and measures	Validation through extensive consultation during Stakeholders/experts during Skype calls
STEP6	Policy makers sensitization and involvement in TNA process	One-to-one briefings to provincial policy makers.
STEP7	Preparation of Draft BAEF Report	TNA adaptation Expert drafted the report
STEP8	Final BAEF Report	First UNEP-DTU experts reviewed and then NEPA officials reviewed / approved the report.

1. National Environmental Protection Agency (NEPA) initially helped through a small search committee in identification and involvement of wide range of stakeholders, which include experts from water and agriculture sectors, officials from relevant ministries and departments, farmers, representatives of NGOs, representatives of suppliers and manufacturers, and officials of some international donor agencies in consultation process.
2. Literature review: as a first step a team of experts listed down potential economic, financial, and non-financial barriers to the diffusion of each prioritized technology in Afghanistan through expert opinion and extensive literature review. Later non-financial barrier category was further broken down into many other barrier categories including

policy, legal and regulatory, institutional and organizational capacity, technical, information, awareness etc.

3. Screening and short listing of key barriers, particularly where the potential barriers list was long, to select most essential ones through expanded stakeholder's consultation process using 'Logical Problem Analysis' through preparation of 'Problem-Solution Trees and 'Market Mapping' tools for relevant technologies. Additionally, interviews with farmer, suppliers and manufacturers were conducted by Mobile call and face to face meeting, also used to firm up the key barriers. Further efforts were mainly focused on creating and developing essential measures to overcome the key barriers and in developing enabling framework for development and diffusion of priority climate change technologies in selected sectors to ensure that Afghanistan follow the path of climate resilient development.
4. Ensured the full use of TNA barrier analysis guidelines (Boldt *et al.,* 2012), resources, information and templates provided by specialists of UNEP-DTU Partnership during and after regional capacity building workshops.
5. Ensured that the TNA outcomes are closely aligned with country's sustainable needs.
6. We tried our best to ensure that the whole process of Afghanistan's TNA, particularly the technology barrier identification and analysis largely remained country driven and participatory in nature.

1.2.1 Sensitization of policy makers

For ensuring the political ownership of TNA process in the country and to ensure the easy follow up later in the implementation of TNA prioritized technologies, special one on one detailed meetings and briefing sessions were arranged with relevant national and provincial policy makers.

1.2.2 Preparation of TAP and project ideas

After the completion of above two TNA stages, the work on the final stage-III, Technology Action Plan (TAP) and Project Ideas' will be initiated in accordance with the UNEP DTU guidelines.

CHAPTER 2: WATER SECTOR

2.1 Preliminary Targets for Technology Transfer and Diffusion in Water Sector

The existing water resources in Afghanistan are under substantial stress due to rapidly growing population size, fast rate of urbanization and subsequent unplanned land use changes. The country has considerable water resources from rainfall on its mountains with more than 80% of the water originate from snowmelt in the Hindu Kush mountains. In the country's eastern part having highest elevation, the snow buildup contributes to continual water resources storage (Ahmad and Wasiq, 2004).

Both Iran and Afghanistan have suffered from prolonged droughts over the last several years. In Afghanistan, the worst drought in decades directly affected two-thirds of the country in 2018-19. Around ten million Afghans were severely impacted by the drought and at least 300,000 were displaced as a result. Afghanistan's water scarcity situation is driven by a mixture of human and environmental factors. While climate change and other climate-related hazards have intensified water scarcity, human interventions have been a key driver. Unsustainable agricultural and livestock-rearing practices, budgetary deficits, years of conflict and a lack of drought management institutions have all played a role (Phoebe Sleet, 2020).

According to FAO (2016) a study on the Computation of long-term annual renewable water resources by country show that Afghanistan has 75 BM^3 (billion cubic meters) of water resources with 20 BM^3 groundwater and 55 BM^3 surface water (FAO, 2016). The estimated annual amount of water used in irrigation is 20 BM^3, which is 99% of all the pumped water and the overall groundwater withdrawal volumes to about 3 BM^3. Around 15% of the entire annually used water initiates from springs and groundwater aquifers while, 85% from streams and rivers. The contribution of the groundwater usage from deep wells is less than 0.5%. The per capita annual water availability is about 2500M^3, comparable with other countries, for example, with Iran (1400) and Pakistan (1200 M^3 per capita annually) (Qureshi, 2002).

The amount of water received in the country through precipitation (327 mm/year) is estimated to be around 213.5 km^3 per year (FAO 2016). According to current estimates, Afghanistan has 65.3 km^3 of potential water resources produced annually out of which 55.7 km^3 is surface water and 10.65 km^3 is groundwater. Out of the total surface water produced, about 18.18 km^3 is externally produced while 37.5 km^3 is produced internally.

The country's water sector conveys a multi-user profile that meets the water demands of agriculture and industry sectors as well as numerous domestic purposes. Presently, 3.9 million ha is cultivated land with 1.3 million and 2.6 million ha by means of rain-fed and irrigation practices, respectively. However, the possible irrigable area is about 5 million ha, double of the under-irrigation area (ADB, 2003).

The government estimates that, during the past 30 years of conflict, "about 4,850 irrigation networks were destroyed and do not work at all." land under irrigation decreased from about 2.8 to 3.0 million ha before 1978 to only 1.5 million ha by 2002 (UNAMA, 2016).

The agriculture-based economy demands for the management and conservation of extant and potential water resources on sustainable basis for attaining a climate resistant growth according to the current climate projections of the country, specify cumulative doubt in spatial and temporal incidence of precipitation across the country.

Water availability for irrigation purpose is a function of the seasonal variation of stream flow and groundwater availability. The irrigation network in Afghanistan has a share of 88% unlined irrigation canals, which causes around 40% of the total water losses across the country (Qureshi, 2002).

However, having considerable water resources for crop irrigation and livestock, the country suffers from poorly maintained or spoiled extant irrigation systems and its overall poor performance (Torell & Ward, 2010). As for a long time, the country's agriculture relied on irrigation, the war has caused in lack of information and 30 years isolation caused the water management technologies to be deficient (Groninger & Lasko, 2011).

Technological development and innovation could play a critical role to achieve food and water security targets of the country considering uncertain climatic conditions cast by climate change by the end of this century.

During the first stage of preparing the Technology Needs Assessment (TNA) in the country, with consensus from climate change Adaptation Technical Working Group members and other important stakeholders, a set of 12 adaptation technologies of Water sector were identified. Finally, four technologies were prioritized through multi-criteria assessment process based on their importance in reducing vulnerability of communities and individuals to the severe impacts of climate change. The prioritized technologies were:

1. Micro irrigation system for efficient water use and management
2. Integrated water resource management
3. Small dams and micro catchment
4. Rain water collection from ground surface

Afghanistan has experience with all of the above four technologies which are available and in use at various levels, but with certain issues and challenges related to their easy deployment and quick spread. To ensure sustainability of these technologies, the TNA project during this second stage of barrier analysis and enabling framework the water expert group through Skype and Mobile communication sets some preliminary targets based on the country's necessities for the transfer and diffusion of these above-mentioned technologies in water sector it depend on availability of sufficient funds for implementation of such activities and targets, which are as below:

1. To build up approximately 1500 public and community-run surface rainwater collecting tanks having capacity around 20000- 60,000 m^3 by 2023.

2. To build and modernize the small dams structures of 15 main cities by 2023.
3. Setting standards for LID (low impact development) structure in 15 key towns as a tactic for rainwater management by 2022.
4. Construct efficient systems of irrigation in dry regions.

To achieve these preliminary targets of transfer and diffusion of technologies in water sector, the relevant stakeholders and players have to get involved and play active role in the successful implementation of technologies. The important stakeholders include water sector policy makers, experts, relevant ministries of Food Security and Research, Water and Power, Climate Change and its connecting departments at provincial level besides National and Provincial Commission on Status of Women (as women and girls being the important stakeholders in this debate). Other players include technology dealers, technicians, and experts in water and irrigation sector. The implementers include NGOs and CBOs focusing on water issues, advocacy groups of women, youth and community leaders active at local and national levels.

2.2. Barrier Analysis and Possible Enabling Measures for Rainwater Collection from Ground Surface

2.2.1 General description of rainwater collection technology

In water-stressed areas, the availability of freshwater in relation to human consumption is significantly affected by runoff collection infrastructure, especially in arid and semi-arid regions with a very intense, often seasonal and little rainfall, (Elliot *et al*., 2011). The insufficient water supply throughout seasonal dry periods and drought disturb the economic growth with substantial influence on agricultural sector. Runoff may be plentiful for short period but may not occur in the rest of the year in these conditions, to ensure the adequate availability of water throughout the dry season, the implementation of such technology can be supportive.

The collection of rainwater from ground surfaces refers to the collection, modification and storage of such water in order to supplement further collection and distribution system of a community to its future usage in dry seasons. The collected ground surface water is normally not used in potable purposes but can be used in irrigation, livestock and other general domestic use. This would decrease excessive drainage, decline the pressure on groundwater resources and improve the beneficial water use.

The reservoirs could be constructed from low-priced or homemade material, it also demands low cost of requirements and upkeep as well as supply safe water adjacent to households, agricultural area etc. Actually, water collecting refers to a system that collects the rainfall in its dropping area and prevent its draining out including the water collected inside the agricultural land and its surrounding surfaces, boundaries of a property as well as from roofs (Kashiwar and Dongarwar, 2016).

Two sorts of rainwater collection could be discussed from the technology; a) divert or slow down the water runoff for storage by micro-catchment that collect rainwater from ground

surfaces and; b) flood water collection flowing from watercourses, rivers, streams as well as other. The technology covers the earthen structures and others to form a small reservoir. The common structures for water collecting are village tanks, roof water harvesting, and percolation tanks as well as check dams. While the choice of a specific one for a particular area depends on socio-cultural and geo-morphological situations of that area.
The check dams are normally built in an lengthwise series of the river sequence. In the areas with deep groundwater tables (many areas of Afghanistan), the construction of the recharge tube-wells in combination with check dams are the effectual and successful solution.

The floods and soil erosion would be controlled by means of constructing the check dams at appropriate location and the stored water (during the rainfall) would benefit the crop cultivation in dry seasons. Check dam's construction in upper catchments diminish the land degradation, sedimentation load and encourage the local community for improved crop production as well as natural beauty of the region's landscape while, check dams in the lower and middle catchments could be useful in recharging the reducing groundwater resources.

These efforts suggest several profits throughout the droughts and dry seasonal periods, specifically in terms of climate change to enhance the intensity and variation of rainfall in the long run. Collection of this water alleviate the depletion of groundwater level along with decreased erosion and flood influx to major rivers by implementing the storage infrastructure. This provide a source of stored water that may be convenient in increased agricultural productivity, reduction of time for rural women to distant water resources to sustain better health and prevent time consumption.

2.2.1.1 Technology status in Afghanistan

From the last many decades, rainwater collection (RWC) is adopted in arid and semi-arid regions of Afghanistan, particularly in rain-fed zones as an important measure in dry land regions for controlling desertification in order to ensure the availability of water for irrigation, livestock and domestic purposes to the concerned communities.
Current irrigation methods irrigate 10% of the overall irrigated area in the country whereas, traditional irrigation methods by means of canal denote about 75% underground aqueducts (Karezes) while, the remaining 15 % of the country's irrigation water is supplied by springs and wells (Hussain *et al.*, 2008).

Up to a certain extent, the country's irrigation is still dependent on the large water quantity to the both of own and downstream users on the field turns of their irrigation. Our growers might inspire in using water collecting measures (large and small storages), trained and familiarized with new technologies of water saving and crop diversities that resulted positively in arid regions alike to the country's conditions (Molden *et al.*, 2010).

The system thrives on the floodwater from hills, diverted to the command area through ordinary earthen and weir-controlled structures. In some areas of Afghanistan, where the spate irrigation system is advanced, the excess floodwater is regulated by diverting it to reservoirs of water through well-established canal networks system and then the stored water

is distributed to the water users functioning inside the command area as per agreement between the government and water-use association.

A recent study of ground surface RWC adoption by small-scale farmers of progressing countries showed its possibility, having Benefit Cost Ratio (B: C) up to 1.6 with internal return up to 76%. However, the net present value varies depending on the currency and the location (Rozaki *et al*. 2017). They also described that excavation and sealing material are included in the micro dam cost which depends on the micro dam's volume and sealing material's type, the devaluation period is the another feature of rainwater construction cost depending on the lining material: soil base, plastic sheet or concrete (Rozaki *et al*., 2017). They strongly relied on the work of Fox *et al.,* (2005).

Fox *et al.* (2005), carried out an investigation on RWC for supplementary irrigation designed for Burkina Faso and Kenya, they stated that usually, 20 years is the set time of depreciation for a reservoir, with the predictable operative life span and proper maintenance of the reservoir. This depreciation times varies with selection of materials *viz.,* the estimate deprecation time for cement-lined selection is 20 years, for the thicker plastic sheet sealants (4 mm) it is 10 years and for thinner plastic (1 mm) 3 years and as the depreciation time expires, the plastic sealants is to be substituted.

The local market prices of the construction materials were used as base for cost estimates. In the construction of the small-scale RWC system, the labor was a major capital input because the calculation was for a reservoir dug by hand and the cost of the labor was set at equivalent to foregone income and during the dry season for fully irrigated agriculture when the price is at its peak. They select tomato as the off-season cash crop with the cereal as a staple crop. Totally, this situation fits Afghanistan because most of the farmers irrigate only cash crops and tomato is grown up in the dry season as a cash crop with the peak price in this season. Analysis of cost-benefits was carried out for a combined system, the costs depend on whether labor is valued based on full opportunity, alternative opportunity or zero opportunity costs along with the cost of used sealing technology of rainwater collection. (Fox *et al.*, 2005).

Fig. 2. 1: Rainwater collection from ground surface in Afghanistan

2.2.1.2. Technology category and market characteristics

The technology of surface rainwater collection is considered as a non-market community good when established at a community level along with the support of provincial level for managing and developing the system. The technology option in this report is community or state-managed rainwater collecting system thus, considered as a non-market public good.

2.2.2 Identification of barriers for rainwater collection technology (RWC)

Preliminary barrier Identification:

A study of important policy and strategy papers along with additional related documents was carried out. Due to COVID-19 pandemic the interactions with the relevant stakeholders' was carried out via Skype and Mobile communication. A list of possible barriers to the progression, transmission and circulation of RWC technology, in the country was prepared and categorized into two main types' *viz.*, economic and financial barriers, and non-financial barriers. The former barriers were further categorized into policy, legal and regulatory, technical, institutional and organizational capacity, social, cultural and behavioral as well as information and awareness barriers.

The initial list of barriers was supplemented by barriers, proposed by participants during the discussion and the summarized list was screened. The decomposition of barriers within category, with elements of barriers and dimension of barrier elements was applied. In random order, the identified barriers included the following:

1. Poor design of the technology
2. High cost of capital
3. The collecting of ground surface water is not a farmers' investment priority.
4. Lack of water prices for agriculture is a restrictive to the technology adoption.
5. Lack of appropriate water and agriculture policies
6. Unsatisfactory legal and regulatory framework for the technology
7. Poor inter-departmental interaction and coordination
8. Lack of monitoring of floodwater flows
9. Lack of consciousness among community
10. Lack of encouragements for community participation and ownership
11. Uncertain and unpredictable rain frequency and irregular flow of water in water conveyance systems
12. Lack of research and trainings
13. Lack of information on social benefits of technology
14. Insufficient institutional capacity and management skills of government departments
15. Conflicted land tenure
16. Health issues arising from water-borne vectors

Screening and prioritization of identified barriers

In order to identify the essential barriers that need to be addressed for transmission and diffusion of technology as well as the non-essential barriers that were unnoticed, Afghanistan's National Environmental Protection Agency initially helped through a small search committee in identification and involvement of wide range of stakeholders which include experts from water and agriculture sectors, officials from relevant ministries and

departments, representatives of NGOs, representatives of suppliers and manufacturers, and officials of some international donor agencies in consultation process. A list of these stakeholders along with their contacts is given in the Annex 2. As a first step, a team of experts listed down potential economic, financial, and non-financial barriers to the diffusion of each prioritized technology in Afghanistan through expert opinion and extensive literature review. Later, non-financial barrier category was further broken down into other barrier categories including policy, legal and regulatory, institutional and organizational capacity, technical, information etc.

Screening and short listing of key barriers, particularly where the potential barriers list was long, to select most essential ones through expanded stakeholders consultation process using 'Logical Problem Analysis' through preparation of 'Problem-Solution Trees and 'Market Mapping' tools for relevant technologies. Additionally, interviews with key respondents were also used to firm up the key barriers. Further efforts were mainly focused on creating and developing essential measures to overcome the key barriers and in developing enabling framework for development and diffusion of priority climate change technologies in selected sectors.

The list was presented to the participants of the barrier analysis by Skype and Mobile communication. The barrier analysis tools *i.e.,* starter problem and solution trees were used to hasten the process of barriers' prioritization. The final list of barriers was achieved through consensus among participants and discussed. The above listed barriers are categorized into two groups economic and financial and non - financial barriers, which are described as follows.

2.2.2.1 Economic and financial barriers

1. High cost of the technology and difficulties to access funds (small and medium farming). Agriculture is not well funded in Afghanistan.
2. In case where international funding organizations such as the World Bank are supporting and financing such projects, once the project is over and most of staff is either terminated or re-assigned to other projects, there is a lingering uncertainty on the continuity and success of project. Due to inherent risk of low rainfall or high floods accompanying with RWC technology, there is high possibility of low crop returns or crop failures that would add to the economic and financial burden of technology management.

2.2.2.2 Non-financial barriers

Policy, legal and regulatory

1. The lack of approved water and agriculture policies in Afghanistan that would provide a clear directive to the rising demands and challenges of the water and the agriculture sectors through a sustainable management of water resources, particularly in the face of climate change. Consequently, traditional rainwater collecting systems, especially functioning in the arid and semi-arid regions of the country, grabs marginal consideration within a policy and regulatory dialogue.
2. Poor consideration of current water rights and rules, particularly in the indigenous RWC systems creates a barrier regarding the good understanding of conceivable

influences of external interventions on existing rules and practices of water maintenance and distribution.

3. Unfair supply of water to the water users at the community level is an important part of this aspect of barrier (Habib, 2014). The measurement of water availability in the system in volumetric terms is difficult due to unpredictability of rains and place-based design of the system that currently bears no control or regulation on flow to various subdivision/channels.
4. Inadequate support of externals to community-based water managers. Wherever it is available, is limited to the provision of heavy machinery (bulldozer etc.) to the user community up to a certain extent in order to restore the water conveyance structure that damaged as result of heavy rainwater flow. The main disadvantage of bulldozer program is the space that creates in the service facility, as they are not replaced when goes out of service (Steenbergen *et al*., 2010).

Technical

1. Frequent siltation of rainwater storage structures is a foremost issue of technical design. The elevation of the irrigation plots raises each year due to heavy load of siltation thus, hinder the entry of the floodwater to the plots and reduces the overall efficiency of the system.
2. High labor demand with technical skill to rebuild temporary diversion weirs and intake structures.
3. Insufficient capacity and local skills of identifying the appropriate rain catchments as well as proper spots of constructing the water tanks/reservoirs.
4. Weak capacity of research institutions in assisting the local communities to identify the suitable technologies and sites of water intake structures and Insufficient capacity of communities, both in terms of know-how and material resources to maintain and manage the technology on a sustainable base.

Social, cultural and behavioral

1. The high disparity of land tenure structures that occurs at the community levels with restricted understanding between developers and practitioners of technology creates a challenge for them to secure a land for water storage structures and reservoirs construction in order to manage the structures and fairly allot the profits among water users. A conflict in land tenure might reflect complexity of risk management allied with the technology that upsurges inequalities and unequal access to resources among social groups and members.
2. The custom of community-run-systems is often limited, scattered and neglected in the country and hence the participation and involvement of community members in the decision-making processes regarding to the development and implementation technology are mostly ignored which clarifies the lack of community ownership for such projects and programs.

Awareness and information

1. General awareness for suitability of the technology and Insufficient information and consciousness about the benefits of Rainwater collection form ground surface technology.
2. Insufficient consciousness of climate change and technological solutions related issues.

2.2.3 Identified measures

The required measures for overcoming the barriers in the implementation of rainwater collection form ground surface technology in Afghanistan is discussed in this section. Development of problem and solution trees through stakeholder participation along with the detailed analysis of current national practices in the relevant field is the core-employed methodology for identification of suitable measures. The discussions during the video conference of barrier analysis through Skype communication led to identification of some key measures for eliminating and overcoming the above-identified barriers.

2.2.3.1 Economic and financial measures

a) The reduction in local taxes on construction material by the government offset the high initial construction cost of water channels, diversions and reservoirs. For a short-term, the government has exempted sales tax on brick and crushed stone and has reduced custom duty on import of construction machinery recently, yet, a raise in other taxes including withholding tax on renting of machinery and equipment etc. However, in the long-term may outdo the benefits of these tax exceptions. A policy of uniform and stable taxes focusing on preferred technologies regarding water and agriculture sectors might be significant measure in order to ensure water and food security in the country.
b) The annual central, provincial and local development funds in association with international donors' grants can be used for sponsoring the initial construction of large and medium sized reservoirs.
c) Introduction and expansion of social safety nets for poor households in the form of low mark-up loans, easy access to extension services inputs, credits, and marketing for their Agricultural products.

2.2.3.2 Non- financial measures

The present management practices of non-financial technology are mostly reactionary due to lack of information in technical, socio-economic and institutional aspects of the technology management and diffusion. In order to overcome the non-financial barriers in the technology implementation, following measures are essential to be taken:

Policy, legal and regulatory

Implementation of the approved agriculture and water policies with support of all key stakeholders of the society. These policies should emphasis on the downgraded part of community through connecting the technology development with poverty mitigation programs and interventions. The visibility of indigenous ground surface rainwater collection from systems of the country might improve through supporting of indigenous knowledge in designing and handover of the technology.

Production and strengthen of water user/local farmer organizations are responsible to farmers and enforcing the rights and distribution rules of water allied with local government within the accepted structures of the concerned communities. It is important that the right to plan or alter their own rules is appreciated by exterior authorities which allows a high level of flexibility to correct unexpected conditions, rapid fluxes in legislations by providing the farmer's with legal recognition and authority to the rehearsal of conflict resolution techniques.

Technical

a) Up-surging monetary support to relevant R&D (research and development) institutes to increase their capacity for undertaking pre-feasibility studies, plus site selection prior to construction.
b) Ensuring the availability of essential technical (construction and maintenance) proficiency at local level for assuring the technology's sustainability.

Information and awareness

a) In order to overcome social as well as cultural barriers and to raise the consciousness of the community about merits of technology, effective educational campaigns need to be commenced at local level. Education Ministries and Climate Change at the central and regional levels could do this through the support of local NGOs.
b) Running a consciousness movement on the influence of climate change on water resources via concerning the entire relevant stakeholders both, from public and private segments as well as water managers, policy and decision makers, users, educators, journalists etc.

Social, cultural and behavioral

Recognize the social and economic framework in which the farmers or water users operates for ensuring sustainability and improvement of the technology design and its successful transfer to the future steps. This should be completed at the time of projects design with consultation of community members. This procedure will be helpful to the managers and technology developers in addressing the exact requirement of various parts of community, particularly neglected clusters including women. It will also improve the technology ownership at different phases of social representation.

2.3 Barrier Analysis and Possible Enabling Measures for Small dams and micro-catchment Technology

2.3.1 General Description of Small Dam and Micro Catchment

A small dam is a structure of impounding water whichever on and/or off stream, which creates a reservoir of water. It is a built off stream on hilly areas for capturing run-off of catchments, which allows the water to taken down by gravity force for irrigation propose. The dam ridges are built of masonry, compacted earth or concrete and the dam is covered either by concrete or clay for seepage inhibition. The hillside site of the dam should be leveled as possible having good suitability of soil and catchment. To reduce the costs, the recommended study on feasibility of ground surface RWC system for Afghanistan is the using of earth having clay soil. The study stated that though, the concrete edifice is good, the

high costs of cement may financially make it unaffordable, the results also suggest the natural basin storage in stream as well as supply of water through gravity for reduction of the operative irrigation cost. Moreover, the study also recommends the construction of interception ditches to cross the slope along with an allied convey canal at the lower spot of slope for collecting flows of the interception ditches into ponds/concrete tanks. The recommended storage capacity of the small dams for small farms ranges from 10,000 and 200,000 m^3 (FAO, 2014). To provide a passageway for extreme floods, the structure and size of the masonry/ concrete channel should be paid with special attention (Smith, 2014).

The local communities should manage the Micro-catchments, the numeral figure of these catchments is not well defined in Afghanistan so far but conceivably will range from 3000 to 4000 (Watershed Atlas of Afghanistan) with three basic types:

1. contour bench terraces
2. runoff strips
3. micro-watersheds

The former two types are suitable for agriculture due to requirement of creating regular patterns and mechanical redesigning of surrounding land, which are fluctuating with revegetation plan and natural location. The third one is most suitable for revegetation; this includes basin, mound and strip collectors.

The micro-catchment refers to curved (contoured) area having berms and gradients planned to upsurge the rainfall runoff and distillate it in a fixed sink where it is effectually infiltrating and reserved in the soil, which is protected from evaporation but available to plants. The micro-catchments could be constructed quickly, simply and economically by using local labor and materials. The runoff water is relatively inexpensive as contains low salt and it is not pumped or transported. These structures decrease soil salinity via increasing the leaching process and are often used to "store" water as soil moisture for agriculture. In order to ensure the availability of adequate water throughout the dry season in the areas of seasonal rainfall, small reservoirs are used (Elliot *et al.*, 2011).

2.3.1.1 Technology status in Afghanistan

The literatures' review on using the small dam and micro-catchment technology disclosed that it is not widely used in the country. The currently operated reservoirs and dams can be categorized into three (3) versatile dams' sites of hydropower and irrigation, twenty (20) and thirteen (13) single purpose dams' sites for hydropower and irrigation, respectively. The Hydropower dams contain the river-runoff form *viz.*, a diversion dam (without storage capacity). In Afghanistan, the small dams have been constructed traditionally since more than previous 1,000 years.

As the US Corps carried out the Assessment of Water Resources (survey on water harvest potential) in Southeast region of Afghanistan under the USAID assistance in (2009) for selecting suitable spots for small dams. The selected dams of 5 meters and 12 meters heights were fortified with basins (reservoirs) and storage capacity. The valuation was completed with identification of 295 dam spots included 159 irrigation and 136 hydropower/irrigation

sites concentrating in the Paktia, Logar, Khost, Paktika, Ghazni and Wardak provinces in southeast Afghanistan by US Corps in December 2009. (JICA, 2011).

The OEGI/USAID office and related USACE teamwork accomplished the watershed valuations based on high-resolution satellite imageries, spatial data availability, on-site observations, regional expert's assistance, in-country experience authors', digital elevation models and publications for the southern, eastern and Northern provinces of Afghanistan. More than 100 possible dam positions are documented so far, mainly for run-of-river hydropower and irrigation water storage.

Fig. 2. 2: Small dams and micro - catchment in Afghanistan

2.3.1.2 Technology category and market characteristics

When recognized at a community level with the provincial level's support in order to manage and develop the system, the technology is considered as a non-market public good, it is a decision of this report that the technology of micro-catchment and small dam is community or government-managed consequently, measured as a non-market public good.

2.3.2 Identification of Barriers

In Afghanistan, the irrigated agriculture is undeveloped to a large extent and a large number of arable lands are in areas with no availability of water source (FAO 2014), it means that the mainstream agriculture of Afghanistan is mostly rain dependent with fewer irrigation systems. However, the collected data of rainfall indicated that the pattern of rainfall remained unpredictable and the growers still rely on rainfall (Chengxiang 2008). Even though the National Authority of Water and Sewerage professed that it (authority) should provide a proper source of potable and/or water for agriculture excluding the shortened rainfall or drought periods, none of agency is providing irrigation water to farmers. Thus, different sources are used to support agricultural irrigation system. Within the country, most of the small-scale farmers rely on rainfed agriculture to a large extent with only 200 ha of land utilizing irrigation technology whereas, the farmers using irrigations generally utilize potable or surface water as a water source. Recently, the country's daily water demand in the dry season is 54,600 m^3 whereas, the highest water yield is 31800 m^3 (FAO 2014) which shows the gap of 22 800 m^3 during the dry season's water supply and demand while, the authority priorities the use of available water for drinkable intents. In random order, the identified barriers included are as follows:

1- High capital cost

2- Poor financial feasibility of technology
3- Poor design of the technology
4- Poor inter departmental interaction and coordination
5- Lack of information
6- Lack of knowledge along with insufficient skilled labor
7- Lack of farmers technical capacity in this area
8- High sedimentation rate
9- Inadequate policies
10- High rate of evaporation
11- High energy cost for running the system
12- Low preference for small dams and micro catchment
13- Conflicts of water and property right
14- High requirement of upkeep
15- Incompatibility to each type of soil
16- Lack of quality products and their certification

Consequently, the systems of irrigation are mainly established on lowland having persistent source of water nearby. The systems of irrigation are primarily installed on the farms cultivating vegetables or crops with short growing seasons which are fully controlled systems but, the farmers are not knowing the real under irrigation area. Many of the farmers use only one water source, sometimes the irrigated area is minor and neglected. Taking in account the challenges of climate change, the micro dam usage for storing rainwater in order to supplement irrigation is suggested (UNDESA 2012). The method of Problem Tree was used for finding the main and contributing causes of limited small dams and micro-catchment usage for supplementary irrigation. A focused group meeting including vital shareholders on behalf of the Ministry of Agriculture, Fisheries, Forestry and Environment, Irrigation Management Unit, along with the divisions of Agronomy, Planning, Environment and farmers was organized for identification of the root causes of micro dam technology's unhurried diffusion along with discovering the essential enabling framework and measures for technology diffusion. The identified core problem was the slow diffusion of the technology because the technology was introduced since 1970's to the country and is still not widely used and slow even though the farmers are facing lengthy dry periods whereas, those with lacking source of water cannot produce agricultural products all over the year. Numerous relating reasons serving as barriers in the technology diffusion were also recognized by the stakeholders which were graded and used in developing the problem tree. After then the prioritized barriers that hinder the acceptance of the technology were clustered into two categories i.e. financial and economic and non-financial barriers.

2.3.2.1 Economic and financial barriers

a) Normally the farmers of developing countries rarely keep the records of their good activities crucial for some of precise financial investigations (Gumbs 1997). Even if farmers are using small dams in Afghanistan, the data of the small dam technology essential for conducting an economic study for Afghanistan was not available while, studies on the technical possibility of small dam technology in Afghanistan was

available. (FAO 2014).The results indicated that RWC of all seven patterns had the B:C (benefit/cost ratio) larger than one, displaying their economic feasibility in the country while, the benefit/cost ratio of vegetable and fruit patterns was highest and means the benefit of this patterns would be higher (FAO 2014). Owing to unavailability of required data in Afghanistan for conducting an economic and financial analysis in the adoption of micro dam technology by the farmers, some international economic and financial studies were reviewed.

b) The only economic and financial barrier is the high adopting cost of the technology as it is constructed from heavy equipment imported from abroad. It means that the country's distance from sea ports results in the machinery's high landing cost and if the apparatus is sponsored by lend from the bank, it is problematic to obtain the essential gear of dam's construction due to high taxes and interest rates.

c) Currently, there is a diminutive installation of this technology in rural areas as the related governmental departments of the dam construction are not well furnished, in addition the mobilization and equipment costs are inflated due to high cost of fuel and construction materials such as cement prices are also overpriced.

2.3.2.2 Non- financial barriers

Economists declared that the success of a new technology depends on its technical and economic viability (Fox *et al.*, 2005).

Insufficient data

In Afghanistan, the studies on the feasibility for agricultural irrigation purpose are conducted but the useful essential data in the designing of the reservoirs (micro dam) was absent. In order to know the sufficiency and capacity of catchment area the information of the rainwater collection efficiency (RCE) of the catchment and water demand is essential. The catchment design and the irrigation system are applicable (FAO 2014).

Lack of technical capacity

The lack of information and knowledge along with insufficient skilled and experienced staff in the Irrigation Unit of the MAIL (Ministry of Agriculture, Irrigation and Livestock) is the main problem in agricultural irrigation leading to the lack of design and construction of micro-dam. The farmers also do not have technical capacity in this area.

High sedimentation rate

As the intensity of daily rainfall increases in Afghanistan, the sedimentation becomes a major problem of the dams. Usually, the first rains falling on topped dry soil causing accelerated run-off, the channel capacity is also a problem and the runoff of these initial storms of the year often cause failure of dams (Smith 2014).

Small size of farm

Since, several conservation practices decrease the available minor area of agriculture or cropping, these practices may be undesirable and inapplicable/unacceptable. Meanwhile, the stakeholders also reported the reduction of available area for cultivation on small farms

particularly for small plots of vegetables cultivation through micro dam construction (Gumbs 1997).

Technology's benefits evidences

Farmers display less tendency in adoption of a strange and practically unseen technology due to lack of awareness on the benefits of the technology. In order to experience and adopt the advanced and new method and technology of agricultural improvement without any prove of advantage, convincing of the decision-maker and farmer is very hard (Chengxiang 2008). Some vital stakeholders were also not conscious of the advantages of the micro dam technology as they were not familiar with this technology. Therefore, they remained hesitant in adopting it until given proof of its technical and financial possibility, they also mentioned that they are not provided with any physical sample and experience to illustrate to farmers on how the technology works and prove its benefits.

Insufficient policies

The relative authorities have no reports of any policy, strategy, legislation and measures in the country to manage RWC for agriculture. This is so despite the fact that many farmers (including farmers of Afghanistan) workout some methods of RWC. (FAO 2014). The National Water Policy Unit of the country does not account the use of rainfall in supplementary irrigation although; it identifies the increasing demand of water across many fields including tourism, industrial and agricultural divisions (Government of Afghanistan 2007). Thus, RWC for agricultural irrigation purpose is not a key section of the working programme of the Irrigation Management Unit of MAIL.

Increasing temperatures/High evaporation

a) As reservoirs are usually exposed to high sunlight leading to high evapotranspiration, the stored and passed over into the dry season water quantity is limited owing to evaporation from micro dam (Smith 2014). The growers are worried about prolonged drought and lack of reliable water storage for agriculture due to drying up of dams in this period. The inconsistency of rainfall along with lengthy droughts are expected to be continued with climate change, causing additional challenges for small farms to access water particularly on hillsides (FAO 2014).
b) Winds and high temperatures cause high evaporation from shallow surface storages including micro dams that are exposed to sunlight. High evapotranspiration rates and drying up of micro dams during drought, which are exposed to winds and sunlight do not offer a relied water storage for agricultural purpose (FAO 2014). Farmers in the country were also troubled about the effects of rising temperatures on the water in micro dam; the trouble is evaporation of water during lengthy dry periods.

2.3.3 Identified Measures

2.3.3.1 Economic and Financial Measures

Building the small dams in the areas of sharing water by several farmers in the dam is proved more cost effective (Chengxiang 2008). Similarly, UNDESA 2012 also recommended the engagement of growers' groups to work together in development of these reservoirs in a way that one storage is to be used by numerous farmers to lessen land losses as the first option.

There are two measures for price reduce in order to deal with the high construction materials cost 1) more investment in the manufacturing of such materials to increase their supply and 2) greater infrastructural investment which reduced the shortage and stabilized the demand for construction materials. The latter measure would encompass the rising pressure on prices in the long run, undoubtedly. To pact with high costs of mobilization as the fuel cost is the key factor here, the imposed plentiful customs on oil is to be reduced and updated.

Credit scheme

The credit scheme for providing loans with low interest for irrigation to comprise reservoirs is to be planned. The Asian Development Bank (ADB) has a scheme of agricultural loans as a group of the regular commercial loan. It is essential to establish the special scheme of credit consisting of low interest and realistic payback period for agricultural irrigation including reservoirs (micro dams) with flexible circumstances particularly for equality and security. Possibly, the scheme will be available through organizations of micro finance plus the union of credit as numerous farmers have memberships of this union thus, have a good opportunity of getting loan. Moreover, the government should also provide a support of labor in constructing the micro dam as an option.

Another option is inclusion of the support in building the micro dam for RWC as portion of the several Agricultural projects in relation to climate change being planned. The strategy, policy, official provision and discreet national Programme implementation should promote and encourage the RWC for agriculture with a special consideration to hillsides operative farmers (FAO 2014). This technology (RWC for agricultural irrigation) is to be included in the National Water Policy of Afghanistan and department of extension to be wired in building the capacity of the main growers along with their organizations in selecting of ordinary topography for collecting and storage of rainwater runoff (FAO 2014). The government should create a baseline in which the monitoring and evaluating benefits the RWC on minor production and continue the sites mapping conferring the designing of rainfall by means of input in the programme for RWC in agriculture (FAO 2014). Establish a practical drill on RWC for experts to get information and ability of project planning, design and building of RWC systems for agricultural irrigation (Chengxiang 2008). Offer a support on planning, development, designing and employment of model project in the field, having the following objectives:

- Examine, adjust and adapt the new technology of RWC
- Remain as a demonstration spot in influence of RWC in supplementing water for augmentation of food production
- Offer a chance for extension workers in learning and gaining skill on the technique application
- Be the best training and practice for local experts and growers.
- The experiment possibly will be placed either on government belongings or on a private farmhouse.

The improvement of the technology in designing the layout of RWC for agricultural irrigation and experimentation on financial structure for reservoir should be one of the aims of the project. The National extension department should be wired in building the capacity of

the main growers along with their organizations in selection of normal slope for collecting and storage of rainwater runoff (FAO 2014).

2.3.3.2 Non-Economic and Financial measures

The major non-financial barrier is deficient technical skills of dams and micro catchments construction as few government staff has the pertinent technical skills. Thus, the Pilot Venture of Water Access for providing skills development scholarships of dam and micro-catchment is required along with raising consciousness about these scholarships by the related organization (government) via outreach visits, programs, agendas and brochures distribution.

2.4 Barrier Analysis and Probable Enabling Measures for Micro irrigation system for efficient water use and management

2.4.1 General description of technology

Owed to climate alteration threats and resultant water scarcity, it is most important to use the water balanced and efficiently which is attained via water saving technologies usage. The micro-irrigation denotes the unhurried application of water as incessant distinct drops, minute spray above, below or on the soil by subsurface and surface trickle as well as sprinkler systems and is applied thru emitters linked to a water conveyance line via low conveyance pressure.

This system of irrigation protects the environment through conservation of fertilizer, water and soil resources, maximize crop output and rises the grower revenue. However, most of the developing countries small-scaled landholders are disadvantaged of this technology owing to its no-adoptability and high cost. Yet, it is unaffordable and also expensive for penniless families as well as too large for very small land plots.

High efficacy irrigation systems *i.e.* drip irrigation practice is the best technology of water saving for irrigation, which is a suitable technology with rising demand and positive effects on crop yield, revenue and food safety. This is a method of supplying water to the specific point of crops typically to the base of the plant. This system comprises a pipes network ended with emitters, which deliver water to the roots of plants. This method is most suitable for vegetables, orchards and cotton. Through this pressurized irrigation system /drip irrigation system by means of better homogeneity and higher efficiency; maximum yields can be achieved.

Installation requirements of this technology:

A pressurized water system is the key requirement of this technology in which the pressure fluctuates from 2-3 bars to more than 10 bars (Pumps) for taking water from the source and deliver pressure into pipe systems for water conveyance along other requirements as follow;

1. Filtration system;
2. Nutrients application (fertigation) system;
3. Pipes (main pipe line and tubes);
4. Control valves and safety valves;
5. Drip emitters and their variances;

6. Monitoring plant water need by tensiometer or others addressing the quantity and frequency of irrigation supplied by experts.

Adoption of this technology offers numerous profits *i.e.* providing fresh water with efficient water use in arid, semi-arid, drought prone with seasonal rainfall areas or those with less predictable rainfall. It declines water demand via decline in evaporation, low nutrients leaching and lowers chance of diseases through fertigation, adaptable to different land slopes and soils (saline and sandy soils) excluding heavy clay soils, works in combination with other ongoing projects for example RWC to adjust to climate change related stresses.

The water use efficiency (WUE) is improved by 90-95 % and 50-70 % under drip and sprinkler irrigation, respectively through this technology implementation. As there is weak sustainability of large public irrigation systems due to high costs of upkeep, operation, low recovery cost and poor governance, (Peacock *et al*, 2007), comparatively lower investment cost with high economic guarantee is required by the technology of micro-irrigation owing to strong governance of local community and lower costs upkeep and operation. Micro-irrigation technology adoption results in expansion of under irrigation areas due to reduced water requirement per unit area, water savings, allowing fertigation (fertilizer application through irrigation system), and up-surged cropping intensity (growing more crops/year). It also results in abridged labour cost, evaporation loss and crop failure risk, improved land productivity, water productivity, savings, crop yield, yield quality and ultimately high societal incomes (Kumar *et al*, 2008).

The technology comprises pressurized systems well matched for larger plots or low gravity pressure nourished trickle system of irrigation fit for small plot. The pressurized irrigation is planned based on soil type, slope, shape, dimension etc. and other field characteristics along with the required technical proficiency of water availability and cropping system in order to design and install the system as compared to the self the gravity fed small irrigation. This system save water via providing accurate water and nutrients delivery to plants thus, increase production.

2.4.1.1 Status of the technology in the country

This technology was introduced in early 80s by the public research institutes and fiscal funding of the international donors *i.e.* FAO, ADB and World Bank in Afghanistan (Ashraf, 2012).
The efficacy of Afghanistan's basin irrigation system is highly compromised because of high water losses at the different steps of conveyance *i.e.* water canals, streams and field.

The initial High Efficiency Irrigation System (HEIS) projects have resulted in a high failure rate allied with high costs of setting up and upkeep owing to usage of imported materials, insufficient technical facilities and unsuitable design of system. Hence, it failed to fulfill local necessities. HEIS have been improved and manufactured within the country but some important parts were imported in the last decade in order to fulfill the requirements. Similarly, government has also given a considerable provision (funding) and technical

support to the farmers from the agriculture departments, which have given rise to extensive adoption of the technology.

Fig. 2. 3: Micro irrigation system (sprinkler and drip) for efficient water use and management

2.4.1.2 Technology category and market characteristics

According to the application scale, the consideration of micro irrigation for efficient use of water and management technology is a farmers' accepted system and categorize as a market consumer good.

The identified market features of medium scale irrigation system are:

1. Farmers are capable of adopting the micro irrigation if sponsored.
2. Except some imported parts such as pumps and timers, many equipment's parts can be locally manufactured.
3. There is need to raise consciousness about the technology's utility primarily by related government organizations accompanied by social organizations.

2.4.2 Barriers identification

For the diffusion of micro irrigation technology, this procedure is primarily based on the reviews of literature, consultation, discussion sittings, interviews and meeting with experts, investors along with market suppliers of the technology as well as with expert working group of adaptation. The documented hindrances and measures were analyzed via market planning, starter problem and solution trees.

These barriers have two core categories *viz.*, financial/economic and non-financial. The latter barriers are also divided into eight subdivisions; regulatory/policy, social, technical, environmental, cultural and behavioral, consciousness and info, human skill, institutional capacity and market failure barriers.The general list of potential barriers in the dispersal and transfer of HEIS is as follow:

1. High set up, upkeep and operation cost.
2. Weak under-developed supply chain.
3. Lake of approved agricultural and water policies.
4. Frail system of water pricing.
5. Conflicts of water and property right.
6. High energy cost for running the system.

7. Low preference for resource conservation technologies.
8. Technical measurements of agencies and governmental organizations.
9. Low practical measurements of consumer group.
10. Lack of technology is cost effective at field and various climate zones.
11. Threat of soil degradation via salinity.
12. High requirement of upkeep, skill labors
13. Incompatibility to each type of soil.
14. Gap of communication between consumer, suppliers and technology developers.
15. Lack of quality products and their certification.
16. Poor financial feasibility of technology for small-scale landholders.

As a consumer good by means of a high user's number and a complex market chain including numerous market performers for apiece micro-irrigation system components, the barriers study was somewhat complex. A pertinent web-based resources and literature review on up-to-date trends and previous experiences, current nationwide reports, mutual meetings with certain informers *viz.*, NGOs, performers of the irrigation equipment marketing, extension officers/workers, responsible experts and researchers of agriculture and water resource management, discussion with irrigation specialists of the related organizations (DAIL/MAIL and Irrigation Authority) as well as consultant information was used for identification of barriers preventing the dispersion and transfer of the technology under local situations. In order to retain the important ones based on acquired local experience in applying irrigation ventures along with the coziness of eliminating those barricades, apiece of the recognized barricades was cautiously analyzed and separated and then, the main barricades were prioritized by shareholder's consultation/discussions. After then the prioritized barriers that hinder the acceptance of the technology were clustered into two (2) categories *i.e.,* financial and economic and non-economic barriers.

2.4.2.1 Financial and economic barriers

The key fiscal barrier in technology diffusion is the requirement of high initial asset as compared to traditional irrigation system, for purchasing the various components of technology, its transportation and installation and the identified main economic barriers through these procedures are; a) High initial building cost of small to average sized micro-irrigation systems. b) High operation and upkeep cost mainly with about 7 years lifetime. Such high costs are certainly unaffordable by Afghani farmers practicing mostly subsistence agriculture and it is significant to plan all works of the system operating due to extreme cost of micro irrigation systems. The micro irrigation system's implementation costs in horticulture/gardening, viticulture and olericulture (vegetable farming) is reliant on the type of the water supply source, distance from the water supply source, tube, equipment, geometry and field layout as well as crop and variety used etc. The major financial barriers in the way of the technology transfer and diffusion are as follow:

a) Requirement of high initial investment in order to purchase various components (pump, water tanks, tanks, fittings, main pipes, lateral, sub-lateral pressurized PVC pipes), transportation and setting up (installation) cost in comparison to other systems of irrigation (high enough price by dealers for their interest recovery on capital and risk reduction).

b) Scarce economic motivations for irrigation equipment purchasing and efficient water use and insufficient vibrant economic motivation for water saving owing to ineffective water pricing.
c) Scarce socio-economic analysis of micro irrigation system usage under small scale conditions as well as renewing irrigation system's (trickle) cost with about 7 years lifetime.
d) High cost of designing, setting up and upkeep (high labor requirement) along with high rate or interest on lend.

2.4.2.2 Non-financial barriers

These barriers are categorized in various groups as described below:

Imperfection and market failure. The micro irrigation system for efficient use of water and management in terms of market good faces numerous marketplace challenges, which are key problems in successful and effective replication and placement of the technology. The local market is small, under-developed with poor supply chain. Nowadays, the agriculture department has 22 competent companies of supply and service with responsibility of drip irrigation system installation and at least two years support for post installation provision. In addition, numerous elements of this barrier are further identified with deficient competitors, attainment of scale economies only at high level of investment, ailing uttered demand and uncertain fiscal condition of the country.

Policy, legal and regulatory

a) Lack of approved agricultural and water strategies with weak organizational basis of water management in the sector of agriculture along with unfavorable organizational agendas and policies regarding agricultural sector's water management.
b) Conflict of property and water privileges in construction small reservoir or water storages at small community levels as well as restricted water flow and micro-irrigation system usage due to canals' drainage confines.
c) Lack of assured and quality equipment at local standards: The micro irrigation system for efficient water use and management parts that are manufactured locally suffer from malfunction in design and quality that depress the performance of technology in the long -run and disheartens the adoption of the technology by farmers.
d) Lack of water savings inspiration by means of extant irrigation water pricing and negative externalities due to poorly defined water rights of pumping from rivers and bore-wells.

Technical:

Technically the Micro irrigation system faces various challenges as listed below:

a) Lack of quality water for trickle irrigation system, as the emitters frequently clog, extensive upkeep is essential while, the technical knowledge of maintenance and repair is scarce.
b) In the unleveled plots, water distribution is uneven which results in less or excess water of plants which is essential for HEIS thus, requires additional investment such

as power source to pump and lift water along with hassled system for uniform water distribution.

c) Reduction of the system's fiscal feasibility owing to high water lifting cost in areas irrigated with groundwater.
d) Insufficient information or improper nationwide economic and social analysis of technology and inadequate data of research in computing the actual saving and productivity of water on different crops and field settings (only experimental farmhouses, few crops and systems and a few locations have the available data).
e) Lack of technical proficiency in considering the type of the soil, size, topography and features of the field in order to operate and maintain the system on sustainable basis.
f) Different spacing of the crops as well as soil slopes, topography and types cases unsuitability of trickle irrigation system for all crops.

Cultural, Social and behavioral barriers

a) Farmers' conflict in altering, understanding of complication, and apparent adverse results (risk), loss of asset in case of crop failure and absence of market leading to preferment of other irrigation systems *i.e.* flood system.
b) In order to achieve fiscal viability, shifting of the system to cash crops may be required which need the farmer to accept novel patterns of cropping while, the technical knowledge of the farmers is insufficient.
c) Requirement of owner's agreement for farmer who lease lands to invest in setting up and upkeep of the technology.

Institutional capacity barriers

a) Limited research & development institutional capacity to undertake practical experiments and pilot projects for demonstration to farmers.
b) Limited good knowledge and practical experience which is necessary to install and operationalize such water saving systems, as each system needs to be site specific for optimal use.
c) Weak collaboration and communication between extension, research and end user.

Information and awareness barriers

a) Lack of training, information facilities and awareness about the utility of the technology.
b) Lack of communication amid the users and producers of the technology.
c) Insufficient knowledge of locally commenced positive events to prove the impression of HEIS on efficacy of water use.

2.4.3 Identified measures

The essential measures in overwhelming the recognized barriers of the earlier segment is discussed in this unit in order to implement the efficient technology of irrigation in Afghanistan. The core-employed policy in identification of suitable measures is the problem and solution trees evolution via contribution of stakeholders along with comprehensive study of current national and international observations in the related area. Subsequently, the discussion in workshop with stakeholders based on solution tree gave rise to the recognition

of essential key measures in diffusion of drip irrigation technology in the country. The prioritized measures through contributors are as follow.

2.4.3.1 Financial and economic measures

a) Providing interest free or low interest loans for obtaining and setting up of apparatus.
b) Providing subvention and allowances on primary installation cost in order to encourage the usage of this water saving technology.
c) Providing generous refund of tax or tax inducements.
d) Lessening of import taxes on the essential importable parts.
e) Fiscal deterrents to inspire optimum use of effective irrigation system.
f) Investment motivation of commercial banking in the rural area for water problems solution.
g) Desirability of international foundations (USAID, UNDP, etc.) for demo projects in small farms.

2.4.3.2 Non-financial measures

Policy, legal and regulatory measures

a) In order to encourage micro irrigation technology in the country, the substantial funding policy should be developed by the government.
b) The apparatus parts of micro irrigation should be standard.
c) In order to improve the products and its access to the market and accordingly upsurge asset in preferment of effective micro-irrigation system, the government should accept the technology as a superior investment part of agricultural production.
d) Informing the extant authorized program to elaborate and strengthen its rules for climate change adaptation.

Technical

a) Valuation of real cropping areas suitable for this technology, which would get advantage from the technology in relation of water efficiency improvements.
b) Proficient training of facility workforces and water users in planning, designing, setting up, operation and upkeep of the technology.
c) Farmers should be trained to know the usage of climate and soil related information in determining the water requirement of the crop, water management along with scheduling the irrigation water by means of when to apply, how much to apply and how to apply.
d) Practical manuals/guidelines on the design, planning and management of the technology should be developed.
e) Organization of growers' trip to the locations of demonstration in order to encourage the farmers in adopting the micro-irrigation technology as well as providing them all the productions, suppliers, price and financial benefit's related information.

Cultural, social and behavioral

a) Describe the fiscal profits of utilizing the technology to the growers by highlighting the contribution of the technology in the well-being/ enabling of female water managers and users.

b) Diminish the risk insight by means of demonstration plots and markets opportunities.
c) Development and application of effectual and suitable mechanisms for evaluating the societal efficacy of the developed and applied measures.

Institutional/Organizational capacity

a) R&D should be provided with essential monetary support by government and other related organizations should commence the required research and preliminary projects of demonstration.
b) Associated institutions of the government might commence dynamic consciousness and info events about the utility of the technology.
c) The R&D societies are to be wired with the specified duty of preparing the long-term climate and scenarios of the country.
d) Resource necessities assessment of various organizational levels via further concentration on regional and local level organizations *viz.,* Extension officers/workers, RDCs, Engineering and Agriculture sectors.
e) Scheduling trainings on water management and irrigation for emerging irrigation experts and engineers in relevant organizations ·
f) Development of organizational gathering for evener application of the technology which may comprise creation of special units in the extant nodal agencies at local, regional and central levels with the tasks of scheduling (planning), certification (approval), management (administration), technical support, application (implementation) as well as monitoring and assessment.

Awareness and information

Undertake capacity building training and consciousness movements on sprinkler and trickle (drip) irrigation methods intended for farmers, extension workers, regional RDCs and district engineers, as this is very important due to insufficiency of expert staffs to install and operate such technologies. In order to modify the traditional farming to the cash crops of high worth and alter the patterns and practices of cropping system through adapting trickle technology with a highest benefit of the technology usage, the growers are to be aware, trained and educated.

Human Skills

a) For making skilled the technicians' staff with moral training of setting up and maintenance of the technology, government/management may deliver fiscal provision to its related organizations.
b) The growers may be skilled and trained alike for routine procedures and slight repairs of the system, at the same time.

Market supports

a) In order to encourage investment in the technology, importers, shippers, suppliers, constructors, traders and dealers may be provided with low interest and tax inducements.

b) The standard of the product is to be develop, implement and control.
c) For having sufficient local level suppliers, markets are to be supported and should be easily accessible to farmers.

2.5. Barrier Analysis and Probable Enabling Measures for Integrated water resources management

2.5.1 General description of the technology

The increasing population and economic growth are triggering a cumulative demand of freshwater in many communities around the world due to increased water consumption rate (more than twice) than previous century. Even though there is no worldwide water scarcity so far, approximately 2.8 billion folks denote over 40 % population of the world residing in river sinks have some kind of water shortage and over 1.2 billion of them are breathing in physical water scarcity environments as result of more than 75 % flows withdrawn of the river (UNDESA, 2008). The water demand of these areas will hurriedly increase to surpass the usual supply in absence of an improved sustainable policy for integrated water resource management (IWRM).

In order to increase resilient and adaptive measurements of catastrophic risks management, damage and loss in a river basin, IWRM is essential and According to definition of GWP (2000) it is "a practice of promoting the harmonized management and development of correlated resources (land, water, etc.). To maximize the subsequent societal and financial wellbeing in a balanced way without any compromise on vital ecosystem's sustainability", in other words IWRM is a procedure that help countries in the efforts of dealing with water problems in a sustainable cost-effective manner. The ADB declared its Water Funding Program 2006-2010 for serving its participant countries to undertake IWRM in 25 river basins of the Asia-Pacific region in March 2006. The designation of IWRM suggests, "An inter-sectoral tactic, illustration of all investors, corporeal aspects of water sources along with ecological consideration and sustainability" (Savenije *et al,* 2000).

The International Meeting held in Dublin (1992) on the Environment and Water, set off four supervisory concepts related to water use as below:

1. Fresh water is a susceptible and finite resource, essential for development, the environment and a sustained life.
2. Water management and development should be based on a participation including policy-makers, planners and users at all levels.
3. Women perform a dominant role in the water management, safeguarding and provision.
4. As water has an economic value in all its rival usages, it should be recognized as an economic good.

The approach of IWRM assists in developing and management of water resources in an equitable and sustainable manner including economic, social and environmental welfares. The combined process synchronizes the management of water resources across interest groups and subdivisions at all levels from international to local. Evidently, climate alteration,

economic growth, demographic fluctuations and population growth exert serious influences on water resources.

Similarly, water resources also exert substantial effect on health and livelihoods, national security, economic growth and production. In case of increasing pressures on water resources, the proper management of renewable freshwaters is essential but, it is ever more complex to manage the water as societal and demographic fluctuations, poverty reduction efforts and economic growth rise the water demands for energy generating, goods and facilities availability as well as food production support. These advances exert countless effects on water resources. (GWP-INBO, 2009).

2.5.1.1 Technology status in Afghanistan

The country's government has formally approved the IWRM as the rudimentary approach for management of the water resources at all related units of water resources management in Afghanistan. Government of Afghanistan introduce reforms by ratifying the new Water law in 2009 and placed the integrated water resource management at the center of its national water reforms. With the aim to inaugurate this program, the RBM (River Basin Management) program was introduced by MIWRE in the country. Under the RBM approach, the country is parted into five important river basins;

1. The Amu Darya River Basin.
2. Northern River Basin.
3. Harirod-Murghab River Basin.
4. Helmand River Basin.
5. Kabul River Basin.

Afghanistan enacted its Water Law based on the principles of IWRM with the goal to make agriculture sector a more vigorous driver of the country's economy in 2009. The law was passed by the parliament in December, (2008) which is conscripted in 7 chapters and 40 articles and is expected to protect the country's water resources and confirm its sustainable, effectual and equitable usage through this law. Afghanistan bonded to the group of the countries those already applied principles of IWRM in their national water sector plans and policies. (Ahmadzai *et al.*, 2017).

Fig. 2. 4: Integrated water resources management (IWRM)

2.5.1.2 Technology category and market characteristics

Integrated water resources management (IWRM) technology is a non-market public good established at a national level along with the support of provincial level for managing and developing the system. The technology option in this report is government or State-managed integrated water resource management system. Thus, considered as a non-market public good.

2.5.2 Identification of barriers

A study of important policy and strategy papers along with additional related documents was carried out and supported by experts, key stakeholders' interviews and workshop brainstorming. As a primary step, a list of possible barriers to the progression, transmission and circulation of integrated water resources management technology, in the country was prepared and categorized into two main types' *viz.,* economic and financial barriers, and non-financial barriers. The former barriers were further categorized into policy, legal and regulatory, technical, institutional and organizational capacity, social, cultural and behavioral as well as information and awareness barriers. In random order, the identified barriers included the following:

- Lack of rules and regulations relevant to the water sector.
- Inadequate suitable data for strategic plans of water resources development.
- Absence of water master plans for the river sinks (basins).
- Scarcity of organizational system and staff.
- Scarcity of power for water supply system operation.
- Coming back of immigrants to the country
- Ineffective national strategic plan for inundation control and drought extenuation.
- Demolition of drinkable and irrigation water set-up.
- Destitute performance of the extant irrigation system.
- Scarce water resources substructure.
- Severely damaged community and rural based water user associations and structure.
- Destitute technical knowledge at community and local level with inappropriate technology.
- Non-harmonization and shortage of awareness amongst stakeholders/investors.
- Inadequate fiscal resources
- Security issues
- Shortage of public consciousness and damaged local/traditional organization.

(Mahmoodi, 2008).

In order to retain the important ones based on acquired local experience in applying irrigation ventures along with the coziness of eliminating those barricades, apiece of the recognized barricades was cautiously analyzed and separated and then, the main barricades were prioritized by shareholder's consultation/discussions. After then the prioritized barriers that hinder the acceptance of the technology were clustered into two (2) categories *i.e.,* financial and economic and non-economic barriers.

2.5.2.1 Financial & Economic barriers

The identified major economic and financial barriers leading to performance gaps, inhibited effectual management and sustainability of IWRM are insufficient budget, capitals (funds) and investment/asset for effectual IWRM and river basin by the major fiscal supporters *viz.,*

international organizations or development allies. The scarce fiscal support by private sector along with scarcity of rule and standard performs in regulation and guiding of financing together with water dues and excises is due to unsatisfactory fiscal models of investments in the IWRM on sustainable basis. Higher amount of community asset (investment) was aimed to use in the other sectors instead of environment as well as water sector. The insufficient budget has restricted IWRM, particularly 1) information management and development including water resources valuation, supply and demand of water, climate variation along with disaster jeopardy and adaptive measurements, 2) pacts and rules on water distribution, usages and excise etc., 3) application and development of comprehensive river basin plan as well as capacity building, and 4) solution of conflict. Subsequently, it weakens the capacity of climate change adaptive and risk resistance. Insufficient subsidy harmonization programmes for different conventions.

2.5.2.2 Non-financial barriers

In order to make the import procedure of the technology simple, exact taxes protocols are absence. Low consciousness level and deficient capacity of communal units, residents and local authorities on the technology merits along with rare harmonization of related organizations might be another barricade to distribution of the technology and weirdness of the technology might be a societal barricade to the technology application as well.

Policy, legal and regulatory

A number of essential subsidiary rules and regulations on clear and detailed guiding principles of river basin management and development together with IWRM adaptation strategies are not prepared by means of ineffective water resources enforcement law. This absence of ineffective subsidiary rule execution is allied with scarce M&E and harmonization among investors, fiscal resources, skills and policy while, only few river sinks have an arranged development plan and strategy.

Though, at provincial level or in an early stage, the strategies were not updated to downscaled village and district level with no climate variation and catastrophe hazard declining actions and policies. Partial integrated project was as a result of information gaps (destitute info sharing), ineffective harmonization and budget scarcity.

Technical barrier of IWRM for adaptation

Insufficient skills and information aimed at adoption of IWRM that comprises inadequate skill and knowledge on policy, economic & financial, technical and other managing features of IWRM. The deficient skills and knowledge originate from the frail human resources development system with deficient capacity and human resource development policy comprising of staff knowledge, targets, mismatched recruitments, capacity management, no harmonization among educational public, private and other employ commands besides supply and demand side. Other factors such as insufficient fiscal investment for capacity building obstructs the Human Resource Management (HRD) and unsatisfactory management (leadership) and individual efforts for learning weakened the skills and knowledge whereas, individual activities and leadership are decisive for capacity building of the staff, cost-effective and very serious for fiscal scarcity.

The IWRM demands multi-punitive methods, effectual harmonization and contract. The realization of efficient River Basin Management (RBM) comprising IWRM, climate variation adaptation is budget and time consuming. Efficient harmonization and collaboration remain as the fundamentals of IWRM, but it is difficult to realize efficacy owing to lack of effectual steering committee. Moreover, it is deficient in effective models and finest performs management and collaboration among investors in River Basin Management (RBM). Conversely, the values on water supply projects, hydropower and irrigation have immediate influences and profits on socio-economic growths.

In short, scarce skills and knowledge on effectual R&D, finest practices on sustainable climate resilient River Basin Managment (RBM) and development, sustained adaptation of river sink, ineffective preferment of the river sink management and development as well as IWRM application are the key barriers in this context.

Social, cultural and behavioral

1. A conflict in land tenure might reflect complexity of risk management allied with the technology that upsurges inequalities and unequal access to resources among social groups and members.
2. The custom of community-run-systems is often limited, scattered and neglected in the country and hence the participation and involvement of community members in the decision-making processes regarding to the development and implementation technology are mostly ignored which clarifies the lack of community ownership for such projects and programs.
3. General lack of awareness for suitability of the technology in water scarce areas.

Information and awareness

1. Insufficient information and consciousness about the benefits of integrated water resources management technology.
2. Insufficient consciousness of climate change and technological solutions related issues.

2.5.3 Identified measures

2.5.3.1 Economic and financial measures

Following measures are proposed to overcome the extant fiscal and economic barriers to the technology application;

1. Regulations of particular taxes for simplifying the technology's import procedures.
2. Regulations of particular excise to encourage the investments of private sector for conception of local water saving technologies.
3. Particular funding mechanism development for boosting the water reclamation technologies' application.
4. Funding services and events for initiatives of water reuse and reclamation to be expanded to simplify such technologies.
5. Movements on capacity building and info activities to rise the knowledge on merits of the technology.

6. Facility of low-interest, long-term lends via different international (World Bank), private (Banks) and government funds (Entrepreneurship functioning Supportive State Fund within the Ministry of Economic Development, Credit Agency).

2.5.3.2 Non-financial measures

Policy, legal and regulatory

Discrepancy of policies and laws on the watershed management resources. There is no policy on developments and planning of IWRM with tactical ecological valuation to confirm that the applied developments in watershed are pertinent to watershed development strategy, agreement and are in harmonized way. Imperfect rule and policy on resources usages and levy with profits allocation. Imperfect contract among investors and directives on watershed managing.

Technical measure

The decisive factors of sustainable RBM in long and short-term are skills and knowledge. Thus, in addition to the human resource management and development system, effectual positioning, employment, knowledge and capacity management of the staff, plan, M&E and capacity development up-gradation, it is essential to improve the study, research in high education and IWRM professional training, on long and short-term basis. The improvement of HR's demand and supply synchronization helps in supporting and responding of the Human Resource Management (HRD) capacity development planning. It is also essential to promote and strengthen the staff commitment and inner culture of learning in addition to the leadership and with the appropriateness of this commitment, learning culture, leadership, skills and knowledge, the ability of relevant organizations for following sustainable and effectual RBM plan and overcoming the barricades could be expected to a maximum extent. The plan of River basin development for water resources state, pressures and development targets together with its susceptibility to climate change and catastrophe, water supply as well as demand identification and actions (measures) of water resources security for industries, consumption, ecosystems and climate change adaptation for apiece river sink must be developed. These demands will be fulfilled via contract among shareholders (mainly river sink's local authorities) on the plans and targets development and application of following doings:

1. Updating and adjustment of the extant water resource plans and policy (strategy).
2. Assessment of Resources, mainly for climate and calamity susceptibility and adaptive capacity.
3. Reform the IWRM plan of climate change adaptation and disaster resistance in apiece river sink.

Social, cultural and behavioral

Recognize the social and economic framework in which the farmers or water users operates for ensuring sustainability and improvement of the technology design and its successful transfer to the future steps. This should be completed at the time of projects design with consultation of community members. This procedure will be helpful to the managers and technology developers in addressing the exact requirement of various parts of community,

particularly neglected clusters including women. It will also improve the technology ownership at different phases of social representation.

Awareness and information

In order to overcome social as well as cultural barriers and to raise the consciousness of the community about merits of technology, effective educational campaigns need to be commenced at local level. Education Ministries and Climate Change at the central and regional levels could do this through the support of local NGOs.

Running a consciousness movement on the influence of climate change on water resources via concerning the entire relevant stakeholders both, from public and private segments as well as water managers, policy and decision makers, users, educators, journalists etc. Briefly, the non-fiscal measures for overwhelming the extant barricades of technology application are as following:

- Strengthening the supervisory and technical skill of wastewater and local water staffs to assess restrictions of existing practice, profits and wastewater reuse necessities along with their capability development to apply new programmes.
- Conduction of information movements on the merits of the applied technology.
- Application of experimental ventures at public/urban level to prove the technology's advantages.
- Facilitating suitable and secure reuse and reclamation programs required for policies and legal frameworks for ensuring environmental and human health and the protection.
- Develop funding mechanism to motivate the technology's local deployment.
- Restructuring organizational foundation for improved harmonization;
- Essential supervisory activities in the customs regulations to simplify the import of the technology.

2.6 Linkages of barriers Identified in Water Sector

This segment surrounds common barriers to water sector technologies. This prioritized technologies of water sector assists the goals of irrigation, somewhat flood defense and recharge of groundwater in the country. RWC is an ancient technology ranging from small sized pools to concrete dams to capture and store rainwater for irrigation purposes of rural communities.

After a several drought periods in numerous parts of the country in previous four decades, there is a steady alteration in water sector's pattern from "water for agricultural growth only" to "integrated conservation and management of water resource", and consequently building and maintenance of dual purposes water storage structures *i.e.,* agricultural irrigation and recharge of groundwater, the latter is a priority in arid and semi-arid regions where groundwater is the only consistent and simply available water source of societies and individuals.

The technologies contribute numerous barriers in terms of similarity in their use and development; hence, to find barrier links for finding possibly more effective chances and methods in addressing their mutual effect, it is imperative to take a holistic approach. The

table 2.1 illustrates the recognized common barricades for the technologies in the water sector of Afghanistan.

Table 2.1 Common barriers identified in different prioritized technologies in water sector

Mutual barriers of Water sector technologies		
Steps	Barrier type	Barriers
Step1	Financial &Economic	High cost of capital and maintenance
		Local governments limited financial allocation
		Inadequate loan and donor funding
Step 2	Policy, legal and regulatory	Lack of sound cross-sectoral policies for protection, growth and management of resources
Step 3	Information & awareness	Lack of information and consciousness about the technology presence and utility
Step 4	Institutional & organizational capacity	Inadequate capacities of organizations particularly at local level in integrating climate change risks' plans development
		Inadequate maintenance skills particularly at local level

These are common barriers inter-linked in technologies of water sector and overwhelming of these would help in acceptance and diffusion of water sector technologies.

2.7. Enabling Plan for Overcoming the Barriers of the Water Sector

The main factor in empowering framework to overcome the barriers in diffusion of technologies of the water sector is the employment of current policy of national climate change and recommendations of its operation outline followed by increasing financial distribution to upsurge the susceptible societies from influence of climate alteration on water assets. Thus, the mobilization of exterior donor agencies, access to international climate change funds mainly Green Climate Fund (GCF) as well as adaptation fund, can facilitate the diffusion of prioritized technology and for this it is necessary to develop a technology based effective adaptation projects promising in offering the probable profits of the technology to all the parties alike *i.e.,* users, managers and other recipients.

The need of ensuring that social, economic and environmental portions of water are unified into sectoral policies and plans is the following vital constituent of sustainable water sector management in Afghanistan, whereas, the guidance for these strategies and plans is to be taken from the themes of cross-cutting water access, equality and threats.

The implementing strategy of documented technology needs to be focus on alternate sources of water, sustainability of ground water and lessening of water related disaster hazard by means of floods that inundate and damage the infrastructure and cause risk to human lives, based on this theme. Several measures are anticipated in improving the diffusion of prioritized technology of water sector, but addressing the most vital, practical and crucial ones first is important.

Augmentation of organizational capacities, firming rules and regulations, ensuring decision in planning climate conversant, sponsoring consciousness about research and technology and

employing pilot demonstration projects can be easily placed in this category. Moreover, continuative confirmation of the essential investment will stand as a vibrant empowering factor in the implementation of all water sector technologies. Barriers and measures may cover these 5 broad issues relating to this context:

1. Confirming proper fiscal mechanism for supporting implementation.
2. Considerations of climate change related to sectoral plans, polices and tactics.
3. Firming the consciousness of research, training and technology amongst stakeholders.
4. Firming the national and sub-national levels' organizational capabilities.
5. Design and implementation of practical demonstration projects.

Table 2.2. Shows some important enabling measures required in diffusing the prioritized technologies of water sector.

Table: 2.2. Key measures identified for three technologies in water sector

Key measures identified
Financial & Economic
a. In order to diffuse these technologies, sufficient availability of development funds from National and International funding sources should be ensured. b. The government should remove or decrease custom and taxes on construction material of these technology. c. To motivate internal and external investors to invest on water sector as well as to provide opportunity for the imposing of such technologies.
Policy, legal & regulatory
a. Approval of pending water policy with superior attention to conservation and sustainable handling of groundwater. b. Defining the directorial groundwater aquifers' boundary along with a sole and authorized body of groundwater management in each province. c. Identify the authority and role of water user group and other managerial set up in official decision-making processes. d. Resolution of possession right to land, water and property rights by means of improved strategy harmonization info.
Awareness & Information
a. Preparation of extensive consciousness and information material about the presence and utility of these technologies along with publicizing these technologies through training, conferences and workshops.
Technical capacity of organizations & Institutions
a. Invest the technical capacity building of R & D as well as local government institutes b. Ensure and approve training and availability of local construction and maintenance staff.

Key enabling framework & water sector measures

In order to ensure conveyance of prioritized technologies and attain the initial goals of technologies' transfer and diffusion, the key enabling and essential measures are as follows:

a) Financing: High cost of capital is a crucial issue of water sector technologies. Thus, ensuring the national development arrangement process in the country with mandatory priority in dispersal of these technologies is needed. Besides the inadequate national development funds, the Division of Economic Affairs should effort for obtaining the grants of the exact project from international donor agencies especially from international climate financing as a Green climate/Adaptation Fund etc.
b) Capacity of R&D Institutions: Essential for ensuring allocation of satisfactory financial resources in yearly budget to R&D Institutions for enhancing their technical capability and undertaking studies of feasibilities in selecting the utmost appropriate spots for surface RWC based on hydro-geological circumstances. Capacity of operation and upkeep: Sufficient financial resources are needed to ensure the sustainable maintenance of water sector technologies and enhance the technical capacity of R&D as well as other relevant departments. Furthermore, for training the local operators in operation and upkeep of the technology, special training plans must be undertaken.

CHAPTER-3 AGRICULTURE SECTOR

3.1 Preliminary Targets for Technology Transfer and Diffusion in Agriculture Sector

The sector of agriculture is the backbone of the economic growth and development in the country. In 2015, the sector contributed in about 60 % of the total national export. Agrarian production is strictly related to climate that makes it one of the highest climate-sensitive of all fiscal segments, the climate risks to the agriculture sector are important problems as most of the rural residents are directly or indirectly reliant on agriculture for their livings. The current forecasts of climate variations in agriculture sector show temperature rise, variations in rainfall, wind and solar radiation with adverse effects on crop production as well as imminent threat to the national food improvements security. The Government of Afghanistan (GoAF) , finds numerous challenges and issues to accomplish the sustained development via water and food security with the most vital challenge in development of the sector *i.e.*, slow rate of high-tech inventions owing to restricted adoption of advanced agricultural systems. Thus, the adoption of environmentally sound technologies is essential in agriculture sector in order to move towards climate resilient progress path and to handle the severe climate change influences.

Keeping in view the influences of climate change on agriculture sector, the TNA project in its step-I prioritized and recognized the following climate change adaptation technologies in agriculture sector:

1. Introduction of plant varieties resistant to climate change;
2. Crop diversification and new varieties ;
3. Responsive agricultural extension;
4. Land use planning;
5. Conservative agriculture;
6. Agro-forestry;

These prioritized technologies of agricultural sector are the key measured adaptations for lessening the population vulnerability reliant on the sector of agriculture to the climate change impact. Though, from the beginning, the availability and utility of all the six technologies are highlighted that are in the country at different levels with only issue of limited implantation and using of these technologies on sustainable basis in carrying the sustainable assistances to the sector.

The identified primary targets for the transfer and diffusion of these technologies in agriculture sector under TNA project are:

1. Installation of micro irrigation systems on about five million hectares of agricultural lands in arid and semi-arid zones.
2. Advanced and encouraged use of wheat, fruits and vegetables drought tolerant varieties capable of growing in drought.
3. Providing the farmers with trainings of effective methods of irrigation and water management.
4. Upgrading the present centers of agriculture R&D in each province.

5. Modernization and upgrading of the country's climate monitoring and predicting system.
6. Agrarian cooperatives, organizations and family farmhouses expansion combined with market via intensive technologies application.
7. Population food security and farming produce supply to the processors on a sustainable basis thru the faithful benefits combination of national food security and comparative advantages of foreign trade.
8. Up-surging agricultural gross product via enhanced labor efficiency, lessening the number of agriculture workers and usage of excess labors in agrarian and non-agrarian sectors thru trainings.
9. Processing the significant agricultural products in the processing amenities of the communities developed by means of medium and small enterprises development.
10. Self-sufficiency of the vital foods, high food security level of the population, decreased rural immigration and poverty.
11. Raising awareness and declarations on climate responsive agriculture.
12. Crop pattern modification, usage of various varieties and cropping almanac including planting and harvesting dates.

3.2 Barrier Analysis and Possible Enabling Measures introduction of plant Varieties resistant to Climate Change

3.2.1 General description of technology

The technology of improved crop varieties and new species introduction aimed to building the resistance of crop to diseases, pests and environmental stresses associated with improved crop health, nutritional value, quality and productivity. The divergence or diversification of crop is the addition of cropping systems or new crops to agrarian production on a specific farm allied with different yields from value-added crops and balanced opportunities of marketing. Improved and new species of crop can be introduced by experiment of farmers with new varieties. Farmers can be supported by agricultural researchers and extension agents in the new varieties identification that might have improved adaptation to climate change conditions, and enable the farmers to compare the new varieties with the already produced ones. Farmers can overcome the losses of production resulted by climate change influence with augmented yield and quality through introducing new crop species.

Extension workers and agricultural researchers can help growers in new varieties identification adapted to climatic change and enable them to compare it with their already produced varieties. Drought- Early maturing and tolerant crop varieties lessen the crop loss risk, improve disease and unfavorable climatic conditions resilience besides varied benefits with the core one of shorter maturity period in comparison to traditional varieties. These varieties enhance crop resilience to environmental stresses, diseases and pest organisms improve plant quality, health, nutritional value and productivity. Thus, the growers will capable of covering productivity sufferers caused by climatic variations influence and gain improved quality and yield by means of new crop species introduction.

The improved and new crop varieties have resistance to the climate change resultant stresses *i.e.,* the heat and water stresses. In dry-land zones, drought is the major limitation of crop productivity affecting the survival of poor societies, however, development of drought tolerant crop varieties is the significant approach for effective use of water and improved crop yield in these areas of unpredictable water supply. Thus, despite climate change uncertainties, the above-mentioned varieties of crops are capable of resisting these stresses along with ensured food security.

This skill (technology) employs both traditional breeding and gene engineering practices as well as tools for creating stress-lenient crop varieties. The plant breeding bids active role of growers through observing the performance of the plants in the field while selecting the drought-tolerance plant characters. The molecular indicators are used to know the genetic drought tolerance basis and select efficiently for this characteristic in gene engineering. Both methods take substantial time to develop a new variety and its procedures of field-testing. Generally, the technology results in effective use of available water particularly in the areas of seasonal rainfall or dry areas; decreases the high-water demand thru lessened evaporation losses.

Crop divergence offers better food security conditions and allows the farmers to produce extra yield for sale, thus increase the revenue to meet supplementary household well-being requirements. The successful application of this technology fruitfully contributes in the country's environmental, social, economic, food security priority via enhanced output, in the economy diversification strategy thru weightiness of agricultural segment inside the financial structure, eventually lead to upsurge income of the rural societies.

The high costs of new species and their cultivation is one of the conceivable drawbacks of the technology. If crops are not selected on market-based assessment, growers may face with the risk of poor monetary incomes. Mostly, this technology will be useful in arid and semi-arid regions of the country. Susceptibility valuation is to be provided in the high risky areas of negative climate change impacts. The involvement of agricultural research institutes is essential in the process for supporting experiments and analyses of new species.

The technology helps in reduction of crop failure risk and facilitate the chances of dealing with climate change uncertainty to the producers due to relatively little rainfall requirement of the technology.

3.2.1.1 Technology status in Afghanistan

Development of drought tolerant varieties is less researched field owed to given minor priority to dry land agriculture. The occurrences of some lengthy drought periods as well as worsening of canal systems in dry land areas in the last few decades has imposed the policy and plan makers to consider the drought tolerant varieties along with rain-fed agriculture.

Afghanistan has numerous locally drought tolerant crop varieties for both irrigated and rainfed areas some are widely espoused by the growers for instance Inqilab-91, Lalmi-1, Lalmi-2, Roshan, Bakhtawar and Mazar-99 are developed drought tolerant wheat varieties

presently used by the farmers and most of them are also resistant to pests with better grain yield and bread-making quality. The cost efficacy and performance of these varieties remains a fairly researchable area at the farm level due to limited evaluation and monitoring of the technology's performance at the farm level.

The country's seed industry is supported by providing a supervisory mechanism in order to control the seeds quality through important organizational setting up structures *viz.*, Regional and National Councils of Seed and Central Department of Seed Registration and Certification. The Central Seed Registration and Certification Department is responsible for controlling the seeds quality, standardization of quality, certification, information on seed varieties' genetically suitability and adaptability as well as publication of the registered seed varieties' lists. The Councils of the seeds have advisory role in order to develop, operate and regulate the seed industries by ensuring investment in the industry, approve seed standards and legalize the regional movements of the seeds (Hussain, 2011).

Fig. 3. 5: Introduction of plant Varieties resistant to Climate Change

3.2.1.2 Technology category and market characteristics

The technology of climate change resistant plant varieties categorizes under both market and non-market goods categories. Preliminary research of climate change resistant plant varieties seeds production and its patenting is usually carried out by state-run research institutes. So, crop variety is a non-market good at this phase while, the technology becomes a market good in the next step, which comprises a complex chain of demand and supply for sale and distribution of drought tolerant varieties through private and commercial organizations working underneath market service area and effect.

The plant seed development is unmarketable good and is diffused and transferred by international contributors, research institutes, non-profit organizations (private) and government, thus, considers as a public good as it is not conveyed as market part but inside the non-commercial public domain. Whenever its sale and distribution is done by commercial organizations, diffused and transferred by private organizations as a market part within commercial domain, it becomes a market good.

3.2.2 Identification of barriers for the technology

Climatic stresses resistance research including temperature, drought, pest etc. in valuable crops, is a lengthy procedure. Afghanistan has several research stations concentrating on drought tolerant plants trait through genetic engineering or traditional breeding

experimentations. There were numerous barriers recognized through literature review, expert views, and communication with growers in the base scale development and placement of the technology. Below is the initial list of potential barriers to this technology:

1. Insufficient fiscal resources for development and research.
2. Absence of technical proficiency, tools, corporeal organization of crops' hereditary manipulation.
3. Inaccessibility to good quality seeds.
4. Poor credit facilities.
5. Poor facilities of seed storage.
6. In order to ensure the seed quality, the seed testing labs are limited and ineffective.
7. The number of registered and certified seed dealer in the market is limited.
8. Low demand of seeds.
9. Problems of new pests.
10. Ineffective system of seed production, distribution and delivery.
11. Small size of the market and supplier chain: hesitation in demand side of the chain.
12. Improper communication methods.
13. The data sharing and collaboration among research institutions is insufficient so high chances of project multiplication.
14. Absence of strong regulatory and legislation framework for controlling the market of the seed.
15. Insufficient patenting of research outcomes with disagreement of IPRs (intellectual property rights).
16. Delayed release of varieties.

After the barricades list compilation, to communicate with shareholder the Mobile and Skype calls was arranged for screening and grouping the barriers in categories (policy/regulatory, technological, social, information, capacity building, financial). A simple technique and criteria such as starter, crucial, significant, less significant and unimportant barricades was applied to group them into key and non-key barriers in order to identify the most important barricades. The relevant barricades to the introduction of resistant crop species to predictable climate change technology deployment were documented in two groups:

- Financial and economic
- Non-economic

A brief summary of main barriers along with their enabling measures is described below.

3.2.2.1 Financial and economic barriers

a) The main barriers of this category in the way of technology diffusion and acceptance are huge cost as well as insufficient availability of fiscal resources to the research institutes for commencing research of suitable crop varieties production to environment, establishing new laboratories of research, human resources development and transfer of information to the technology user groups.

b) Usually, the high poverty rate of the country is in rain-fed areas where growers are small-scale landowners with inadequate access to available water resources. The constant water supply for agriculture is ensured through RWC and use of groundwater. The soil is deprived of nutrients with high fertilizer demand and land

preparation practices. These factors rise the average crop production cost as compared to irrigated areas and discourages taking risk of converting to new varieties of crop such as drought tolerant ones.

c) Drought lenient verities have high prices than other seeds due to poor regulation of market prices by the government. Despite, the agriculture is profoundly funded sector in the country, unfortunately, the policies of tax and funds to small-scale farmers particularly in rainfed areas are poorly targeted. Another important economic barrier is the high seed testing and quality assurance cost.
d) There is no exact financial barrier to the introduction of crop species resilient to climatic variation technology deployment. Thus, deficient government support for research activities improvement to test and select heat lenient crop species might be one of the technology diffusion barriers. Furthermore, there is scarce fiscal facility for research institutes (private and state) to facilitate profound analysis for most durable and heat lenient crop varieties selection. Fiscal provision of the testing organization is also scarce.
e) Frail availability of fiscal sources for local growers might be a fiscal barricade. Excessive number of the growers are inaccessible to fiscal sources of suitable terms for affording high quality seeds and all the essential agro-technical measures.

3.2.2.2 Non-financial barriers

Market failure and imperfection

In comparison to other agricultural products, Afghanistan's seed market is small and covers both government and private sectors in which 30% of the seeds originates from private sector, 30% from government research institutes, and the 40% is grower's own seeds which is grown each year and some of them is saved for the following year.

a) Frail seed distribution mechanism and supply chain: inaccessibility to good crop variety particularly for the distant farmers is a key diffusion barrier with the main element of minor market of drought tolerant seed and less registered seed suppliers' number in order to meet growers' demands and several low quality fake brands of the seeds in the markets.
b) Uncontrolled pricing of the seed: certified and quality seeds are expensive for the farmers. Some of the local companies import untested low quality and cheaper seeds under the popular brand names. Among farmers, these untested seeds gain high demand initially but after cultivation the failure of farmers in achieving production targets, these seed losses its preferability as well as market demand, gradually. Eventually, this is one of the major causes of slanted and small markets of the seed.
c) Inefficient, slow and lack capacity seed supply chain that fails in meeting the demand of market. As the available seed storage houses are insufficient, the seeds storage is a key problem of seed suppliers.

Legal, policy, and regulatory

In the history of the country, the "Plant Breeder's Rights Bill" grants the protection of Intellectual Property Rights IPRs to the breeders and permit the private companies to introduce genetically modified (GM) varieties for the first time. Ecologists and growers have

reservation of GM varieties' safety and seed market monopolization by the international private companies of seed. The Plant Breeder's Rights Bill is still pendant for the approval of the government to enact. The agriculture subject is decentralized to the provinces and they own the authority of changing or passing any of acts or laws related to agriculture after the amendment. The existing legal authority and status of the seed laws (both) and the right of direct investment to the private sector in the seed market are put in the question by this fact and after the amendment, the power and authority of the MAIL and Central Seed Registration and Certification Department remains ambiguous on the regulatory front.

The government has somewhat helpful policy of agricultural development with some tools such as discount prices on fertilizers retailing or funding mechanisms and supports private and national seed producers as well. Therefore, there is no specific supportive mechanism (any motivations or funding) to promote the introduction of climate change resilient crop species technology deployment.

Market barrier:

The inaccessibility to new improved seeds strains is the most important barrier for distant growers as the topography of the country is tough and the extant institutes capacity is limited to perform effectual distribution. The governmental sales workers display less attention in encouraging new cereals varieties mainly rice owing to their low-priced nature, in that way their lower contracts.

- Deficient production, distribution and delivery systems of seed.
- Defective supplies.
- Low seed demand and seeds demand hesitation.
- Lack of varieties entree to certified seed production system.
- Scarce promotion of the technology.

Technical

Lack of strong research organizations in specializing the genetic experimentation with most of the old-fashioned laboratories and insufficient technical skills and labor and this also factual for provincial scale seed quality testing laboratories. The applied methodologies for new varieties development are olden and there is considerable trust on germplasm in the outdoor country institutes. The out-of-date research laboratories require the equipment upgrading, insufficient technical skills in crop breeding, germplasm utilization and employees are thoughtful obstacles. The institutional capacity building inside the country with the ability of domestic and self-reliant new seeds varieties breeding is needed in a long run.

Social, cultural and behavioral

The country's growers traditionally develop crop varieties (breeds) hence may disinclined to new varieties adoption particularly due to requirement of supplementary investments and varied agricultural practices. Likewise, the existing farming nature together with small-scaled landholdings hampers the new technologies adoption up to a certain extent. Strangeness (Unfamiliarity) of the new technology is also a social barricade to technology deployment, local growers are familiarized to traditional seeds application in the agriculture and

cultivation with deficient information on the new species advantages. Ineffective agricultural extension facilities and lack of taking people preference into account are also barricades to the technology deployment.

Consciousness and information

a) Parallel to the technical, the consciousness and information also lacks among users and technology developers about the international protocols convenient in understanding the IPRs agreements. Farmers are reluctant in trying the drought resistant varieties of the seed in field by means of noticing them as late ripening, labor cumulative and low productivity due to lack of information on use and possible benefits of use these varieties along with concerning their storage capability (if they are susceptible to pest attacks).
b) Overall deficient education, information and consciousness of the growers about new technologies and their merits that hampers the acceptance of the technology. Similarly, growers are not familiar with the procedures of new crops varieties multiplication and should repeatedly purchase the new varieties from the market, the recurrent cost of these new seeds varieties discourages growers in new varieties adoption, thus avoid its extensive diffusion.

3.3.3 Identified measures

There are many remedy measures for the current stagnant situation of the technology via continual research need along with strengthen the situation of under-developed market for the technology, these measures are as below:

3.3.3.1 Financial and economic measures

a) To overwhelm the above-discussed key fiscal barriers, the provincial governments must allocate the fund drought-sensitive zones to encourage drought lenient crop varieties via agricultural extension programs and facilities. The domestic funds are to be proved by international foundations *viz.,* ICARDA (International Centre for Agricultural Research in Dry Areas) and FAO (Food and Agriculture Organization of the United Nations) etc. to ensure subsidy for seed testing laboratories and research institutions up gradation.
b) Issue lends and soft credits to growers for ensuring the affording ability of farmers for drought lenient varieties. The scope and network of poverty decrease programs and funds to be expanded to contain small-scaled farmers of rain-fed zones.
c) Decrease excises on equipment, apparatuses and other essential as well as useful tools of research for drought lenient crops' virtuous breed development. Inspire the resource conservation technologies usage *i.e.,* rainwater collecting, effectual irrigation systems to decrease the land preparation cost, laser land leveling, crop cultivation, management and use of drought lenient crosses.
d) Create an improved private-public company of seed supply chain that meet the demands and needs of the seed market.

The proposed measures for overcoming the extant financial and economic barricades to the introduction of new species resistant to predicted climate variation are as follow:

- In order to enhance the technical capacity of research institutes, fiscal support by the government should increase.
- To augment the new crop species application by the growers, develop funding mechanism.
- Facility of low-interest long-term lends via varied international (IFAD, World Bank), private funds (Banks) and state resources (State Entrepreneurship Support Fund in the MoE D, Credit Agency) to facilitate farmers in new species application.
- Facility of agricultural credit and lends along with on terms ensured accessibility of farmers.
- Affordable capital facility for seeds purchasing.

3.3.3.2.1 Non-financial measures

Market failure and imperfection/ Regulatory, legal and legislative

a) The most vital step for provincial and central governments is cautious revision of the extant laws and acts for drought lenient and other alike crop varieties. Before the ultimate approval and its application of the bills, addressing and reservations of main private shareholders and small landholding farmers' right protection is very important.
b) For market strengthening, create an improved private, public and private-public partnership, as this would lead to a sustained and effective system of seed distribution. The big transnational seed companies of private sector own well-resourced widespread research capacity, widespread technology suppliers' network capable of transferring the adapted germplasm within the countries, easily.

Policy, legal and regulatory

Besides rice and maize, strengthening the country's existing seeds policy and rules also emphasis on other crops through research and development on genetically modified (GM) crops, rules and regulation. These policies' strengthening help in generating an allowing situation in expansion and distribution of these crop varieties. The outline of the policy is arranged but it desires to be wired for assisting focus on the technology expansion and diffusion. An inclusive development policy for the agriculture sector will ensure a mutual image for the sector and sidestep the overlapped responsibilities amongst various agencies and subdivisions (departments).

The program of seed quality control: the government to develop policies for farmers' rights recognition and provision of adaptive as well as flexible processes of seed quality control fit to local circumstances through developing a national program for the seed quality control in the market.

Subsidy support for a comprehensive seed R&D Programme development. Community resources budgets and programmes to be directed to research and development in farmers' current seed systems through farmers' varieties development and improvement. Farmers should be considered as part of the system, as seed producers and breeders to meet the seed demand of the seed sector, not only as end user.

Technical

a) Building research organization, human resources and knowledge transfer to strengthen agriculture research organizations' capacity.
b) Establishment of properly equipped agricultural seed quality testing labs for providing the essential seed quality testing service to the growers.
c) Improvement of agricultural extension services to distribute suitable consciousness and knowledge about drought resistant seeds varieties availability and benefit.

Social, cultural and behavioral

Improved seeds' demonstration: The release of new diversities should be convoyed through demonstrational fields' formation for the learning purpose to resolve all technical issues. The farmers will have information that enable them in conversant decisions making through learning and observation which promote the adoption of released varieties.

Networks establishment: Government to discourse the harmonization challenge of the value chain performer by means of discussion (consultation) with the main investors of seed management. In order to ensure the technology's public acceptance, related government organizations should develop consciousness materials, communication and promotional policies.

Consciousness and information

Sustenance of farmers' information sharing through extension services improvement. Encourage usage of grower fields for promoting the improved seeds usage. Reorientation of Agriculture Seed Agency (ASA) subsidy to encourage new seed companies' development in unfavorable areas of the country via services of private sector in business planning, internal quality control mechanisms and marketing along with increased farmers' considerate on the certified seed importance. Plan consciousness activities to distribute related information of the extant crops' challenges and the requirement of pest and drought resistant new varieties development and distribution, this will comprise:

- Panning of consciousness movement for growers.
- Recognizing the basics of such movement.
- Emerging the relevance of such movement to growers.
- Cooperating with the village builds for suitable information distribution and directing such a movement.
- Media broadcasting
- Effective case studies to inform growers.

3.3. Barrier analysis and possible enabling measures for agroforestry technology

3.3.1 General description of the technology

Most of the private landowners in the country are currently not applying this practice owing to scarce knowledge. This practice has extensive possibility of application which offers a variety of merits *viz.*, maximum land use, greater land-use efficacy, protected and improved soils and water sources as well as land productivity and etc. This is an approach of the

production in which non-tree crops, trees and animals are integrated on the same segment of the field. The crops are grownup in separate plots, in rotation or together at the same time and the materials of them are used for the others benefit.

In agroforestry, the trees benefit the system in many ways *i.e.*, provide shade, construction materials, fuel and foods, reduce erosion through soil holding, upsurge soil fertility via transporting nutrients from deep soil layer and depositing them on the soil surface or by leaf-fall and biological N fixation.
The system of agro-forestry at agricultural lands comprises:

1. Shelterbelts (windbreaks) around agricultural area decreases wind speed thus, reduce the moisture evaporation from soil surface as well as soil deflation.
2. Windbreaks around agricultural area prevent dry winds around the land thus lessen soil salinization.
3. Windbreaks around arable gradients improve snow distribution, control and reduce run-off, soil erosion, soil deflation and increase soil moisture content.
4. Tree strips at the tree nurseries, alleys, citrus plantations, tea and vineyards improve the area's surrounding microclimate and protect it against strong winds.
5. Eventually, agro-forestry upsurges the yield and decrease the requirement of purchased inputs (fertilizers, etc.).

Furthermore, agroforestry has a role of C (carbon) sequestration along with additional advantages *i.e.*, provide firewood, organic matter (natural fertilizers), fodder, improve soil water flows and fertility followed by improved soil structure. In Agroforestry, the yields of crops could be lesser than in alternate systems but the agroforestry system reduce the harvest failure risk. The requirement of considerable management could be a disadvantage of the agro-forestry systems. Integration of crops and trees into a single system results in competition for light, space, nutrients and water and hinder the agrarian production mechanization, thus, it is essential to manage the system in such way to decrease the competition and maximize the productive and environmental profits.

3.3.1.1Technology status in Afghanistan:

Though the technology is practiced in the country, it is not applied extensively by local growers with the main reason of lands division among farmers afterward privatization, extant systems are destroyed and ignored owing to knowledge scarcity on its advantages. The technology employment lines positively with the societal, financial and ecological development primacies of the country. Additionally, it contributes to food security via increased production and increased rural income with decreased migration outside the country. The technology is primarily useful in areas having high erosion threat. The areas of high risk to the climate change negative influences should be provided with vulnerability assessment by participation of agricultural research organizations in the process for inclusive analyses and viability studies associated to the technology application. Agroforestry system restores the degraded agro-ecosystems as a result of insufficient organic matter from destitute ecosystem supervision and agriculture intensification.
The system of agroforestry is categorized into three main categories:

1. Agro-silviculture (trees with crops);

2. Agri-silvipasture (trees with crops and livestock);
3. Silvo-pastoral (trees with pasture and livestock) systems.

Agroforestry practices comprise:

- Alley cropping: rising annual crops between the trees' rows.
- Boundary plantings (living fences): planting trees lengthwise to the boundaries.
- Multi-strata: home gardens and agro-forests combining numerous (multiple) species, common in humid tropics.
- Scattered farm trees: increasing the numeral figure of shaded perennial crops (such as coffee and cocoa), shrubs or trees distributed amid crops or pastures along farm boundaries.

Planning the features of earthworks, soil loss (erosion) control, ravine maintenance and fruit trees spacing according to eventual spacing necessities as well as annual or perennials succession commencement with the shade lenient for the final years of intercropping is very important. It is also essential to have substantial knowledge on the trees properties used in planning of agroforestry systems. Required information encompasses the usages, species climatic adaptations as well as adaptations to different stresses and soils, type and size of the root system and canopy as well as the aptness for different practices of agroforestry. The crops variety similarly needs information of usages, adaptation and market prospects.

The agroforestry system improves the resistance of agrarian products to current as well as long-term climate variation through intensification of the trees, adjustment and protection of the growing systems as the trees are significant in plummeting susceptibility, rising agricultural systems resistance and protecting agricultural products from climate-related threats. Trees have deep rooted system with large reserves thus, less vulnerable to short-lived risks such as inundations or droughts as compared to annual crops. Therefore, tree-based agroforestry systems assist in maintaining production throughout drier and wetter years.

In Afghanistan, about 79% of the Afghan population relies on wood for fuel, construction, timbers which provided from natural forests and affected natural forests very badly. Therefore, one of the ways to conserve and protect the natural forests is implementing the agro forestry programs countrywide. Between 1990-2000, Afghanistan lost on an average of 29,400 hectares of forest per year and annual deforestation rate of 2.92%. Forest now occupies less than 2% total area of the country. Forest Directorate has started agroforestry in 17 provinces through 360 forests associations since 2013 with an objective to substitute supplying wood and timber need from the agroforestry and should conserve the natural forests (Gurung and Temphel, 2015).


Fig. 3. 6: Agroforestry process under Nuristan province condition

3.3.1.2 Market characteristics of the technology:

As the agroforestry is a non-market-based technology, so, there are no financial barricades to the technology deployment. The marketplace of the agroforestry system is simple, particularly in its application by the government.

The technology's enabling agenda comprises communal objects *viz.,* fiscal strategy, technical morals and sectoral policy, legislation and specific objects *viz.,* forest management and National Forest Program of the country, illegal logging. The specific items are particularly significant stated the loss of formerly existed systems because of illegal logging. Meanwhile several of earlier systems are managed by the forest agency; abundant land is still possessed by the forest agency thus, establishment of new systems is essential to be harmonized with the aforementioned. The agency could be directly tangled in planning of agroforestry systems, particularly in essential demonstrational ventures to display the technology's benefits to growers.

Marketplace performers include processing companies, communities, growers, foresters, and nurseries. Whereas, communities and growers are the key recipients (beneficiaries) and purchasers of the technology. Nurseries and foresters act as goods suppliers and consultants and the processing companies could be technology's co-recipients by means of high production and improved protection of farmhouses from climatic threats will lead to lower priced consistent supply of agricultural products to them.

The facility providers of the technology comprise agriculture support centers, National Agricultural University, fiscal organizations, NGOs and international officials, the former two are most significant owing to their consciousness raising and capacity building functions.

3.3.2 Identification of barriers

The process of barricades identification was based on the references of the Manual on Overcoming Barriers to the Transfer and Diffusion of Climate Technologies developed by UNEP DTU Enterprise (2nd Edition). The preliminary list of barricades was discussed among the venture team towards barricades ranking, the barricades were categorized and the decisive ones were selected. The partakers of the Skype call were habituated with the aforesaid Guidebook recommendation, as well as the barricades groups such as unimportant (easy starter), less significant, significant, decisive and killer (non-starter). The initial list of barriers is as below:

1. In accessibility to technical inputs.
2. Scarce of governmental provision for research enhancement on hydrological regimes, soil analysis and areas identification.
3. High cost of capital.
4. Scarce access to credit , high rate of interest.
5. Insufficient knowledge of local communities.
6. Shortage of extension workers and their frail capacity.
7. Small scale lands.
8. Insufficient availability of drought and heat lenient trees species.
9. Absence of technical proficiency.

10. Improper communication methods.
11. The data sharing and collaboration among research institution is insufficient.
12. Absence of strong regulatory and legislation of agroforestry in the country.
13. Inadequate motivations

The results of the workshop discussion were considered in identification of the most important barricades' final list along with their overcoming measures. The barriers related to technology application were evaluated in numerous aspects *i.e.,* financial/economic, capacity/information and social barriers.

3.3.2.1 Financial and economic barriers

As the price of seedlings is low and grower could raise it without any difficulty, the technology does not face any major fiscal barricades, though, the growers frequently prefer short duration. Growers do not priorities their income usage for purchasing agroforestry seedlings but they priorities the way of their income usage which is used for actions offering instant benefits while this technology benefits them in lengthened term, so, they may not consider it significant. Inaccessibility to the technology inputs (seedlings) might be a barricade for some of the growers and it could be overcome by giving free seedlings to recipient growers.

Scarce governmental provision for research enhancement on hydrological regimes, soil analysis, areas identification that should provide with agroforestry could be fiscal barricades to technology application. Frail access of the local growers to fiscal sources could be another fiscal barricade; most of the growers are inaccessible to fiscal sources of satisfactory terms for buying trees to plant them on cultivated lands. Scarce access to credit, high rate of interest, high initial investment as well as absence of instant monetary profits are also limitations in the technology deployment.

3.3.2.2 Non-financial barriers

Policy, legal and regulatory:

Despite the fact that many farmers (including farmers of Afghanistan) workout some methods, the pertinent authorities have no specific strategy, policy and legislation in the country. A number of essential subsidiary rules and regulations on clear and detailed guiding principles of agroforestry development strategies are not arranged by means of ineffectual enforcement law. This skiving of ineffective subsidiary rule execution is associated with scarce M&E and coordination amongst stockholders, financial resources, skills and policy.

However, at early stage or provincial level, the policies remained un-updated to village and district level with no climate change and disaster risk decreasing policies and activities. Incomplete project was as a result of information gaps (destitute info sharing), futile coordination and budget insufficiency.

Technical:

Insufficient knowledge of local communities on financial and ecological merits of the technology is the significant barricade in the technology application. Shortage of extension workers and their frail capacity could also be a non-economic barricade as these workers

rarely encourage agroforestry that could be due to lack of motivation or knowledge. Development of an agroforestry system includes extension workers to provide growers with the training and motivation to encourage the deployment of the technology.

Social, cultural and behavioral barriers:

The possession and structure of the lands generates significant fences in technology application and according ownership status, lands are parted into following major groups:

1. government lands
2. municipal lands
3. Private lands.

The technology is applicable on municipal and private lands but, on cultivated government lands, its application requires considerable investment. However, it is difficult for local growers to apply agroforestry system on small-scale lands and destitute supportive actions hinder the local growers to apply the technology on large-scale lands. Strangeness (unfamiliarity) of the new technology is also a societal barricade to technology application.

Consciousness and information:

The non-financial barricades of the technology application could be as follows:

- Destitute consciousness and knowledge of growers and landholders on financial and ecological benefits of the technology.
- Scarce and frail quality extension facilities.
- Weak supportive actions.
- Frail availability of drought and heat lenient tree species.

3.3.3 Identified measures

3.3.3.1 Economic and financial measures

The following measures could be proposed to overcome the extant fiscal barriers to the agro forestry technology application:

- Development of Specific National Action Plans for enhancement of the technology application on private cultivated, municipal and state lands via participation of pertinent governmental organizations (National Academy of Sciences, Ministry of Economics (ME), Ministry of Agriculture Irrigation and Livestock (MAIL), Ministry of Rural Rehabilitation and Development (MRRD) Ministry of Energy and Water (MEW) and NGOs.
- Development of funding mechanism for growers to enhance the technology application on private lands.
- Facility of low-interest long-term lends via different international resources (IFAD, World Bank) and private foundations (various Banks) for supporting growers in the technology application.

3.3.3.2 Non-financial measures

The following measures could be proposed to overcome the extant non-fiscal barriers to the agro forestry technology application:

- Provision of research organizations to provide valuation of useful heat lenient tree species identification.

- Experimental ventures to prove the usefulness, successes and outcomes of the technology application.
- Arrangement of fund and info movements on the advantages of applied technology for raising consciousness and increase the growers' (small and large-scale growers) capacity on ecological and financial merits of the technology and supportive activities by participating the NGO sector and local authorities.
- Improvement of agricultural extension facilities for offering essential capacity building activities and recommendations to growers and local landowners on the technology advantages.

3.4. Barrier analysis and possible enabling measures for application of conservation agriculture technologies

3.4.1 General description of the technology

Conservation agriculture (CA) is an agricultural system with the goals of water and soil preservation, nutrient and production improvement. These technologies are based on the following three main principles

- Minimum soil disturbance (zero-tillage)
- Good and permanent organic soil cover maintenance (residues, mulches and cover crops)
- Suitable crop rotation or crop species diversification dependent on land availability.

Conservation agriculture is an approach of agro-ecosystems management aimed at continual (sustained) and enhanced productivity, food security and profits along with resource and environment enhancement and conservation (FAO 2017). Afterwards and earlier to the next crop planting, the crop residue (corn stalks, wheat stubble, etc.) of the previous year's crops is left on the fields crop for soil erosion and runoff reduction and further benefits (carbon sequestration, etc.) in CA. As there will be an increase in weed growth and pest infestation as a result of climate change, the CA reduces these problems and help in technology adaptation. Increased mean temperature and rainfall unpredictability disturb soil moisture regime results in crop failures and reduced yields. These practices reduce soil erosion, enhance moisture holding, minimize soil compaction thus decrease drought risk, and improve resistance to climatic effects (floods and drought), It helps crop to combat pests and diseases as soil nutrient recycling is improved and benefits agriculture via enrich the soil by improving soil fertility status, improved stabilization of soil surface, reduced nutrients leaching, decreased evaporation, improved water retention, reduced need for tractors to pass on farm thus, reduce the use of fossil fuels an results in improved yield.

CA is considered as an approach of environmental protection not as a technical practice only which is based on zero or reduced tillage, the soil is fertilized soil by mulching and these activities are to be combination with crop rotation. This method is envisioned to lessen the GHGe (greenhouse gas emissions *i.e.,* methane, steam water, CO_2) and to store increased soils carbon.

The principles of CA are appropriate to all agricultural lands with locally adapted practices with the little requirement of external inputs (agrochemicals, nutrients from organic or mineral source). The technology facilitates good agronomy supplemented thru additional good practices *viz.,* quality seeds usage, integrated weed, pest, water and nutrient management which is a base of agricultural production intensification on a sustainable basis. It allows the production sectors combination as well (integration of crop-livestock and of trees and pastures into agricultural lands). Furthermore, the technology also reduces labour by up to 40% and avoids crops and residue burning thus, considers as a truly sustainable technology.

3.4.1.1 Technology status in Afghanistan

Globally, CA is being practiced on about 125 M ha .The major CA practicing countries are USA (26.5 M ha), Brazil (25.5 M ha), Argentina (25.5 M ha), Canada (13.5 M ha), Australia (17.0 M ha) and India (1.5 million hectares) (Jat *et al*., 2012). Conservative sowing has emerged as an alternative to the conventional sowing method due to losses in soil fertility emerging as a result of soil structure deterioration (FAO, 2009). In Afghanistan, CA adoption is still in the initial phases. Over the past few years, adoption of zero tillage and CA has expanded. The major CA based technologies being adopted is zero-till (ZT) maize in the maize-wheat (MW) system. With respect to the sustainable use of natural resources, on the other hand, erosion and drought can be prevented with the use of this technology. The CA based resource conservation technologies (RCTs) also help in integrating crop, livestock, land and water management research in both low- and high-potential environments. In Afghanistan, efforts to adopt and promote conservation agriculture technologies have been underway for nearly a decade. Spread of these technologies is taking place in the irrigated Area of the Afghanistan where the maize-wheat cropping system dominates. The focus of developing and promoting conservation technologies has been on zero-till seed-cum fertilizer drill for sowing of maize in maize-wheat system.

Currently, the country's agrarian lands are facing some problems various *viz.,* compaction, water logging, soil losses, soil fertility decline, loss of productive functions, crusting and sealing, high sediment yields, soil surface lowering, agro-chemical and nutrient accumulation, iron toxicity development, eutrophication and waste disposal which results is in high loss of different crops, thus, among them the soil fertility decline is most considerable. The synergetic outcomes of conservative agriculture assure the conservation of land and associated natural resources through the protection of crops from negative impacts of wind (lodging, breaking, corrosive effects, etc.) and consequently, increase livestock and agricultural production. These practices increase the ability to tolerate the negative influences of climate change with widespread paybacks. In spite of continuing efforts, the conservative agriculture remains as a thoughtful limitation in the country for the sustainable improvement of agriculture indicating that the technology is still unaccepted proficiently. Thus, appropriate helpful activities should be taken to address the relative adaptive problems related to the diffusion and transfer of the technology. These barriers are complex demanding a systemic and systematic tactic (approach).

Fig. 3. 7: Conservation agriculture technologies to protect soil and water

3.4.1.2 Market characteristics of Technology

The technology of conservative agriculture is considered as a non-market community good when established at a community level along with the support of provincial level for managing and developing the system.

Whenever its tools sale and distribution is done by commercial organizations, diffused and transferred by private organizations as a market part within commercial domain, it becomes a market good.

3.4.2 Identification of barriers

The identified barriers to the implementation of CA technology includes economic/ financial, technology, information/capacity and social barriers. There is no recommendation of CA in saline soils, soils having high clay content, humid areas having shallow water table, for crops with no residues left, small holders that are unable to access machinery and to apply economically feasible crop rotations.

3.4.2.1 Economic and financial barriers

The usage of specific agricultural machinery is required in order to apply the technology of conservative agriculture. The current number of machineries is insufficient by means of limited application of this technology by farmers, the country has to import these machineries and most of the growers, mainly small-scale ones cannot afford these agricultural machineries. Thus, the designing of enabling framework with accessibility of the farmers and landholders to low-interest long-term lends is essential (leasing mechanism etc.). In short, some of the significant economic barriers related to the technology deployment are as follow:

1. High initial application cost as compared to conventional.
2. Inadequate capacity and fiscal availability to encourage and adopt CA and field trials demonstration.
3. Inadequate fiscal provision for extension, research and crop insurance that inspires the CA application.
4. Minute assessment to the optimistic impacts of CA practices in relation to ecosystem services and environmental damage.
5. Inaccessibility to financing for provide the insurance of loan applications support.
6. Unfavorable loan conditions with within single season reimbursement and crop failure risk may result to asset seizure.
7. High interest rates of Commercial banks.

3.4.2.2 Non-financial barriers

Policy, legal and regulation

- Frail application of extant official and legal agendas for inspirational research and CA transfer.
- Inadequate motivations to inspire the implementation adoption of CA.

Technical:

- Site-specific barricades including characteristics and types of soils, rainfall quantities and ground settings.
- Requirement of extension workers' greater specialization.
- Crops with inadequate residues are unfavorable for CA.

Social, cultural and behavioral:

- Growers are accustomed with conventional agriculture and they recognize the CA as a downgrade in comparison to the basic technology.
- Inadequate promotional activities on CA resulted in limited awareness of growers on the benefits of CA.
- Growers' resistance in changing the conventional agriculture to CA.

Information and awareness

The land is divided amongst the famers with the average size of only 2-3 ha of single farmer's land after privatization whereas, the application this technology is ineffective on these small-scale lands. The weak capacity with scarce technical skill and information of the farmers' as well as unfamiliarity of the farmers (local growers are familiarized in the application of traditional farming methods to new technology along with the absence of efficient agricultural extension services are the significant barriers to the technology application.

- Limited information about the availability and diffusion of CA.
- Limited consciousness of growers to allow acceptance of CA.
- Frail organizational capacity.
- High ratio of grower to extension worker due to staffs' high attrition rate.
- Unfamiliarity of growers with all aspects of CA technology.

3.4.3 Identified measures

3.4.3.1 Economic and financial measures

The following measures are proposed to overcome the extant financial and economic barriers to the application of conservative agriculture technology:

- Regulations of specific taxes for simplification the technology's import procedures;
- In order to enhance the availability of the machinery to the farmers, specific governmental program of purchasing the essential agricultural machinery for existing Agro-services;
- Development of exact funding to the farmers in enhancing the application of the technology on private lands;

- For supporting the farmers in technology application, facility of low-interest long-term lends by international resources (World Bank, IFAD), private sources (Banks) and other different funds Agencies.
- Facilities of governmental funding to growers for reducing the initial application costs of CA adoption.
- Establishment of sustainable fiscal provisions to encourage extension, research and crop insurance that inspires the application of CA.
- Skills and techniques for CA's benefits assessment are applied and accepted regarding to ecosystem services and environmental damage.
- High growers' income from CA to allow collateral facility for loan applications support.
- Unfavorable loan conditions with within single season reimbursement and crop failure risk may result to asset seizure.
- Grower's pact with village level fiscal facilities by providing the growers with low interest rates (about 5%).

3.4.3.2 Non-financial measures

Policy, legal and regulatory

- Legal apparatuses and strategies of the agriculture sector are abundantly applied to inspire implementation and acceptance of CA.
- Sufficient governmental motivations to inspire implementation and acceptance of CA.
- Popularization of CA technology and growers' satisfaction leads to the acceptance of CA.
- Availability of extension workers with greater specialization.
- Adoption of crops with high crop residues to encourage CA.

Technical

- In order to build a higher number of extension workers for improve grower to extension worker ratio, the government has provided skills, capacities, and motivations.

Information and awareness

- Information on CA is available and extensively distributed to growers; Informational movements on the merits of the CA should be subsidized and prepared by the government for increasing the growers' capacity (both small-scale and large-scale farmers).

Social, cultural and behavioral

The measures for overcoming the extant non-financial barriers to the CA implementation technologies, could be as follow:

- Implementation of experimental ventures to prove the practical outcomes and successes of the CA application involvement of the NGOs and local authorities in the process.

- Info movements on benefits of supportive activities amongst the growers to encourage them in private land's mutual usage and ease the CA technologies application at cultivated lands.
- Improvement and enhancement of agricultural extension services for offering essential capacity building activities and recommendations on Mthe technology advantages.

3.5. Barrier Analysis and Possible Enabling Measures for Promotion of Crop Diversification and New Varieties

3.5.1 General Description

Climatic variations intensify the crops loss owing to destitute soil moisture content because of destitute rainfall and lengthy dry periods. Drought lenient and early maturing crop varieties preferment assists in the reduction of the crop loss risk and improve the resistant to harsh climatic circumstances, pest organisms and disease. These crop varieties have varied advantages with the key one of shorter maturity period/growing season in comparison to traditional varieties. In addition, they improve yield quality, health, nutritional value and plant productivity via building resistant to pest organisms, diseases and environmental stresses. Improved diversities of crops are resilient to water stresses and heat throughout the wet and dry climatic conditions, respectively. Sustainable and ecofriendly agricultural practices are emphasized (no/minimum chemical fertilizers application) once new varieties are made known to the growers.

The crop modification (diversification) denotes the addition of new crops to agricultural products on a specific farm, considering the different benefits from the crops with matching opportunities to climate variation.

The technology offers optimum circumstances for food safety through its adaptation to variety of climatic variations and allows growers to produce excess products for market, so increase the revenue to meet additional requirements of family welfare. The application of this expertise positively lines with the financial, societal and environmental development primacies of the country.

3.5.1.1Technology status in Afghanistan:

In the country, numerous studies indicated the better yields from improved variety as compared to traditional varieties. A study was carried out by FAO on value chain mapping and cost structure analysis for Afghanistan in 2010 and the outcomes showed that the average per hectare yield of early maturing varieties was about 2.5 folds higher as compared to traditional varieties. However, early maturing drought lenient crop varieties have some difficulties of promoting with the important one of caution of small growers in accepting the unfamiliar improved crop varieties. Besides, the improved crop varieties introduction by research organizations have given rise to weeds or pests at times of their escaped control.

Fig. 3. 8: Crop Diversification and New Varieties

3.5.1.2Market characteristics of technology

The Crop diversification technology is measured as a community goods or non-market technology. The community plays the role of extension along with R&D, whereas the private sector together with growers participate in the technology implementation and expansion to attain target the of production with climate change adaptation.

3.5.2 Identification of Barriers

There were numerous barriers recognized through literature review, expert views and communication with growers in the base scale development and placement of the technology. Below is the initial list of potential barriers to this technology.

1. Insufficient fiscal resources for development and research.
2. Absence of technical proficiency, tools, corporeal organization of crops' hereditary manipulation.
3. Inaccessibility to good quality seeds and Poor facilities of seed storage.
4. Poor credit facilities.
5. In order to ensure the seed quality, the seed testing labs are limited and ineffective.
6. The number of registered and certified seed dealer in the market is limited.
7. Ineffective system of seed production, distribution and delivery.
8. Small size of the market and supplier chain: hesitation in demand side of the chain.
9. Improper communication methods.
10. The data sharing and collaboration among research institutions is insufficient so high chances of project multiplication.
11. Absence of strong regulatory and legislation framework for controlling the market of the seed.
12. Insufficient patenting of research outcomes with disagreement of IPRs (intellectual property rights).
13. Delayed release of varieties.
14. Insufficient knowledge and information amongst the growers about early maturing and drought tolerant varieties.
15. Inaccessibility to suitable varieties.

After following many outlined steps of the overview, the following two significant barricades to the preferment of suitable crop varieties having characters of enhancing climate change adaptation were categorized: 1) economic and financial and 2) non-financial.

3.5.2.1 Economic and financial barriers

The inaccessibility to drought suitable varieties was considered a financial and economic barricade as it mainly results from the high price of hybrid seed, which in turn arose from the research and new varieties breeding high cost. The principal costs of investment comprise; new seed diversities buying, training costs, labor time, field tours and on-farm apparatus. The total costs of a five-year project including around 1,000 growers in a project in Mexico emanated to around $300,000 (Smale *et al*, 2003).

Inadequate capital and inaccessibility to private sector and smallholders' finance to apply crop modification is the main financial barricade in the technology application. Likewise, the inadequate fiscal support and budget from government on the extension and preferment are also considered as the financial barriers. Investment shortage, finance shortage for seed production development, obsolete base of seed production and variety testing that are applied ineffectively to ensure the high quality seeds production, destitute rural substructure to certify quality seed of high reproduction of the finest diversities, facility provision and scarce fiscal resources for stimulation of agrarian employees for a satisfactory climate technology are some of the other financial barriers to the technology deployment.

3.5.2.2 Non-financial barriers

Insufficient knowledge about the suitable varieties is non-economic barricade rises from provided scarce info to growers regarding to the diversities they plant and essential management at their various production cycle stages. The insufficient information resulted from the unsuitable reform at the MAIL while the extension and research division were elevated to executives and analogously started working which in brief resulted in to destitute link amid extension and research.

Policy, legislation and regulation

Defective supervisory and statutory basis (implementation responsibility and state land quality monitoring) of accountability and monitoring for land quality. Extension and developmental plan and policy of crop. The type of adoptable and promotable systems crop diversification is unclear to specify the introduction of specific novel species or crop diversity, rotated or combined in extant agricultural systems for enhancing its resistance to climate variation and catastrophes including pest and disease and its adaptive capacity. In addition, the effectual interference of resources mobilization for location of crop diversification preferment (where) or when, how much, how and for who are also obviously unknown.

The crop diversification development is certainly restricted due to plan skiving, particularly efficacy and activity of capitals distribution and mobilization for crop diversification encouragement and development. The key limitations for development of crop diversification plan include capacity, info and investigation (research), fiscal provision as well as integrated land planning with the land aptness maps.

Consciousness and information

Scarce information and consciousness about pertinent local population and local government authorities on the requirement of having soil organic matter and quality seeds to support agricultural potential and quality. The guidelines and information are insufficient for

development and encouragement of optimum and strong crop diversification for climatic adaptation. The misplaced guiding principle and info are:

- Resistance and susceptibility of extant production systems and crop diversities to climate variations and hydro-encountered calamities.
- Suitable crop diversifications for different agro-ecological regions with feasibility (farmers' choice, financial including cost and benefit, technical).
- Orientation venture with finest guiding principle.

The assurance of crop diversification extension and development for adaptation relevance and efficacy is problematic without information (Vernooy, 2015). The restriction of the research as well as budget and skills are due to limitation of related information and statistics (data). In the country, the prime research of crop diversification practice's assessment and redefining in orientation venture with finest performs is incomplete.

Resistance and susceptibility related research of the current production systems and crop diversities and ideal crop varieties for climate change and hydro-encountered calamities is negligible. Inadequacy of skills and information on crop varieties is certain as it is not sufficiently publicized in systemized and standardized capacity building and training in pertinent institutions.

Limited knowledge and skills on crop diversification

Insufficient kills and knowledge about the main pertinent institutions to recognize, study and encourage the appropriate systems of crop diversification that create ideal ecological and socioeconomic paybacks with adaptation and this gaps in the skill and knowledge are outcomes of useless Human Resource Management (HRD) system as well as teaching and learning in capacity building high education system in the vital institutions. Research and education organizations such as Department of Agriculture (DoA), etc. are deprived of R&D, practical curriculum, satisfactory specialists, research and teaching amenities as well as drills on crop diversification besides, scarce knowledge on capacity requirements for crop diversification.

3.5.3 Identified Measures

3.5.3.1 Economic and Financial Measures

It is approved that the appropriate seed diversities process from research to marketing constantly make hybrid seed expensive thus, the encouragement of seed companies is required in order to practice inexpensive seed production approaches (two-way cross technique). Encouraging chalet seed invention amongst small-scaled grower's results in improved accessibility as in addition to enhancing quantity provided, it leads to the proximity of hybrid seed supply.

A. Protected fiscal investment and provision for extension of crop diversification

It is the main objective with the following key measure to ensure fiscal and investment:

1. Increasing the resources utilization efficiency.
2. Upsurge efficacy of fiscal resources management and distribution.

In order to have accessibility to effective resources utilization (mobilization) and fiscal provisions, it is essential to conduct investment and fiscal necessity valuation, investment's cost and benefit analysis, funds foundations, financeable offer and resource utilization plan. Furthermore, the surveying and developing of crop diversification development strategy is also essential for supporting the planning and implementation of fiscal and resource utilization.

To increase efficiency of fiscal assistances and civic investment management, an effectual system of fiscal resource management is to be developed which ensures the efficacy of the civic investment rule, particularly;

- Distribution (allocation) of civic investment budget.
- Tracking and reportage system of investment record and fiscal provision.
- Negotiation for planning and reflecting to improve the efficacy of fiscal management.

The capacity building is required for enabling the investment management measures and financing implementation.

B. Research and motivations for preferment of crop diversification

Studying and recognition of appropriate financial encouragements will be steered by participation of all significant investors, particularly Ministry of Agriculture Irrigation and livestock (MAIL), Ministry of Finance (MoF), etc., who finally decides on this problem and the mechanism is notably required to be efficiently enforced. Therefore, strengthening the implementation capacity or encouragement measures and mechanism's enforcement is also significant.

C. Enhance finance access for farmers and entrepreneurs

Three key barricades must be addressed for ensuring finance accessibility.

1. Entrepreneurs' producer's capacity on enterprises' fiscal supervision system and financeable proposal preparation along with business financial analysis, possibility study.
2. Studying and development of mechanism and strategy to ease and ensure financial and risk managing accessibility.
3. Improvement of fiscal supervision transparency and efficacy including feedback scheme, database as well as M&E.

Development of financial encouragements system for agriculture enterprises applying plant modification system; motivations of investments attraction for eco-friendly technologies in agriculture sector; fiscal fund's onset for encouraging the seed farms development and deliver highest quality seeds to the growers at the internal resources cost are conceivable overcoming measures for above stated barriers.

3.5.2.2 Non-Financial Measures

These measures pact with a wide range of problems in institutional capacity and policy, legal as well as regulatory.

Policy, legislation and regulation

Augmented encouragement of climate technologies via grants related systems of agricultural practices; levy discount for climate technology encouraging forms; confirm answerability at all statutory instruments levels for confirming the application and amenability of climate technologies with technical measures. State-run accountability and monitoring for the land quality. Development of plan and strategies for crop diversification extension and development. The policy and action plan for crop diversification extension and development is developable with the existent capacity but it demands for financially ready capacity and data to be further practical and inclusive.

Consciousness and information

Educational system improvement along with new climate technology related problems, civic consciousness on ecofriendly technologies application as a vital element of the distribution and application of the technologies. These comprise information development on:

1. Resistance and susceptibility of current production systems and crop diversities to climate fluctuation and calamities.
2. Systems of crop diversification appropriate for different agro-ecological regions.
3. Financial feasibility together with cost, benefit and market.
4. Technical guiding principle on the production.

The understanding of these necessitate additional monetary investment as discussed above as well as human resources (HR).

Social, cultural and behavioral

Cumulative importance of sustainable climate technology via supervisory tools and science, confirming the action process transparency.

3.6. Barrier analysis and possible enabling measures for land use planning technology

3.6.1 General description of the technology

Land use planning (LUP) technology meant at reinstating degraded land and maintaining healthy soil in the country to ensure food safety, alleviate rural hunger and poverty and build resistance to foremost environmental problems. The objective of LUP is to concentrate on degraded land restoration and stop further degradation of any natural land to confirm sustained ecosystem functions and health. LUP covers the economic, socio-cultural and ecological proportions of sustainable development and it encompasses land use designing and planning of as well as land development as a process.

As demand for manifold ecosystem services and land uses rises, competition for land also increases. Technologies for the LUP practices' adaptation, application, acceptance and distribution rely on methods of empowering and enabling people to this end.

The issues of emerging carbon markets, renewable energy and food security are generating signals of prices for agricultural land conversion and other usages *i.e.*, biofuels and reforestation. This take place analogously with additional rising demands for land systems such as biodiversity conservation, mining, services, suburbanization and food production whereas, land use alteration might rise the supply of some eco-services and existences of

trade-offs with other amenities. Management of increased competition for these facilities' supply and various investors' benefits, necessitates LUP for effectual land allocation that encourages sustainable land use choices (Bryan, *et al*., 2015) Land use efficiency: anticipating future demand for land-sector greenhouse gas emissions abatement and managing trade-offs with agriculture, water, and biodiversity.

LUP affects the environmental conditions as its application might exert some negative and positive influences on the ecosystem. For example, Jia *et al.* (2003) claimed that occurrence of abundant environmental degradation of in China is strictly associated with the manners of land usage.

3.6.1.1 Land use planning status in Afghanistan

Afghanistan, with population of more than 37135635 people in an area of 652,237 km^2 is a country with high population densities in which land degradation is the extreme environmental problem in all agro-ecological zones at different intensities that seriously affects the economic growth (demographics of Afghanistan, 2019). As the land is interrelated with other natural resources essential for human survival *viz.,* fauna, flora, air and water, finely managed healthy land supports the protection of natural resources and environment thus, enable the continual success of environmental amenities and functions on a sustainable basis.

In the country, the impacts of land degradation is various *viz.,* compaction, landslides, water logging, heavy soil losses, soil fertility decline, loss of productive functions, crusting and sealing, high sediment yields, soil surface lowering, acidification (desertification, acid sulphate soils formation), alkalization, salinization, agro-chemical and nutrient accumulation, iron toxicity development, eutrophication and waste disposal. Among these, the soil fertility decline and erosion are chief happening degradation processes, high sediment yields and heavy soil losses triggered by soil erosion are very severe.

Presently, the country's agricultural lands are fronting the soil erosion problem which results is in high soil loss in the sloping lands under intensive agriculture's different crops, thus, human stirred land degradation is most considerable than that by natural forces.

Additive and synergetic results of LUP assure land conservation and accompanying natural resources consequently, upsurge livestock and farming production. These collectively increase the ability of the nation to tolerate the undesirable influences of climate variation with wide-ranging benefits. In spite of ongoing exertions, the issue of land degradation remains as a critical constraint in the country for land resources sustainable development representing that the LUP technology is still unaccepted efficiently. Thus, suitable remedial activities should be taken to address the LUP technology diffusion and transfer related problems for adaptation. These barricades are often complex demanding a systemic and systematic tactic (approach).

Fig. 3. 9: Land use planning under Afghanistan circumstances

3.6.1.2 Market characteristics of the technology

Land use planning technology is a non-market public good established at a national level along with the support of provincial level for managing and developing the system. the technology is implemented at community level. Governments use land use planning to manage the development of land within their jurisdictions. In doing so, the governmental unit can plan for the needs of the community while safeguarding natural resources. Thus, considered as a non-market public good.

3.6.2 Identification of barriers for land use planning

The barricades identification procedure involved meetings with experts, literature reviews and consultations with stakeholders and the possible barricades according to stakeholder to the progression, transmission and circulation of land use planning technology are as follows:

1. High implementation and long-term investment cost.
2. High monetary cost of conservation activities and social limits in small land holdings.
3. Low investment on research and development.
4. High land pressure due to high reliance on land for living.
5. Lack of appropriate policies.
6. Unsatisfactory legal and regulatory framework.
7. Insecure land possession.
8. Insufficient knowledge.
9. Insufficient of institutional capacity and management skills of government departments.
10. Lack of information on social benefits of technology.
11. Unsuitable and poor farming practices and land management.
12. Lack of accessibility to essential information and data.
13. Low conservation priority to non-agricultural land usages.
14. Lack of encouragement for community participation and ownership.
15. Poor inter-departmental interaction and coordination.

Screening and short listing of key barriers, particularly where the potential barriers list was long, to select most essential ones through expanded stakeholders consultation process. The list was presented to the participants of the barriers analysis by Skype and Mobile communication. The barrier analysis tools i.e., starter problem and solution trees were used to hasten the process of barriers prioritization. The final list of barriers was achieved through consensus among participants and discussed. The above listed barriers are categorized into two groups economic and financial and non-financial barriers, which are described as follows.

2.6.2.1. Economic and financial Barriers

The investments level which affect all allied actions of LUP adoption is key economic barrier. By means of inadequate financial provisions, the goal of LUP remains indefinable, as it frequently clashes with poverty reduction, health, education, defense and competing primacies of economic development.

a) High Implementation cost and long-term investments return: most of the organic means for soil fertility improvement (compost and manure application) are labor-intensive thus, unpractical by growers working on distant packages or handling fairly large land extents. Moreover, the practices are mostly reliant on the technology's application ways and paybacks in long-term, e.g., the usage of partly processed manure are less effective as its Nitrogen (N) content is lost along with increased incidence of pests, diseases and weeds. The technologies of LUP are knowledge-intensive so, the application of feasible low-priced economical and technical alternatives and best practices which reduce the soil erosion desires to be discovered. Skiving of immediate noticeable improvements in soil quality, health and important short-term paybacks owing to application of preservation activities stood as vital factors via growers' detraction from the sustainable use of soil maintenance activities. Thus, the growers' investment on expensive structures of soil conservation (stone terraces) having long-term payoff is un-expectable.

b) High monetary cost of conservation activities and social limits in small land holdings: Most of the country's agriculture or agricultural land is under smallholdings; most of these holdings are about less than 0.5 ha on average basis and are continually decreasing due to division as with increasing population, the pressures on land continue to increase. The further division of existing smallholdings poses a challenge to the application of LUP practices for noticeable reasons *i.e.,* further decrease of agrarian land owing to soil preservation approaches application. As smallholders are confronted with problems to adopt LUP methods even with short term benefits, the application of soil conservation applies that consume land are un favored in the smallholdings and the mechanical practices of soil conservation are mostly impracticable in irregular, scattered small holdings distributed around agricultural lands due to grower lethargy. The chemical, biological and physical degradation of soil decrease land productivity as a result of continual monoculture farming practice and cultivation on these smallholdings owing to land insufficiency without suitable management practices. In conclusion, the soils nutrients are extracted and resulted in declined yields and revenues.

c) Low private and civic investment on research and development: The availability of scientific, eco-friendly and financially possible inclusive decisions for a specific condition is absent due to inadequate land management and soil conservation research. National budget neglects the importance of LUP land degradation problem. Thus investment (private and public) on the development of technology and research is low and under civic organizations and extension facilities' subsidy dealing with NRM (natural resources management) and environment lasts to be victorious which presents a thoughtful limitation to the mainstreaming and adoption of LUP. The

strengthening of research-extension grower/end user critical links for sustainable acceptance of best agricultural activities is difficult under such conditions. Low extension and research subsidy could be accredited to the scarce appropriate valuation of ecological amenities in financial terms and payments institutionalization for ecological amenities. The paybacks of LUP with widespread environmental benefits is to be recognized, the estimation and recognition of these paybacks strengthen the calls of more subsidy for LUP.

d) High land pressure due to high reliance on land for livings: A huge percentage of the country's labor is land dependent for living. The employment and income chances are significantly low outside the agriculture sector to lessen the dependence on land relevant initiatives as a prime revenue source. The majority of the farmers are smallholdings and are mostly concerned with instant paybacks from their fields against future gains from land development plans. As a whole, the mishandling and overexploitation of land reduce the soil productivity, the overexploitation is partially as a result of enhanced investment that for maxim profit with slight or no effort of soil productivity maintenance. As that land productivity reduction by means of land degradation is closely allied with poverty, therefore, this reliance functions as a vicious cycle for supporting the undesirable effects of land mishandling.

3.6.2.2 Non-financial barriers

These barricades are resultant from skill or knowledge gaps *viz.*, Policy, legal and regulatory:

a) Insecure Land Possession: Most of the country's land is not readily available as it is limited by ecological or topographical limitations or designated for conservation. Land balance sheet shows that about 35% of the country's total land area is under agriculture usages, around 31% under forest, catchment protection and wild life conservation. This data discloses the rising pressure on the land predominantly on agrarian lands owing to population growth. The country's land strategies pact with different tenure categories *viz.,* state lands, private lands, estranged state lands, legalized and illegalized intruded state lands. The land scarcity is an important causal factor in the high intrusion level on State land so, reducing the forests hurriedly. The difficulty of getting State lands possession intruded by growers generates destitute attention to the appropriate lands use for highest agricultural production. People who use the land without suitable title activities do not take any attention or inspiration on soil conservation or cumulative land output owing to their ownership hesitation. Most of the country's growers are accustomed to cultivate the others land on the basis of a primitive tenancy system (sharing harvest by the farmer and the owner). Un-clarity of land tenure is a limitation of land degradation problems evaluating and applying LUP practices.

b) Destitute implementation and scarcity of laws, regulations and Policies: The taxes/funds by the government accelerate land degradation, particularly the soil erosion. The high paid funds by the government for N (nitrogen), P (phosphorus) and K (potassium) fertilizer in current years have caused imbalances and soil fertility degradation owing to high residual P and K levels build up in soils. The uncontrolled fertilizer application results in the increased water pollution and eutrophication. The

fertilizers' availability at high prices activated the 'national program for soil-test based fertilizer recommendation' to become absolutely useless. Numerous other safety measures are put in nationwide legislative about soil and environment conservation and are destabilized by such shortsighted strategies.

Human Skills barriers:

a) Insufficient knowledge on suitable LUP and its new challenges: Use of unsuitable and poor farming practices and land management are the key factors of biological, chemical and physical degradation of urbane land leading to total loss of ecosystem health and production. The knowledge shareholders on LUP practices at the local level is usually limited to outdated methods and is shifted through generations. The new technologies, information and skills on traditional technologies adaptation to the new tasks are the main primacies. For instance, any growers work and animate in isolation, lacking accessibility to essential information and data for right crop variety selection, precision farming methods, accurate irrigation water quantity, soil test-based fertilizer recommendations and preparing for a possible natural calamity. Higher consciousness is vital for soil fertility revival and quality maintenance and can be accomplished via rising grower's knowledge on the problem extent and subsequent impairment. Absence of basic knowledge amongst growers on up-to-date farming practices (farming machinery usage, High Yielding Varieties (HYV) preparation, right amount and timing of irrigation, usage of proper fertilizers and pesticides, etc.) hinders the effectual land use and higher productivity attainment. Thus, an urgent experience and skills is required for land planners support in poignant in the direction of further sustainable land use. Providing the land planners with the opportunities of their skill up-gradation on climate variation and sustainability problems results in their resistance and profitability as the requirements of transferring climate variation technology will not be attained with existing competence.

Organizational and institutional capacity barricades:

1. Low conservation priority to non-agricultural land usages: Around 35% of the country's total land area is under agricultural activities and the portion of non-agricultural land uses is hurriedly increasing with monetary setup, residential and important entertaining developments of economic expansion.

LUP is not prioritized by combining conservancy into these expansion plans, policies, regulations and legislation. Activities' outcomes causing irreversible impairment and severe disturbance to the land resources are regularly noticeable in the areas of large land-based substructure projects implementation therefore, making conservancy a necessity in the projects disturbing the land and should be accepted as a priority.

2. Destitute relevance of wide-ranging methods owing to land, soil, terrain, weather, size diversities and land usage as well as formation: The observed significant feature of the country is excessive climate diversity. The country's rain distribution is conventionally generalized into dry, wet and intermediate climatic zones though, accessibility to further time-based and three-dimensional data and Geographical Information System (GIS) technology have led to numerous agro-eco-logical sub

regions. As based on the formation modes and relief-based morphology, land unit and their planning in the physiographic area, various land structures were recognized for the key Agro Ecological Zones (AEZ) in the country and the intensity, severity and type of land degradation disclose varied extent and pattern.

Social cultural and behavioral barricades:

1. Individual efforts are ineffective: The management of natural resource (LUP) may not be sustainable without an active involvement of all residents of the concerned area and the revival of environment is feasible when these concerned residents understand its necessity and are authorized to control the management, conservation and utilization processes of the resource. Assumed the country's land holding's diverse nature of the different environments, disorganized tactics such as terracing or curved (contour) bunding on separate holdings or a cluster of farmhouses are slightly advantageous by neglecting influences on the adjacent area's hydrological physiognomies. Such individual activities mostly fail in grower's desirability by means they are not acquiring paybacks proportional to their investment and efforts and generate further degradation problems at the same time. Consequently, all progress actions must be carried out thru a participating, interdisciplinary and an inclusive system to maximize advantages.

3.6.3 Identified Measures

The identified overcoming measures through a consultation process with shareholders and reported confirmed analysis results from international and national experiences of land degradation management and LUP encouragement are below.

3.6.3.1. Financial and Economic Measures:

Only the education and consciousness rising without providing some assistance cannot encourage small-scale landholders to undertake suitable LUP practices. The LUP practices are usually expensive in comparison to crops cultivation cost and the paybacks of these practices are usually attained in more than a few years and not instant as well. Thus, small-scale landholders are unable to accept such follows without some assistance to reimburse the associated charges.

Some of the LUP practices requires funding and further support from the State as they cover a variety of off-site societal paybacks such as wide-ranging ecological amenities allied with LUP doings *viz.*, erosion control, silting prevention of civic water-bodies, water conservancy, recharge of ground water, etc.

a): Cumulative affordability and returns to LUP acceptance: The high cost of soil conservancy and other practices implementation including technical knowledge materials, labor and equipment hesitate the growers to adopt suitable land planning measures. Financial motivation (reimbursement) for ecological amenities is a key to investments encouragement in laborious LUP follows. Marginal land holders are obligated in intensive land use without considering alternate opportunities *i.e.,* application of appropriate manure, other inputs and crop rotation so, it is essential to introduce a motivational program to encourage the organic fertilizers' usage and other LUP practices. Working out soil conservational follows and information on LUP and

its up-to-date low-cost techniques' importance and on influences of soil erosion critical as well. Some sorts of financial encouragements are already used for developing the growers' desirability and capacity to apply LUP practices. The extensively used monetary encouragements are support and recompense labor with equipment. For the first time in 1962 at the onset of Green Revolution, the government established a funding mechanism for chemical fertilizer, and continued for more than 20 years. The usage of fertilizer has resulted in augmented land productivity along with increased grower capacity to follow conservation activities and adopt LUP practices, beneficially. Nevertheless, its effects were not optimistic as growers were completely turned to the chemical fertilizers usage and neglecting the organics application. Similarly, the augmented production via green revolution technologies pressurized the agrarian lands not used for any agricultural purpose hitherto. Thus, a key moral learnt in encouraging protective activities against land degradation is the inauguration of LUP practices that connect monetary motivations for mainstream smallholders. For inspiring the LUP practices at the farmhouse, upcoming plans must integrate a suitable combination of indirect and direct encouragements in which the payment for soil conservational structures setting up, funding seed and planting supplies as well as organics' application expenses could be as direct motivations, while technical support, extension facilities and training are as indirect ones.

b): Increasing affordability of LUP follows and reducing societal limitations in smallholdings: Existing LUP practices design and its implementation are based on individual properties. The payment is mostly allied to the holding subject size. Though, in some conditions of small properties such as lands on the steep gradients, the real monetary cost for each property might be excessive. LUP practices and its application on a watershed basis might minimize the effects on minor properties along with overall cost reduction regarding to LUP adoption, however, the existing practice of suitable measures determination and imbursements at the grower level does not allow such modernizations with the clear result that the real amount of applied LUP is not optimistic. Consequently, financial inducements (funding) is to be planned and applied for the whole watershed, with different imbursement systems based on the nature of accepted LUP practices. This offers a chance to smallholder poor growers for obtaining appropriate technologies and accepting maintainable follows.

c): Rising private and civic investment on development and research: LUP related expenses are insufficient for studying and recommendation of site-specific measures to circumstances' diversity. The modern technology usage (satellite imagery, GIS mapping etc.) provide the users with hasty results. Due to insufficient monetary provisions availability from the domestic foundations, it is essential to explore the donors' support.

d): Reducing livelihoods reliance on land to reduce pressure on land: In a growing economy where the agriculture is conquered by smallholdings the revenue raising fails to match the non-agricultural revenues so, it is essential to consider the livelihood growth as an integration of off-farm and on-farm works to create a satisfactory revenue for rural residents. However, the limited chances for generating

alternate revenue results in obligatory reliant of the rural people on land for a living and revenues. Thus, the growers alternate to intensive agriculture with fewer conservancy requirements in an effort of income maximization from the lands is the reduction of LUP extent or ploughing back of any available capital for investing in LUP into cultivations. The availed off-farm works needs to empower the growers to reduce reliant on intensive land manipulation with fewer conservancy requirements. This will be a challenging approach as a vital part of economic solution. Temporary keys (solutions) *viz.,* preferment of valuable crops hydroponic culture in conservation could be primarily considered. Land independent livelihood enhancement ventures could be arranged for employment generation in long term *i.e.,* Bee keeping, farming based Fisheries, Agro-processing and Mushroom production.

3.6.3.2. Non-financial measures

Policy, legal and regulatory measures:

a): Securing Land Possession: This is a key factor in cumulative land efficiency and agricultural growth enhancement. Land possession privileges' assurance inspires the investment in suitable LUP practices by landholder thus, it is essential to assure the land possession privileges through legal instruments' supplies *viz.,* possession transfer or continuing leases. The country is establishing a fit strategy and legal agenda mainly to settle down the concerned land tenancy to maximum independence and fairness for its utilizing as an unreliable monetary natural resource.

The possession assurance process is not a simple task. The government departments *viz.,* Land Survey, Settlement, Registrar General's and Commissioner General's Departments are mutually involved in this process though, the pace of the project's forward moving is measured very unhurried for its substantial effect.

b): Introduction and implementation of LUP rules, regulations and policies: Land conservational legislature is based on top-down, control and command rules reliant on obedience and implementation. Actually, the government's failure in effective implementation of the rules regularly leads to behavior conservancy by residential land handlers. In these conditions, rules are ineffectually enforced, unwell understood and subject to unreliable clarifications. It is essential to upsurge the agricultural advisory officers' skills in changing the representatives, effectively by improving their skills in providing adaptive solutions fit to the growers' socio-economic background and corporeal situations. It is impossible to work out an identical method with a different cluster of small growers having widespread knowledge level and economic capacity. The field extension officers' capacity in interacting with growers effectually is to be improved to enable them work with growers of varied resource capacities and experiences. Education, consciousness and capacity building of the growers via suitable on-farm demos and other is essential to strengthen such exertions. Moreover, direct implementation of legislature is required to protect the regulatory system's reliability as it is a vital in obedience assurance though, such exertions is to be supported thru education and consciousness rising on the legislation's importance.

Human skills measures:

a) : Increasing knowledge on suitable LUP practices and new challenges: Afghanistan requests to make an evidence-based approach for land degradation management in the severely affected zones, these approach needs scientific data and analysis-based policies validated by previous experiences wherever such evidence occurs. Whereas, the connection amongst poor LUP, land degradation and unsafe weather events are well documented, applying and formulating a robust LUP strategy is prohibited by scientific evidence scarcity that can alter it to exact conditions. LUP issues and land degradation mainstreaming into nationwide progress processes and agendas together with governmental financial procedure would include the strategy paper development on the paybacks of LUP targeting at the conclusive ministries as well as decision makers. Human capitals are the most crucial and frail resources hence, there is a necessity of training a huge number of officials and shareholders *viz.,* forest groups, growers, NGOs, public bodies along with the users by developing and conveying skills and knowledge via drills and supplementary approaches. Organizations dealing with LUP are also frail and capacity requests emerging tools, guidelines, mandates and systems of info management for effective functioning of suitable organizations. Formation of an allowing situation for applying LUP projects, plans and policies is essential at the organization level, which need a framework of financial, strategy, supervisory, and responsibility to develop (monitoring and evaluation) in the LUP program.

O**rganizational capacity measures:**

a) : Confirming appropriate care to conservancy in non-agricultural land uses: Augmented land allocation for non-agriculture, a movement related to financial growth by non-agricultural division ignores the LUP objectives as these necessities are factually allied with agriculture which was the substantial user of land. It is essential to bring the non-agriculture divisions under some discipline in order to ensure the LUP as a national duty and may be attained by recognizing the LUP as a societal duty unrestrained by agriculture division and considering it as a priority. Land conservancy must be recognized as a national primacy in all land uses.

b) : Improving relevance of wide-ranging methods to weather, terrain land, soil, and size diversity as well as land use and formation. Novel technologies *viz.*, remote sensing, geo-spatial mapping and GIS (Geographic Information Systems) are vital in attaining a positive change from traditional practices to sustainable development due to their combined (linking financial, environmental and social data) and locative excellence (representing relations amongst places at national and local levels). Thus, these technologies must made usage of site-specific finest LUP development appropriate for varied environments and land classes in land degradation reduction.

Social cultural and behavioral Measures:

a): Encouraging cooperative land planning measures: An effective land planning must be originated based on an interdisciplinary, participatory and social method. LUP, water management, soil conservancy, forestry, and farming systems are the basics of an

applicable community-based land planning. Moreover, financial and societal portions also exert a considerable influence on land planning. The nutrient management in varied agricultural systems is the key sector problems an should be taken in account, as this exerts impact on the entire subdivisions such by means of perennials in the upland, mixed-cropping and seasonal crops in the mid and inferior areas where apiece of the subdivisions are to be inter-reliant.

3.7 Barrier analysis and possible enabling measures for Responsive Agricultural Extension;

3.7.1 Description of Responsive Agricultural Extension;

The Responsive Agricultural Extension (RAE) is a rural agriculture extension model based on the intensive and specialized technical drills idea provided to known people of rural societies for technologies encouragement and offering technical facilities along with review and provision from an extension group. The RAE is a demand-based model that provide the growers' community with the chance of communication with the facility provider for precise info and associated amenities. This model could contribute to climatic adjustment adaptation via facility workers' training in collecting, analyzing and distributing the climate related data in their operational areas and by building local level's capacity for finding local climate change problems to allow communities pick up suitable responsive approaches.

The usage of the model left overs as a preliminary basis with restricted attention. CARE International NGO also promotes climate change adaptation. The RAE practice has also been extended to several technical fields such as agronomy, etc. RAE provides the growers with the chance of augmented accessibility to elementary extension amenities as well as development of climate related skills and information.

3.7.1.1Technology status in Afghanistan

Afghanistan's agricultural sector is a mission pillar for country and agricultural extension had been a vital tool for agricultural development prior to the occupation. The General Directorate of Agriculture Extension is one of the key arms of the ministry managing technical departments. The Extension Service suffers from (a) an unrealistically ambitious mandate, (b) outdated models of extension, and (c) inadequate human and financial resources. Because of these constraints, donor-funded agricultural development programs are also involved in the delivery of Extension services. The Afghanistan Agricultural Extension Program was designed and managed by United State Department of Agriculture (USDA). USAID, and Afghanistan's Ministry of Agricultural Irrigation and Livestock (MAIL) to address gaps within the public extension service resulting from decades of war. The Mission in Afghanistan recognized that the extension model left many smallholder farmers with little access to extension services; yet, public extension professionals were left with little knowledge of how to disseminate agricultural techniques and lacked technical knowledge. Although quite a bit is known about what happened to agricultural production during the occupation, little is known about what happened to extension during this period and what might be done to rebuild the agricultural sector. MAIL intends to develop a clear and realistic National Extension Policy that is (a) in line with current political realities facing the National

Unity Government in Afghanistan as the country steps into the decade of Transformation, (b) appropriate to a constrained financial environment, and (c) recognizes the increased capabilities of the Private Sector and NGOs.

Fig. 3. 10: Responsive Agricultural Extension

3.7.1.2 Market characteristics of technology

The technology of Responsive agriculture extension is considered as a non-market community good when established at a community level along with the support of provincial level for managing and developing the system. The marketplace of the responsive agriculture extension is fairly simple, particularly in its application by the government.

3.7.2 Identification of barriers to encourage and diffuse RAE

The technology related barriers' identification and analysis were done by means of the problem tree by involvement of expert's knowledge and experience as well as stakeholder consultations in the process. In order the initial list of barriers are as follows:

1) High cost of RAE programme and its structure development.
2) Insufficient development and application of an inclusive consciousness rising programme.
3) Lack of training and recognition of RAE workers.
4) Lack of equipment and tools facility to assist agents' work.
5) In appropriate technical assistance and management by focal extension group.
6) Lack of appropriate policies.
7) Improper communication methods.
8) Absence of strong regulatory and legislation framework.
9) Lack of consciousness among community.
10) Lack of sufficient information and research.
11) High interest rates of commercial banks.
12) High ratio of grower to extension worker due to staffs' high attrition rate.
13) Lack of governmental encouragement for implementation of the technologty.
14) Security issues.

The technology's main problem was insufficient extension facility to the growers that hindered the application of upgraded follows in their fields with the low productivity and subsequent general low living standards of rural communities via household poverty, food insecurity. Moreover, unsuitable production practices ensuing poor supervision of natural

resources following extensive degradation (biodiversity, rivers, forest and land) and ecosystem system's resistance falloff, which exposes the societies to further extreme climate related disasters.

3.7.2.1 Economic and financial barriers

The fiscal barricade to the technology's preferment and distribution are scarce inspiration of the personnel due to insufficient monetary paybacks for the agents' work within their societies, equipment and tools scarcity to do their onuses pleasingly as well as insufficient training of the workers. These are the results of scarce financial provision for supporting RAE as it is unknown as a vital part of the nationwide extension service as a consequence of the extant national agricultural extension strategy.

1) For supporting the farmers in technology application, facility of low-interest long-term lends by international resource , private resources and different funds agencies.
2) Facilities of governmental funding to growers for reducing the initial application cost of technology adaptation.
3) Establishment of sustainable fiscal provisions to encourage extension and research.
4) High poverty rate of the country is a major constraint to the adaption of this technology.

3.7.2.2 Non-economic and financial barriers

Policy, legal and regulatory

1) Inadequate motivation to inspire the implementation adaption of responsive agricultural extension.
2) Urban-rural immigration is a reason of required personnel's unavailability for drills as well.

Technical

1) The lack of proficient staffs as an outcome of scarce qualified personnel for training is the main barrier, which is the upshot of destitute educational quality inside the rural societies.
2) Lack of strong research organization and institutional capacity.

Social, cultural and behavioral

1) Inadequate promotional activities on responsive agricultural extension resulted in limited awareness of growers on the benefits of this technology.
2) Growers' resistance in changing behavior to accept new technology.
3) Strangeness of the new technology is also a social barrier to technology deployment, local growers familiarized to traditional agricultural technology.
4) Ineffective agricultural extension facilities and lack of tacking people preference into account are also barriers to the technology deployment.

Information and awareness

1) High ratio of growers to extension worker due to staffs' high attrition rate.
2) Absence of efficient agricultural services are the significant barriers to application of the technology.
3) Overall deficient education, information and consciousness of the growers a bout new technologies and their merits that hampers the acceptance of the technology.

3.7.3 Measures to address barriers to RAE promotion and diffusion

The measures via consultation with shareholder and experts for improving the promotion and diffusion of RAE were firstly recognized for apiece barriers' category and rearranged into financial and non-financial measures.

3.7.3.1 Economic and financial measures

The review of current extension structure is essential by the central in addressing economic barricades to empower the alliance of RAE into the national extension system for enabling the financial distribution to support its application. Besides, this might be an engaging mechanism with Relief Agencies, NGOs, Trustee and Grower-based Establishments, etc. for supporting the protagonist of the technology's exact positions in association with the local supervisions. The provision of needed equipment and establishment of a clear modality is necessary for payment of proficient staffs. Moreover, the training of personnel along with training facilities should be perpetually.

3.7.3.2 Non-economic and financial measures

Policy, legal and regulatory

The nationwide extension amenity is to develop an inclusive activity policy for progressing and supporting RAE in rural societies ample with drills activities. The most vital step for provincial and central governments is cautious revision of the extent laws and regulation for the agricultural extension in the country. The government should insure the technology's public acceptance, and develop consciousness materials, communication and promotional policies. Popularization of technology and growers' satisfaction leads to the acceptance of technology.

Technical

The revision of existing extension and transfer system is required to comprise RAE for empowering its prioritization and credit as key step in addressing the extensive gap among existing extension employees and growers. Improvement of agricultural extension facilities for offering essential capacity building activities and recommendations to growers and local landowners on the technology advantages. In order to build a higher number of extension workers for improve growers to extension worker ratio, the government has provided skill, capacities, and motivation.

Social, cultural and behavioral

Governmental and related organization provides promotional activities on responsive agricultural extension resulted awareness of growers on the benefits of this technology. The development and implementation of appropriate extension programs changing the behavior of the growers and increase acceptance of the technology.

The effective agricultural extension facilities and tacking growers' preference into account are also help to the technology deployment.

Information and awareness

The undertaking of continuous consciousness on the paybacks of RAE amongst rural societies is required for eliminating the misunderstandings and inspiration of unofficial knowledge amongst the mature people. Panning of consciousness movement for growers and develop media broadcasting for information sharing.

3.8 Identified common barriers in agriculture sector

This unit contains the common barricades of prioritized agricultural sector's technologies. The Table 3.1 indicates the mutual and inter-related recognized barricades among agricultural sector technologies; overwhelming one barricade of a technology would resolve some problems in others, that would finally result in more sustained and hurried acceptance and dissemination of all these technologies in the country's agriculture division.

Table 3.1: The identified common barricades of prioritized agricultural sector's technologies.

Common barriers		
Steps	**Barrier Category**	**Barriers**
Step1	Economic & Financial	High capital, operation and maintenance costs
		Low motivations in terms of short-term funding or easy lends
Step2	Consciousness & Information	a. Inadequate consciousness and info on the technology's presence and utility b. Restricted interaction between technology users, supplier and developer
Step3	Organizational capacity	Inadequate organizational capacity Inadequate R&D capacity Inadequate human drills and skills in system's installation and designing
Step4	Market failures	Small immature market. Frail supply chain and delivery mechanism

The aforesaid barricades are mutual and inter-related thus, disabling these barricades would massively assist in acceptance and dissemination of all three prioritized technologies.

3.9 Enabling framework for overcoming the barriers in agricultural sector

Cultivation is the spine of country's economy but any long run agriculture development policy and strategy has rarely considered related to the upcoming challenges towards food safety. The food security is intimidating by climate fluctuation as it can impair the water resources scarcity via unpredictable abridged precipitation and extreme evaporation regimes.

The subsequent unit discovers the required exact measures for enabling the country in overcoming the recognized prioritized barricades of agrarian technologies. The discussions with technology users, specialists and review of literature specify that firming and producing the allowing situation for supporting agrarian technology rest on several important factors that are knotted with regulatory and policy outline, market limitations and other organizational capacity building remedies.

The most decisive identified elements through this research-based participatory process are:

1. Policy and regulation:
2. Public agricultural research:
3. Enterprises growth:

Policy and regulation:

These outlines are significant via acting as a guide in technology's externalities avoidance confronted by end-user. A vital factor of the allowing plan for overcoming the barricades to agriculture related prioritized technologies' diffusion is to be the initial acceptance of draft nationwide agricultural strategy and the current general climate variation plan's enhanced operationalization and its application outline's suggestions regarding to the water and agriculture. This should be supported via better financial provision for the aforesaid prioritized technologies' diffusion by enlistment and easing of national financial funds as well as outdoor donors. Similarly, robust supervisory setting is decisive in market imperfection's handling especially in technology novelty case paybacks from intellectual property rights and patents while, in case of technology's immature or poor markets, high transfer cost hinders the technology's development and diffusion. The destitute quality control by inexpert or fake initiatives, varied sorts of inputs, suppliers, importers and other mediators who distribute technology to the growers as well as the cost of getting new technology's information are the examples of agrarian technology. A robust supervisory system to handle the high operational expenses is vital for growers' protection against technology's environmental externalities together with operational expenses.

Civic agrarian research:

The civic research organizations are confronting serious problem of reduced subsidy by donor or government. Private firms are not investing in research that create info on privately unmarketable methods. Therefore, it is essential to invest in civic research as agricultural research organizations enhance their trade-based links that boost their aptitude and knowledge to communicate with private initiatives. In case of working with private initiatives that are capable of conveying their technologies to the growers, the sound consciousness of the agricultural research organizations about intellectual property rights and establishing their safety policies is crucial regarding to the technology innovation.

Initiatives growth:

Involvement of private enterprises in destitute ecologically susceptible technology development and diffusion is highly documented. The private sector's capacity is a key factor in distributing effective public and private agricultural technology to the end user. Which comprises private industrial companies of effective irrigation structures, seed firms, contractors and construction designers. The mandatory investment's assurance is the important allowing issue in implementation of all agriculture divisions' technologies.

The allowing actions could profit from essential measures *viz.,* enhancement of organizational and human capacities drills, rules and regulations firming, suitable strategies setting (encouragements or discouragements), climate related decision planning assurance, rising technology and research consciousness and experimental demo ventures implementation. Thus, the proposed allowing outline can be divided into following categories:

a) Confirming suitable fiscal system for supporting the prioritized agrarian technologies growth and dissemination to balance the cost of high capital and upkeep operation.
b) Considering the majority of climate variation regarding to sectoral plans and polices.

c) Assurance of adequate monetary resources availability to R&D organizations for commencing and firming drills, research and technology consciousness events amongst shareholders.
d) Strengthening organizational capacities maintenance at sub-national and national levels. Training of local experts in operation and upkeep of prioritized agricultural technologies.
e) Implementation of useful demo projects.

In order to transfer a technology on a sustainable basis, a suitable allowing setting could create a standard swing from development of short-term outlined venture-based location to development of skill in technology end users (farming community). Growers' engagement for skill progress and conveying information to them would develop technology possession which is significant in widespread up gradation of the technology. The following issues necessitate the involvement of all shareholders in designing, planning and application at demo site and other training and information sharing agendas for apiece technology as well. An explanation of recognized barriers and required measures in diffusing each prioritized agriculture sector's technology is stated in Table 3.2.

Table 3.2: Focal technology barricades and measures for the country's agriculture sector

Technology barriers	**Measures**
Micro irrigation system for effective water management and usage Climate change resistant plant diversities introduction	
1. The required high initial assets for hereditary manipulation or crop breeding experimentations for producing favorable seed diversities. 2. Immature and small market for these crop diversities; high competition amongst imported and local varieties. 3. Inadequate seed testing and certification centers.	1. Credits and lends facility to growers and confirming accessibility of agricultural community. 2. Functional market establishment and info enhancement. 3. Increase number of testing facilities and of skilled staff.
Early warning system of climate predicting and monitoring	
1. High installation cost, O&M 2. Scarce dense climate monitoring station network. 3. Inadequate research in weather and climate change science area. 4. Lack of free data exchange among national users.	1 & 2. Provision of increased financial resources for expansion, up gradation and modernization of climate predicting monitoring and early warning systems in the country. 3. Subsidy facility to R&D organizations and their capacity building 4. Improve teamwork and harmonization amongst international, national and regional institutions and R&D agencies for products and information sharing, and enhanced relationship with other users' institutions.

Linkages of barricades identified

As specified in earlier units, the barricades of agricultural sector's technologies application were recognized in five sorts:

i) Financial and economic.
ii) Policy/regulatory.
iii) Technology.
iv) Information/capacity.
v) Social.

Some of these barricades are alike in all the technologies *viz.,* frail capacity and scarce info on technology merits and usage as well as unfamiliarity with new technology are the key barricades to implementation of all agriculture sector's prioritized technologies.

In order to increase the efficacy of irrigation water use regarding to water saving technologies, supervisory activities of the government are required on the pricelist system. High substructure and investment cost is another barricade to the extensive implementation of the technology. Inaccessibility to long-term low interest monetary resources results in the private growers' incapability for providing adequate investment in the technology development. Scarce essential agricultural machinery is a key barricade in conservative cultivation technology. Societal barricades *viz.*, unawareness of local growers on financial and environmental merits of the technology are also significant.

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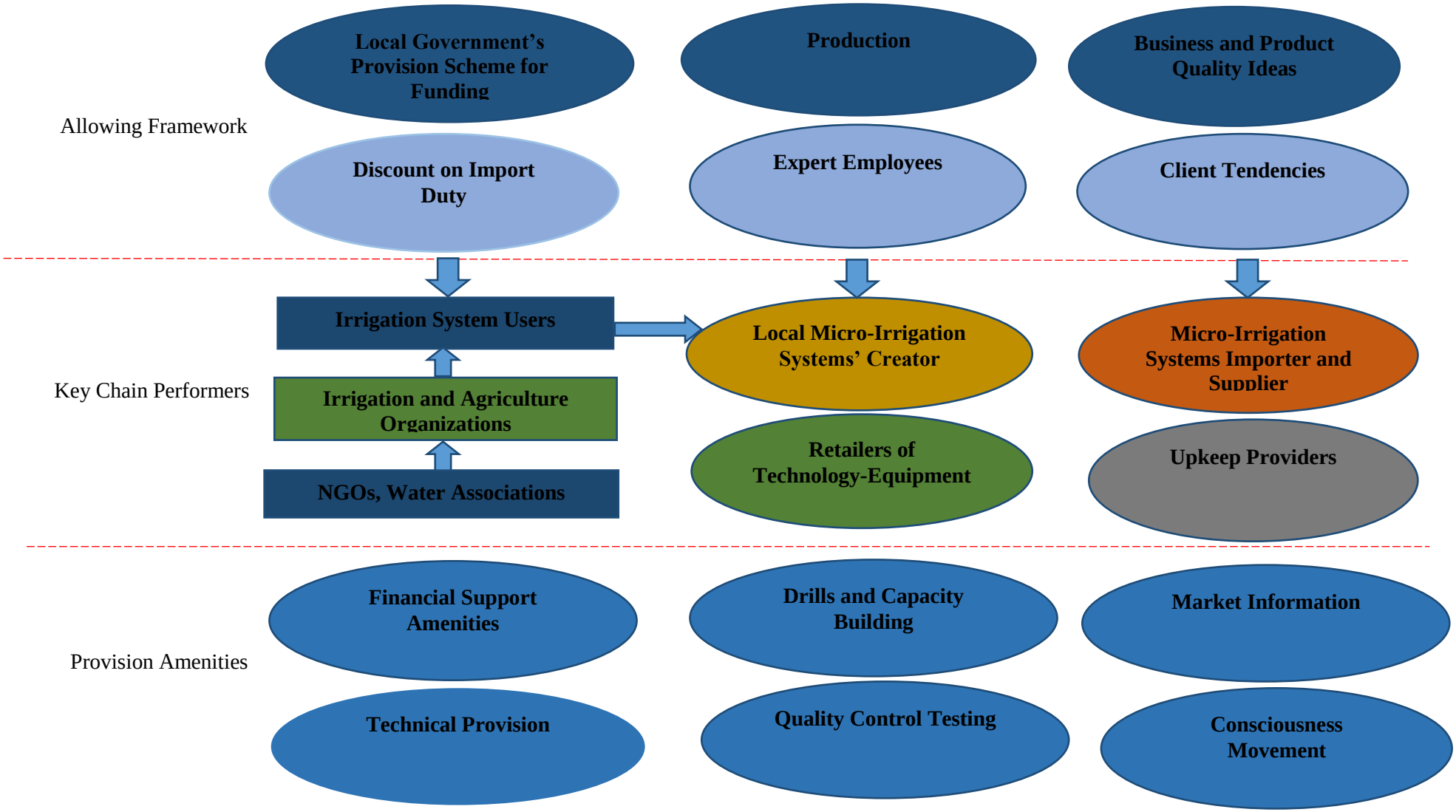
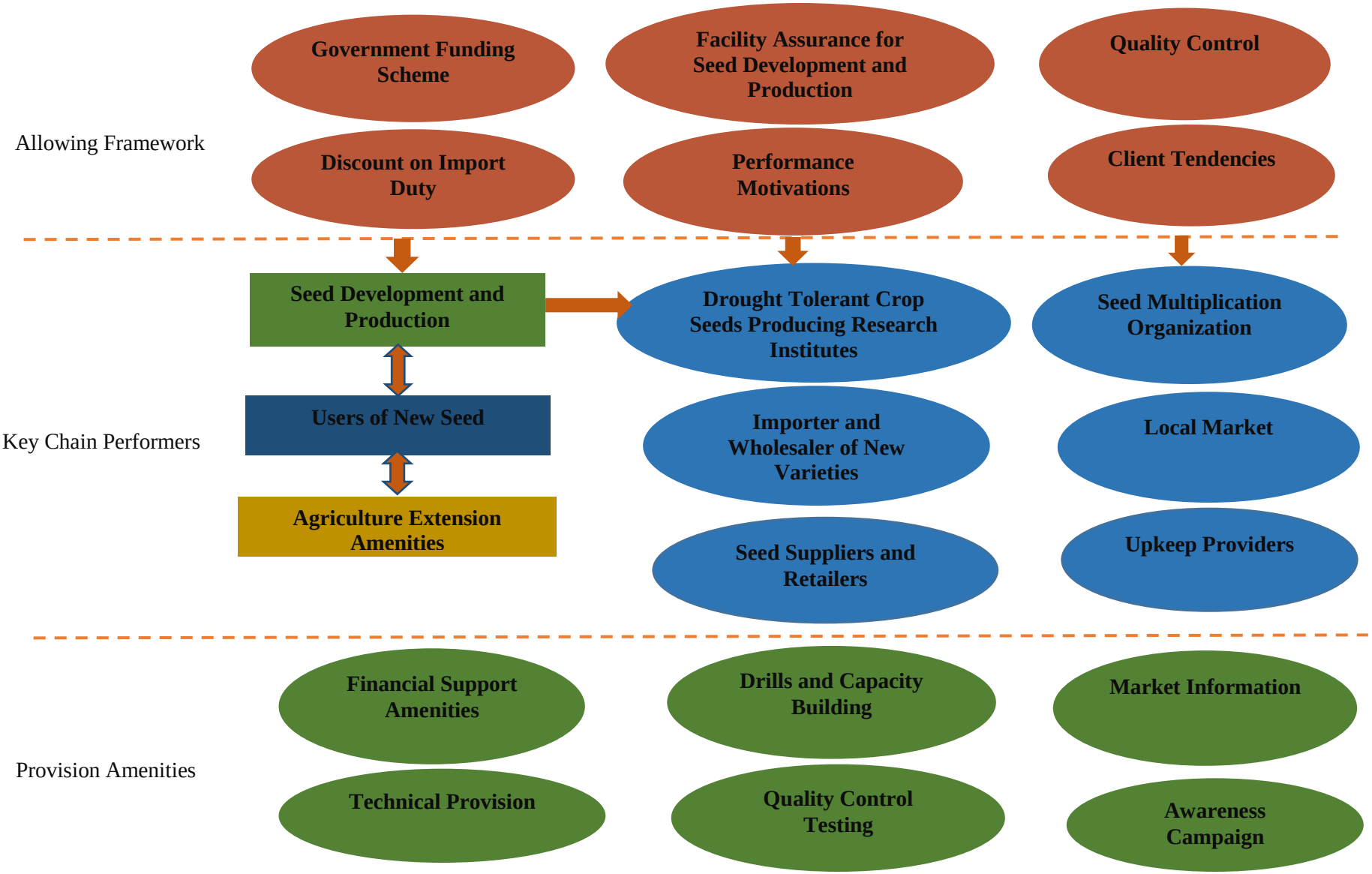
APPENDIX I

Annex-1: Market Map and Problem Trees

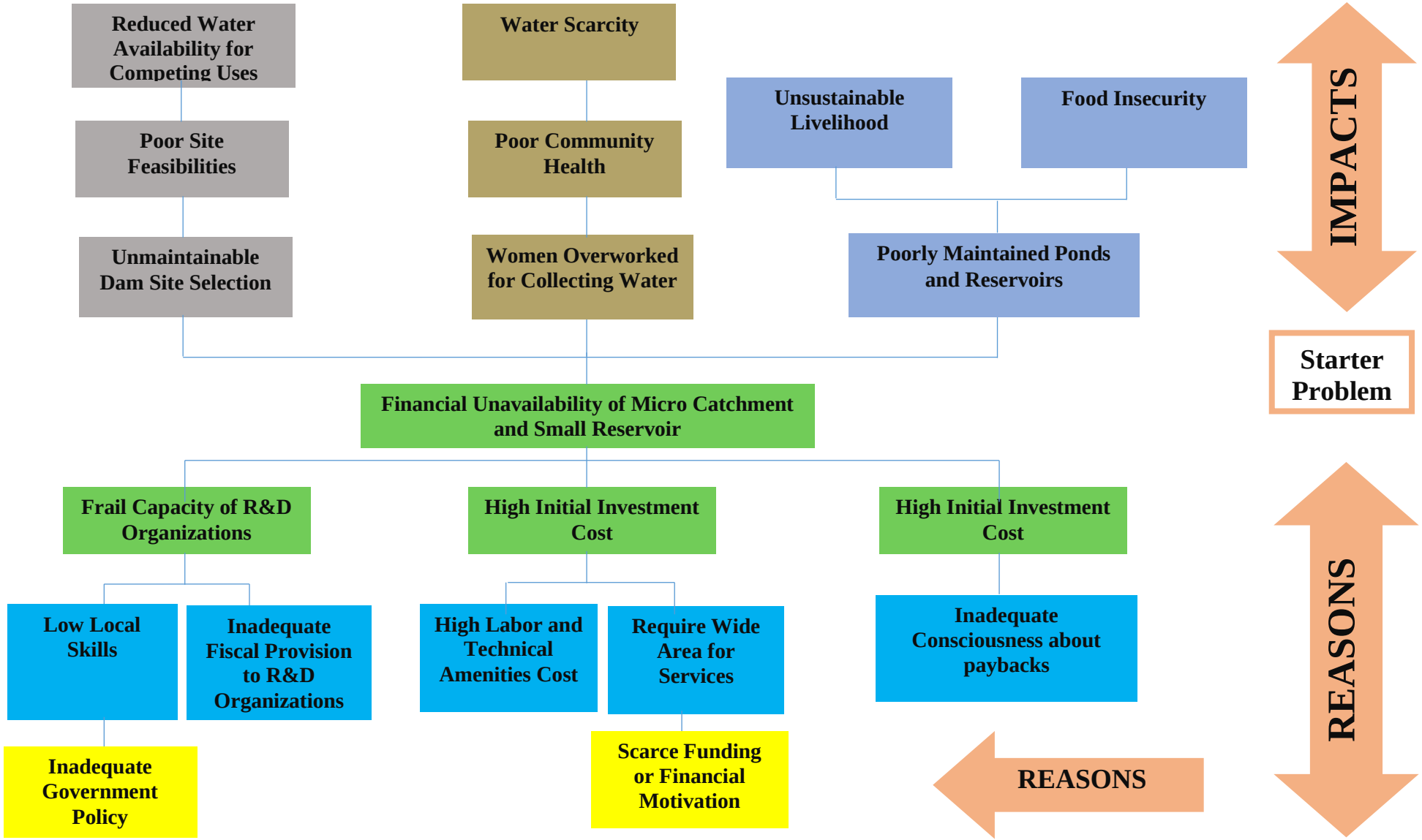
Annex-1.1: Market Map for Micro Irrigation System for efficient water use and management



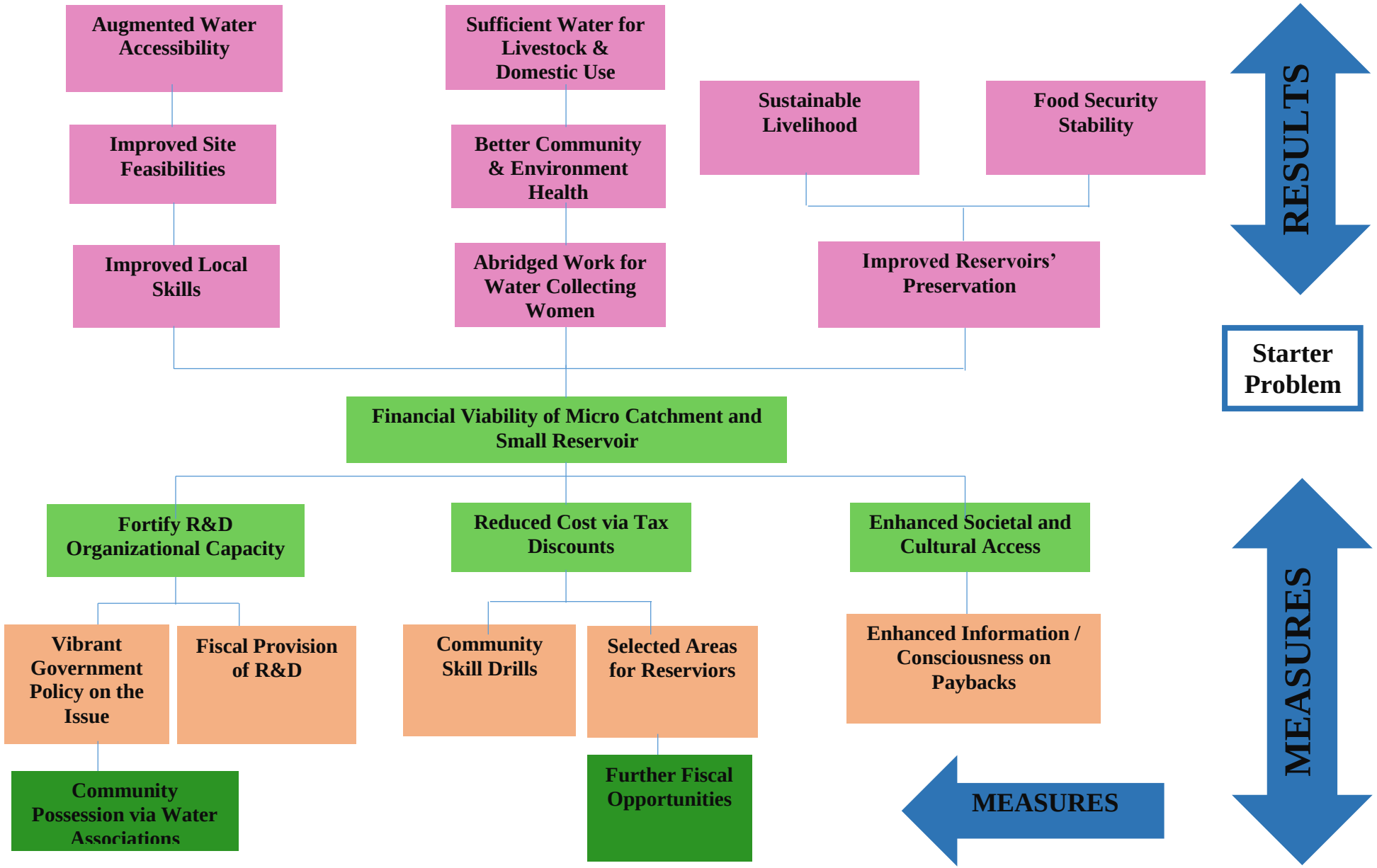
Annex-1.2: Market Map for Introduction of plant varieties resistant to climate change



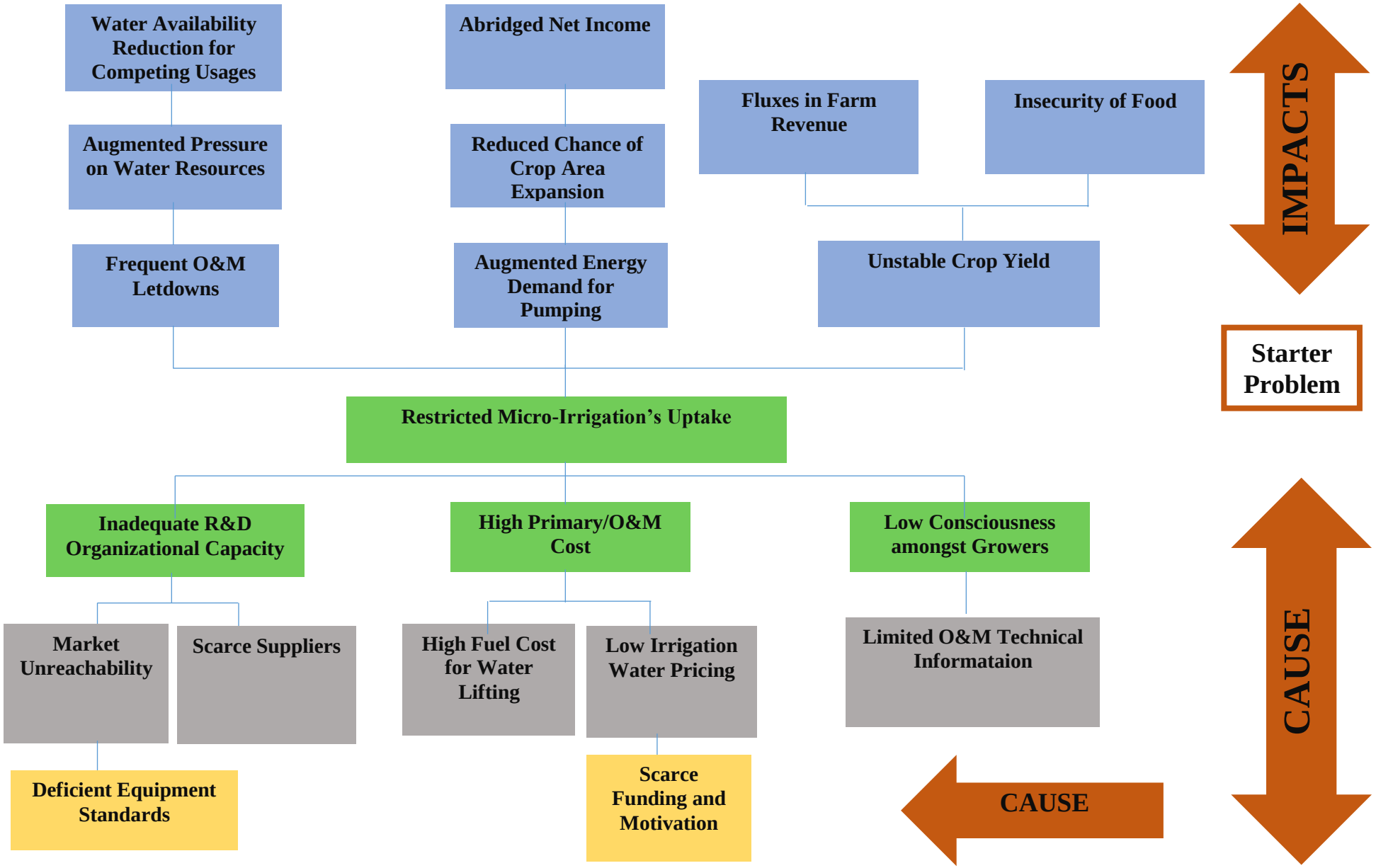
Annex 1.3: Problem Tree – Rainwater Collection from Ground Surface



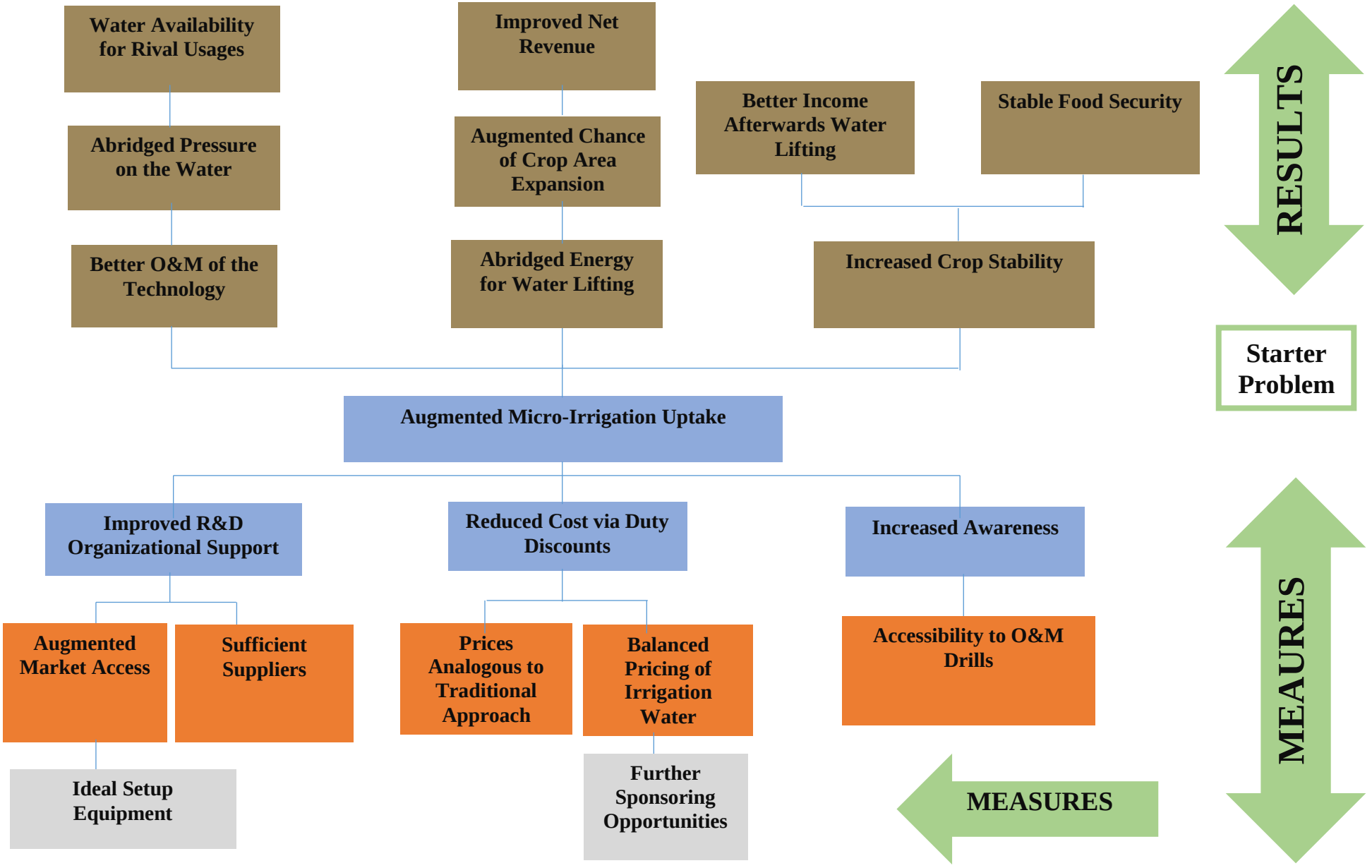
Annex 1.4: Solution Tree – Rainwater Collection from Ground Surface



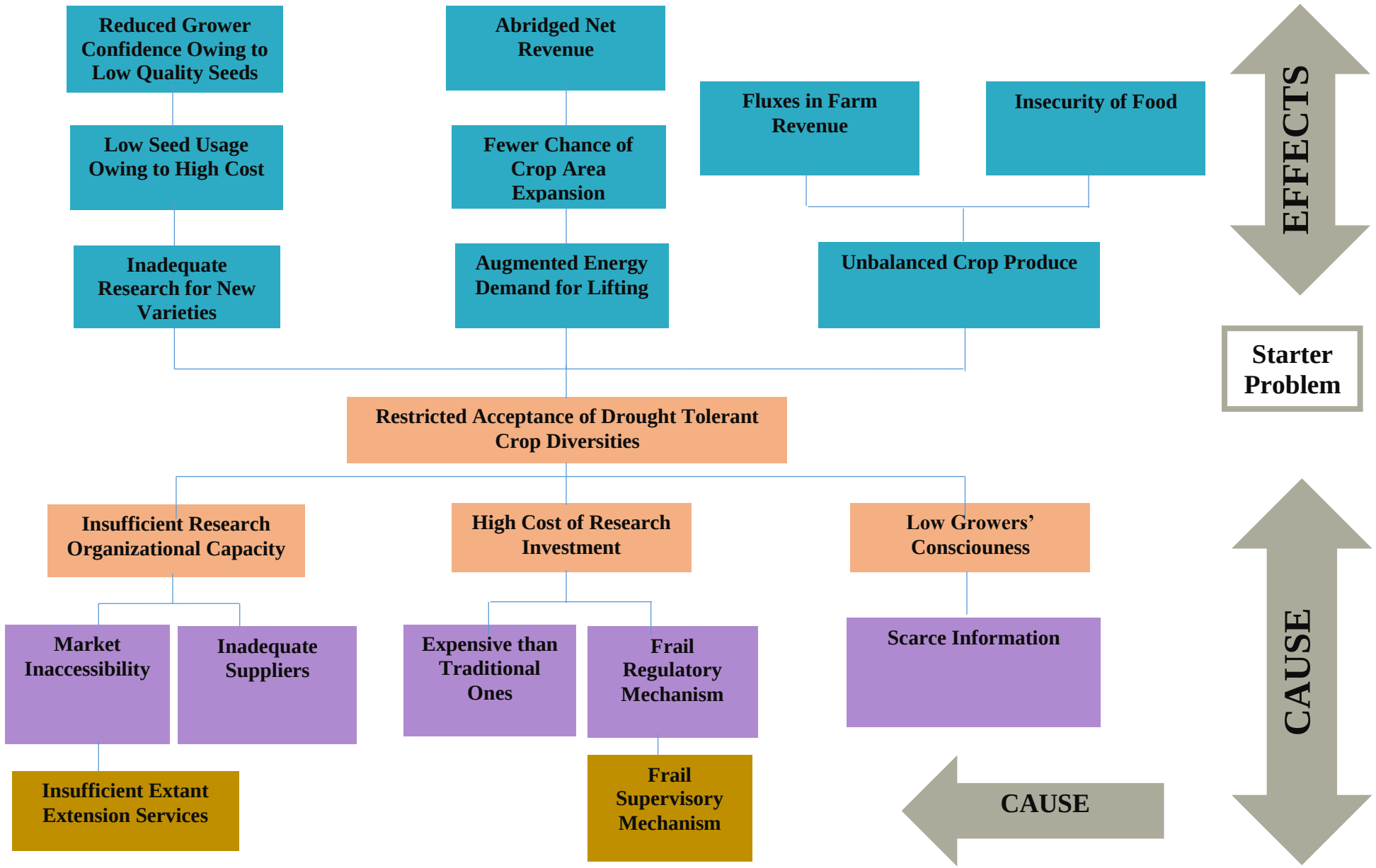
Annex 1.5: Problem Tree – Micro-Irrigation System for Efficient Water Use and Management



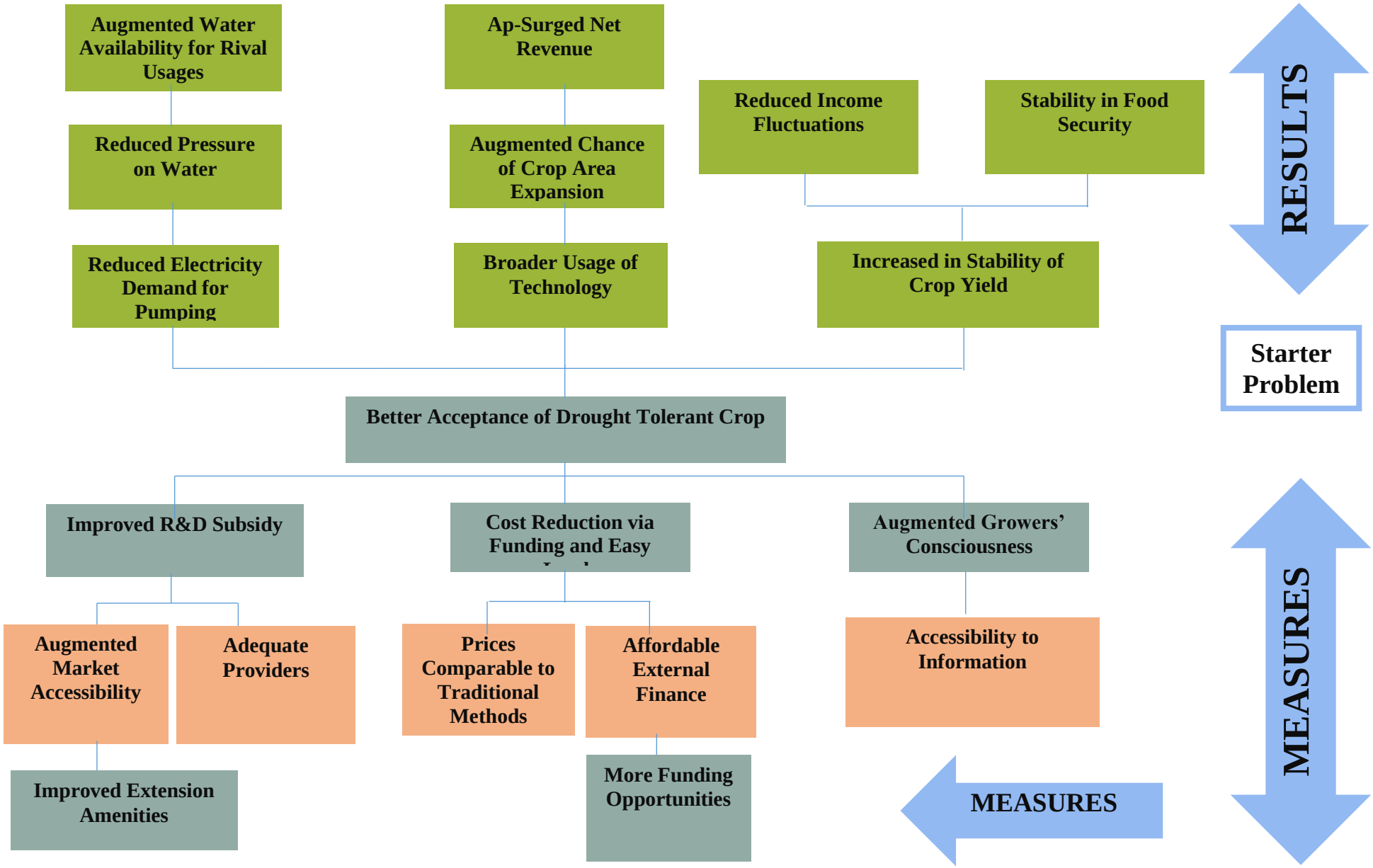
Annex 1.6: Solution Tree – Micro-Irrigation Systems



Annex 1.7: Problem Tree – Drought Tolerant Crop Varieties



Annex 1.8: Solution Tree – Drought Tolerant Crop Varieties



Appendix II

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