Government of the Islamic Republic of Afghanistan

National Environmental Protection Agency

Technology Needs Assessment for Climate Change Adaptation

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Foreword

Afghanistan's high vulnerability to the adverse impacts of climate change, particularly extreme climatic events, means that the country is in dire need of innovative adaptation technologies to reduce losses of and damages to life, property, natural eco-systems and economy of the country.

Against this backdrop, I am confident that the Technology Needs Assessment (TNA) project initiated by the National Environmental Protection Agency in collaboration with the United Nations Environment Programme (UNEP), Climate Technology Centre and Network,(CTCN) and Denmark Technical University (DTU). The project plays an important role in increasing resilience against climate change vulnerabilities through transfer and diffusion of prioritized technologies in the agricultural and water sectors as well as removing barriers to their adoption.

I am pleased with the extent to which this TNA exercise has been a nationally-driven process involving local expertise and knowledge, supplemented by international experience. The sectors and technologies that have been prioritized in Afghanistan's TNA adaptation report are the sectors and technologies emphasized in Afghanistan Climate Change Strategy and Action Plan (ACCSAP), Nationally Determined Contribution (NDC) and National Adaptation Programme of Action (NAPA). I strongly believe that the implementation of the adaptation technologies prioritized in this TNA adaptation report will help the country in building resilience to the impacts of climate change.

I thank the members of the TNA National Team, TNA National Steering Committee, and my colleagues in the National Environmental Protection Agency and experts of the Adaptation Working Group for their invaluable contributions to the preparation of this report.

I also thankfully acknowledge the contribution of the Adaptation Consultant and other experts of the Global Environment Facility (GEF), United Nations Environment Programme (UNEP), UNEP-DTU Partnership and the Asian Institute for Technology (AIT) for their continued support for the implementation of the TNA project which has identified specific and prioritized measures for climate change adaptation in Afghanistan.

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PREFACE

Climate change is one of the most daunting threats that the world faces today. For Afghanistan, it is a colossal challenge to achieve its sustainable development goals without compromising on its socio-economic development needs. Due to its exposure to the recurrent episodes of drought, flooding, earthquake, avalanche, deforestation, land sliding, heat waves, and glacial lake outburst floods in the past few decades, the country is consistently ranked as being a highly vulnerable to the impacts of climate change by multiple climate change vulnerability indices.

Building resilience and adaptation to climate change is becoming in dispensable for Afghanistan. Fortunately, environmentally sound technologies are gaining a high priority in sustainable development policy dialogue and implementing frameworks. Technology Needs Assessment (TNA) is one of the critical steps towards identifying and assessing climate change adaptation challenges in 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 successfully pursue climate resilient development.

This report on a technology needs assessment for Climate Change in Afghanistan is the main output of TNA project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP/ DTU Partnership in collaboration with Asian Institute of Technology (AIT). The TNA process in Afghanistan was undertaken in July 2019 with the assistance of the National Environmental Protection Agency. This report identifies and provides a list of prioritized adaptation technologies for climate vulnerable water and agriculture sectors in 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, stakeholders, and National TNA team.

I extend my appreciation to all stakeholders for their constant support and valuable comments through the development of this report. I hope that this assessment will go a long way in mitigating the country's climate change vulnerabilities.

Mohammad Gulab Omari (Ph.D.)
TNA Consultant
National Environmental Protection Agency of the Government of the Islamic Republic of Afghanistan

ABBREVIATIONS

AIT	Asian Institute of Technology
ANDS	Afghanistan National Development Strategy
ACCSAP	Afghanistan Climate Change Strategy and Action Plan
ACT	Action on climate today
CTCN	Afghanistan Climate Center and Network
CC	Climate Change
CCOP-WG	Climate Change and Disaster preparedness Working Group
CEC	Committee for Environmental Coordination
CARD-F	Comprehensive Agriculture and Rural Development Facility
DTU	Denmark Technology University
EPA	Environmental Protection Agency
EST	Environmental Sound Technology
EIA	Environmental Impact Assessment
FEWS-N	Farming Early Warning System Network
GDP	Gross Domestic Product
GCISC	Global Change Impact Studies Center
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIRoA	Government of Islamic Republic of Afghanistan
HCDM	High Commission for Disaster Management
HDI	Human Development Index
HFC	Hydro fluorocarbons
ICE	Inter-ministerial Commission for Energy
ICIMOD	International Centre for Integrated Mountain Development
ICRE	Inter-ministerial Commission on Renewable Energy
IDA	International Development Assistance
IFC	International Climate Fund
INC	Initial National Communication under the UNFCCC
INDC	Intended Nationally Determined Contribution
IPCC	Inter-governmental Panel on Climate Change
kWh	Kilowatt hour
LDC	Least Developed Country
LDCF	Least Developed Countries Fund
LEDS	Low Emission Development Strategies
MAIL	Ministry of Agriculture, Irrigation and Livestock
MUC	Multi Criteria Analysis
MDG	Millennium Development Goal
MEA	Multilateral Environmental Agreement
MEW	Ministry of Energy and Water
MoEc	Ministry of Economy
MoEd	Ministry of Education
MoF	Ministry of Finance

MoFA	Ministry of Foreign Affairs
MoHE	Ministry of Higher Education
MoIA	Ministry of Interior Affairs
MoMP	Ministry of Mines and Petroleum
MoPH	Ministry of Public Health
MoPW	Ministry of Public Works
MoT	Ministry of Transport
MPH	Ministry of Public Health
MRRD	Ministry of Rehabilitation and Rural Development
MUDA	Ministry of Urban Development Affairs
MW	Mega Watt
NAPA	National Adaptation Plan for Afghanistan
NDC	National Determined Contribution
NEPA	National Environmental Protection Agency
NEAC	National Environmental Advisory Council
NGOs	Non-Governmental Organizations
NADF	National Agriculture Development Framework
NBSAP	National Biodiversity Strategy and Action Plan
NFMP	National Forestry Management Policy
NREP	National Renewable Energy Policy
NABDP	National Area Based Development Programme
NCSA	Nation Needs Self-Assessment
SRMP	Rural Renewable Energy Policy
RREP	Sustainable Rangeland Management Plan
TAPs	Technology Action Plans
UNEP	United Nations Environment programme
UNFCCC	United Nations framework Convention on Climate Change
UNDP	United Nations Development Programme
UN	United Nations
UNCBD	United Nation Convention on Biological Diversity
UNCCD	United Nation Convention to Combat Desertification
USGS	United State Geological Survey

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Executive summary

Afghanistan is a landlocked country in South and Central Asia with a rich history and diverse population. Afghanistan shares borders with six countries: Pakistan to the south and east, Iran to the west, Turkmenistan, Uzbekistan as well as Tajikistan to the north and China in the far northeast with total geographic area of 652,864 km^2 (SNC, 2017). Afghanistan is the 41 largest country in the world. Since 1950 Afghanistan's mean annual temperature has increased significantly and considerably by 1.8 ^{0}C. This warming is most pronounced in the south, which experienced a temperature increase of 2.4 ^{0}C, as well as the central highlands and north that experienced increase of 1.6 ^{0}C and 1.7 ^{0}C, respectively. In terms of future projections, under an optimistic [RCP 4.5] scenario, Afghanistan shows a trend of warming by approximately 2.5 ^{0}C above current temperature by 2100. In contrast, a pessimistic [RCP 8.5] scenario shows extreme warming across the whole country of approximately 3^{0}C until 2050, with further warming up to 7 ^{0}C above current temperatures by 2100. Under both scenarios, there are regional differences with higher temperature increases expected at higher altitudes than in the lowlands. This climatic variability translates into a heightened level of uncertainty about frequency and intensity of extreme weather events with potential to adversely impact the major economic sectors of the country such as agriculture and water. Within this context, Afghanistan needs to build and improve its coping capacity against the climate change risks through adopting a climate resilient development strategy where technological innovation, transfer and successful diffusion sits at heart of effective national response to a low vulnerability pathway in order to effectively address the climate change challenges.

Technology Needs Assessment (TNA) is one of the most important 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 order to reach the final selection of the most vulnerable sectors of the country to the impacts of climate change, six climate sensitive sectors were assessed against the set of the following criteria:

1. To contribute to the sustainable development priorities of the country
2. Climate change impacts on Afghanistan and its degree of vulnerability
3. To support and minimize vulnerability to climate change
4. Sector specific adaptation needs of the country
5. Technology innovation in the sector to improve adverse impact of climate change

Finally, through this process Water and Agriculture sectors were chosen as priority sectors for country adaptation technology needs. After the sector prioritization process was complete, the TNA process entered in its next step of identifying and prioritizing technologies for each sector through an extensive stakeholder engagement process. For this purpose, the TNA process utilized MCA tool for comparing adaptation technology options across a number of diverse criteria while taking into account the priorities and values of multiple stakeholders, thereby moving forward the formal decision-making process in a

transparent and consistent way. Identifying technology options was a critical initial part of the MCA process by expert sectoral working group-adaptation. Based on desk reviews of technology requirement and status in each sector and expert opinions, initially a list of 12 technologies was prepared for Water sector, and 12 for Agriculture sector, 4 to 6 technologies for each sector through discussion with key experts and stakeholders. 'Technology Fact Sheets' were prepared for the pre-selected lists of technologies that included: brief technology descriptions, total cost of the technology, the application potential, current status and implementation barriers in the country, the adaptation and other social, economic, and environmental benefits. Using MCA tool and inputs from expert sectoral working group-adaptation, top 4 technologies for Water sector 6 technologies for Agriculture sector were identified, assessed and then prioritized by following several key steps that included:

(a) Identification of technology options for water and agriculture sectors.
For water sector, the technologies identified were;
1) Sprinkler irrigation,2) Drip irrigation, 3) Early warning system for water supply management through snowpack monitoring technology, 4) Ground water mapping and modeling technology, 5) Integrated water resource management, 6) Micro irrigation system for efficient water use and management technology,7) Small dames and micro catchment technology, 8) Rain water collection from ground surface technology, 9) Water saving technology (Reducing water leakage in water management facilities),10) Water user association technology, 11) Wells for domestic water supply, and 12) Water legislation improvement.

For Agriculture sector, the following technologies are identified
1) Ecological pest management technology, 2) Responsive Agricultural extension technology, 3) Wind break technology, 4) Crop growing under Plastic mulches technology, 5) Agro-forestry technology, 6) Conservative Agriculture technology, 7) Crop diversification and new varieties technology, 8) Introduction of plant varieties resistant to climate change technology, 9) Land use planning technology, 10) pasture improvement technology, 11) Seed and grain storage technology, along with,12) Green-house crops(Cucumber, Tomato, Capsicum) technology.

b) Selection of basic criteria and (sub-criteria) for performance evaluation of each technology.
The criteria included cost (of technology setup and maintenance), economic benefits (with sub-criteria of creating jobs and improving economic performance), social benefits (with sub-criteria of improving health and reduce poverty and inequality), environmental benefits (with sub-criteria of supporting environmental services, protect biodiversity and environmental resources), and climate related benefit (with sub-criterion of potential to reduce vulnerability and build climate resilience.

c) Weighting and scoring of the criteria by using multi criteria analysis (MCA) tool to get the final top prioritized technologies for the sectors of water and agriculture. Based on the final total weighted score, four prioritized technologies identified through TNA process for water sector of Afghanistan are:

1. IWRM (Integrated water resource management)

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

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

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

The results of sector and technologies prioritization in water and agriculture sectors of Afghanistan, undertaken through extensive stakeholder's consultation process were endorsed initially by the National TNA Committee and subsequently by the TNA Steering Committee during their meetings held in July 2019.

Chapter 1: Introduction

1.1 About the TNA project

This project is implemented in collaboration with Global Environment Facility (GEF), United Nations Environment Programme and Denmark Technical University (UNEP-DTU) partnership and the Asian Institute for Technology (AIT), as the first comprehensive national exercise undertaken towards addressing Afghanistan's climate change concerns. Thus, the TNA Report provides an assessment of the priority technology requirements and action plans for climate change adaptation activities in agriculture and water sectors. The current Global TNA project, deriving from window (i) of the Strategic Program on Technology Transfer is designed to support countries to carry out improved Technology Needs Assessments within the framework of the UNFCCC. The purpose of the TNA project is to assist participant developing country Parties identify and analyze priority technology needs, which can form the basis for a portfolio of environmentally sound technology (EST) projects and programs to facilitate the transfer of, and access to, the ESTs and know how in the implementation of Article 4.5 of the UNFCCC Convention. Hence TNAs are central to the work of Parties to the Convention on technology transfer and present an opportunity to track an evolving need for new equipment, techniques, practical knowledge and skills, which are necessary to adapt new technology and/or reduce the vulnerability of sectors and livelihoods to the adverse impacts of climate change. Climate change (CC) is rapidly emerging as a global challenge with capability to erode the gains of sustainable development of countries, specifically of economically vulnerable ones, through amplifying the level of climate change risks to their natural and socio-economic systems and consequently tightening the poverty trap around the most vulnerable communities and nations.

Afghanistan is consistently ranked as one of the most vulnerable countries of the world due to its recurrent exposure to extreme weather events such as floods, droughts, landslides, earthquake, avalanche, deforestation, desertification and aridification in the past one decade that have taken a heavy toll on both human lives and its pace of economic growth. The country's past climatic trends indicate a rise in temperature by 1.8 ^{0}C. The projected rate of warming is most rapid in summer and relatively uniform across the regions of the country; high precipitation variability embedded with extreme (wet/dry) precipitation episodes. This climatic variability translates into a heightened level of uncertainty about frequency and intensity of extreme weather events with potential to adversely impact the major economic sectors of the country such as agriculture, and water. Within this context, Afghanistan needs to build and improve its coping capacity to the climate change risks through adopting a climate resilient development strategy where technological innovation, transfer and successful diffusion sits at heart of effective national response to a low vulnerability pathway in order to effectively address the climate change challenges.

The country driven Technology Needs Assessment (TNA) process offers a framework to assist developing-nations that are signatory to the United Nations Framework Convention on Climate Change (UNFCCC) in determining their technology priority needs in order to achieve their goal of climate resilient development. Afghanistan is amongst 23 countries of the world

conducting TNA process in the third phase of this program under the auspice of UNEP, the implementation entity of TNA on behalf of GEF. The National Environmental Protection Agency is leading the TNA process in the country covering both areas of adaptation and technologies. The first level of analysis caters to the country's developmental priorities in context of its socio-economic demographic and geographic conditions and the level of climate change risk it is exposed. It reviews various national and sector-specific development plans, policies and strategies, for example, Afghanistan Climate Change Strategy and Action Plan (2016), National Natural Resource Management Strategy (2017-2021), National Comprehensive Agriculture Development Priority Programme (2017-2021), Second National Communication Report under the United Nation Framework Convention on Climate Change (UNFCCC 2017), Climate Change Action Plan 2015 to 2024 etc.

In 2015, as part of the Intended Nationally Determined Contribution (INDC) preparation process, NEPA convened a series of consultation and awareness raising workshops to bring together decision makers from government institutions and stakeholders from non-governmental organizations to develop the current INDC and establish a sustainable development vision for Afghanistan. Through this INDC process and existing policies and strategies, the overall vision that was developed for Afghanistan aims to enhance the adaptive capacity and resilience of its agriculture, environment, and population to climate change.

1.1.1 Adaptation Visions, Goals and Targets:

Afghanistan's vision for addressing the adverse impacts of climate change through adaptation aims to protect the country and its population by enhancing adaptive capacity and resilience, effectively respond to the vulnerabilities of critical sectors, and efficiently mainstream climate change considerations into national development policies, strategies, and plans. In order to achieve this vision, a national strategy for climate change adaptation must include community level vulnerabilities and build up their adaptive capacities by investment in short- and long-term initiatives.

Afghanistan has initiated a number of steps to promote the country's sustainable development. In term of national development policies, plans, and legal frameworks, considerable effort has been placed on addressing environmental challenges, disaster risk reduction, food security, and water security, protection of forest and rangelands, and biodiversity conservation, all of which have clear relevance to climate change adaptation.

1.1.2. Technology Needs Assessment Process and Objectives:

By recognizing its high vulnerability to climate change impacts, Afghanistan adopts TNA process to identify and prioritize adaptation technologies for its climate sensitive sectors. The first level of analysis caters to the country's developmental priorities in context of its socio-economic demographic and geographic conditions and the level of climate change risk it is exposed. It reviews various national and sector-specific development plans, policies and strategies, for example, the TNA adaptation process is aimed at eventually leading to the formulation of a national strategy and action plan for technology innovation for developmental and climate change objectives in its next phase after the completion of this phase (I) activity. The plan would also take an in-depth look at barriers in transfer and diffusion of these prioritized technologies to create an enabling environment for the

technology transfer and diffusion process. Once completed, it is expected that TNA project would benefit the country by creating an enabling environment for technology deployment and diffusion through addressing policy and legal gaps, and institutional capacity issues. The main objective mentioned as follows:

1. To identify and prioritize through country-driven participatory processes, technologies that can contribute to adaptation and adaptation goals of the participant countries, while meeting their national sustainable development goals and priorities (TNA).
2. To identify barriers hindering the acquisition, deployment, and diffusion of prioritized technologies.
3. To develop Technology Action Plans (TAPs) specifying activities and enabling frameworks to overcome the barriers and facilitate the transfer, adoption, and diffusion of selected technologies in the participant countries

1.2 Existing national policies related to technological innovation, adaptation to climate change and development priorities

1.2.1 National circumstances

1.2.1.1 Land resources:

Afghanistan is landlocked country in south and central Asia, with a rich history, diverse population, and a total geographic area of 652,864 km^2. Afghanistan has some of the most complex and varied geology in the world. With more than a quarter of its territory having altitude of 2,500 meters, and it is split east to west by the Hindukush mountain range.

1.2.1.2 Forest Resources:

Afghanistan has important forest and rangeland resources that help support much of the country's rural livelihoods. These forest and wooded areas are particularly valuable in dry land areas because they provide fuel wood and timber, as well as other forest product such as nuts and medicinal plants. Nevertheless, the trees and plant that make up Afghanistan's forests and rangelands face a number of climate change risks and adaption challenges as temperature increase and availability of water resources decrease. Afghanistan forests are already severally damaged as result of decades of deforestation, overharvesting, mismanagement and drought, and today account for only approximately 1.5-2 percent of the country's total land cover.

1.2.1.3 Water Resources:

Afghanistan's annual renewable surface water resources are estimated at 57 billion m^3 distributed across five river basins. Afghanistan has an estimated overall surface water availability of 2,775m^3 per capita per year, which is considerably higher than other countries in the region (Saffi and Kohistani, July 2013). Nevertheless, these water resources are not evenly distributed across the country or equally accessible at all times of the year, the availability of water in Afghanistan is also characterized by considerable intra and inter annual variation, and has the lowest per capita water storage capacity in the region. This reduces the opportunity to harness surface resources and renders the country more vulnerable to drought and other water related climate shocks.

1.2.1.4 Agriculture:

Agriculture is foundation of Afghanistan economy and livelihoods supporting some 80 percent of the country's population, either directly or indirectly. Of the country's total agriculture lands, it's estimated that only approximately 2.5 million hectares are irrigated and regularly cropped, while another 1.1 million hectares are rain-fed and cropped opportunistically, depending on precipitation.

Livestock products contribute more than 50 percent agricultural GDP. Over the past 30 years, livestock population in Afghanistan have fluctuated between period of prosperity and drought from highs of more than 5 million cattle and over 30 million sheep and goats to lows of only 3.7 million cattle and 16 million sheep and goats. Increasing pressure on available land over the last two to three generations has led to expansion of rain fed wheat cropping into traditional grazing lands and high mountains (Bajra Kharya and Shrestha, 2011).

1.2.1.5 Natural resources:

Protection of the natural environment is the responsibility of the state, as enshrined in the constitution of the Government of the Islamic Republic of Afghanistan (GIRoA). In 2007, Afghanistan approved the environment law, which established the regulatory framework for the sustainable use and management of Afghanistan's natural resources base, and provides for the conservation and rehabilitation of the environment towards achieving the country's social, economic, reconstruction and ecological development goals. The National Environmental Protection Agency (NEPA) is an independent institutional entity, responsible for coordinating, monitoring conservation and rehabilitation of the environment, and the implementation of the law (SNC, 2017).

1.2.1.6 Climate Change:

Climate change is defined by the UNFCCC as: a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Whereas climate change is a global phenomenon, the effects are local. Physical impacts are determined by geography and micro-level interactions between global warming and existing weather patterns.

In Afghanistan, impacts are likely to be particularly severe due to the arid and semi-arid nature of the country and the extreme poverty within which a large proportion of the Afghan population currently lives.

1.2.2 National strategies, policies and actions related to climate change:

The Afghanistan National Development Strategy (ANDS) with its Vision 2020 aims for environmentally sustainable development. Although, ANDS does not emphasis "climate change" various sectoral programs/projects included in ANDS and more recently in the form of National priority programs help build national capacity to adapt to the impacts of climate change in Afghanistan. Mainstreaming climate change mitigation and adaptation in the national and sectoral policies plans and programs in urgent.

Existing institutional and coordinating mechanisms and some environment and disaster related policy and legal frameworks are supportive but need to be reviewed from climate change perspectives.

Afghanistan as a Least Developed Country (LDC), has prepared its National Adaption Program of Action (NAPA) though a nationally driven consultative process submitted to UNFCCC in 2009. The NAPA process identified 51 different actions in seven different sectors as the potential adaption projects and prioritized 11 of them for immediate implementation. The prioritized adaptation actions are: improved Water Management and Use Efficiency; Land and Water Management at Watershed Level; Development of Horticulture; Improved Terracing, Agro-forestry and Agro-silvo Pastoral System; Agriculture Research; Rangeland Management; Development of Disaster Management Strategy; improved Food Security; Improved livestock Production; Creation of Off Farm Employment; and Climate Related Research and Early Warning System. All these projects need to implemented with priority and GIRoA is seeking financial and technical support from bilateral and multilateral partners and the GEF.

1.2.2.1 National Environment Policy 2005:

The policy provides guidelines for protection, conservation and restoration of Afghanistan's environment in order to improve the quality of life of citizens through sustainable development. The policy provides sectoral and cross-sectoral guidelines for environment protection and sustainable development. The Policy also focuses on climate change and ozone depletion; energy efficiency and renewable energy; water supply and management; air quality and noise; waste management; agriculture, livestock; forestry, biodiversity and protected areas and multi-lateral environmental agreements.

1.2.2.2 The National Environment Strategy (NES):

The National Environment Strategy was developed in 2007 through the ANDS as a reflection of the environment as a crosscutting theme across all of Afghanistan's development priorities. The NES focuses on the two priority objectives, environmental governance and environmental management, and lays out thematic strategies for the following six areas: i) forestry and rangelands; ii) protected areas and biodiversity; iii) water and wetlands; iv) air quality; v) urban and industrial environmental management; and vi) environmental education and awareness. Although the NES does not make any mention of climate change, its overall focus is on the mainstreaming of environmental issues into national development priorities and plans in order to strengthen the management and governance of the country's environment and natural resources. Thus, the NES provides a valuable framework for the mainstreaming of climate change into national development priorities and plans, particularly through concrete recommendations for institutional strengthening and capacity building, as well as targeted thematic strategies that bring together the full spectrum of government institutions and stakeholders for the country's major environmental sectors.

1.2.2.3 The National Environmental Action Plan (NEAP):

The national environmental action plan was drafted by NEPA and UNEP in 2009, as per the legal requirement of Article 9 of the Environment Law, and builds off the NES to identify

specific actions to protect and address the country's environmental challenges. The NEAP focuses specifically on air, water, land, and biodiversity, but also strongly emphasizes on the need for environmental considerations to be mainstreamed into national policies in order to maximize environmental opportunities and minimize negative environmental impacts. Climate change is mentioned several times in the NEAP, particularly as a serious risk to biodiversity and the water sector, as well as the specific action to "undertake a study to determine the likely impacts of climate change on the agricultural and natural resource base of Afghanistan" framed within the discussion on the forestry and rangeland sector.

Vision: The National Environment Strategy aims to improve the quality of life of people of Afghanistan through conservation, protection and improvement of the country's environment.

Goals: Secure a clean and healthy environment for the people of Afghanistan. Attain sustainable economic and social development while protecting the natural resource base and the environment of the country. Ensure effective management of the country's environment through participation of all stakeholders. The strategic vision and goals of the National Environment Strategy proceeds from the application of four priority programme areas to build NEPA's capacity and ability to conduct its mandate. From there, the Strategy elaborates priority programme areas for environmental management based on thematic strategies.

1.2.2.4 Focal Point for the Overall TNA process:

National Environmental Protection Agency (NEPA) is the focal entity responsible for the overall process of technology needs assessment. NEPA is mandated by the Government of Afghanistan for the preparation of national policies, plans and programs for climate change mitigation and adaptation. The Agency is also the national focal point for Kyoto Protocol/ CDM, Montreal Protocol, UNCBD, and other environmental conventions and protocols.

1.2.2.5 Priority Programme Areas for NEPA

The main priority programmes for NEPA are Training and Capacity building, Legal and Regulatory Frameworks, Environmental Education, Awareness and Outreach, and Environmental Information and Policy.

1.2.2.6 NAPA Vision, Objectives and strategies

The NAPA vision for Afghanistan is to increase awareness amongst all stakeholders of the effects of climate change and climate variability on their lives and to develop specific activities that build capacity to respond to current and future climate change threats.

The objectives of NAPA are to identify priority projects and activities that can help communities adapt to the adverse effects of climate change; Seek synergies with existing MEAs and development activities with an emphasis on both mitigating and adapting to the adverse effects of climate change; and integrate climate change considerations into the national planning processes.

Strategies of NAPA

Through closely adhering to the guidelines for the preparation of the NAPA, the Afghanistan process has been guided by the following principles:

A. Multidisciplinary: The Climate Change and Disaster Preparedness Working Group (CCDP-WG) represented various sectors of the government, and the women's Affairs at national and provincial levels for completion and return to UNEP.

B. Country driven approach: The information generated by the CCDP-WG and in the regional workshops has formed the basis for this present report.

C. Cost effectiveness: Cost effectiveness was one of the indicators used when prioritizing project profiles.

D. Simplicity: The NAPA process aims to have simple and clear approach to addressing adaptation to climate change, four regional workshops included the presence of farmers from settled agriculture, livestock, rain fed agriculture, and pastoralist livelihood. This ensured the expression and consideration of multiple perspectives in the analysis realized.

E. Participatory approach: Regional consultations were undertaken in four locations and people from eleven provinces participated. This allowed for the inclusion of stakeholder views and also increased Afghan ownership of the process.

F. Synergy generating: National development strategies formed the framework for the NAPA process and synergies with other multilateral environmental conventions were one of the indicators used when prioritizing project profiles. The recommendations presented here therefore aim to be highly complementary and synergy generating.

G. Sustainable development: Poverty reduction to enhance adaptive capacity formed one of the four criteria used to prioritize and select project profiles.

H. Gender component: Although the Ministry of Women's Affairs was invited to participate in the CCDP-WG, they declined to participate. Furthermore, given the cultural constraints associated with involving women in public events with a high male presence, they did not participate in the regional workshops.

1.2.3 National Legislation, and planning on sustainable development and environmental protection

In striving for sustainable and environmentally sound development, Afghanistan has developed and enacted a number of pieces of legislature, policy, and approaches to address key sectors. Although the country is still developing its legislative and governance documents for climate change, the following Table 1.1 summarizes that the existing legislature and government planning from key sectors and areas that are of significance to climate change.

Table 1.1: Sectoral legislation, policies, and planning on sustainable development and environmental protection

Sector/area	National legislation, policies and planning	
Climate change Adaptation and Mitigation	Law	None
	Framework	None
	Strategy	Afghanistan climate change strategy and action plan, year 2016
	Policy	None
	Plan	National adaption plan year 2016
	Other	Nationally determined contribution
Agriculture	Law	Rangeland law (OG 795)
		Improved Seed law (OG 1005)
		Agriculture cooperative law (OG 958)
		Agriculture pesticide law (OG 1229)
		Land management law (OG 958)
		Law of land survey, verification and registration (OG 346)
		Law on land expropriation (OG794)
		Veterinary services law (OG 1229)
		Law on food security (OG 1222)
	Framework	National Agriculture development framework (NADF)
	Strategy	None
	Policy	None
Biodiversity and ecosystems	Plan	None
	Other	Wheat strategy regulation (OG 998)
		Regulation on grains and root crops reserve (OG 998)
		Regulation on imports, distribution and application of pesticide (OG 795)
	Law	Environment law (OG 912)
		Wildlife conservation and hunting law (OG 795)
		Nature conservation law (OG 912)
		Law on conservation of plant diversity (OG 1229)
		Plant quarantine services law (OG 795)
	Framework	None
	Strategy	National biodiversity strategy and action plan (NBSAP)
		National environmental strategy
		Natural resource management strategy
	Policy	National environmental impact assessment policy
		National waste management policy
	Plan	National environmental action plan (NEAP)

	Other	Clean air regulation (OG 991)
		Environmental impact assessment regulations (OG 939)
		Plant quarantine service regulation (OG 795)
		Afghanistan protected area interim procedures
		Regulation on reduction and prevention of air pollution(OG 991)
		Regulation on controlling materials destructive ozone layer (OG 894)
Energy	Law	Minerals and hydrocarbons law (OG 972)
		Mining law (OG 1143)
		Lon managing electricity energy service (OG 1231)
		Nuclear energy law (OG 1182)
	Framework	None
	Strategy	Energy sector strategy
		Rural renewable energy strategy
		Energy efficiency strategy
	Policy	Power sector strategy (draft)
		National energy policy
		National renewable energy policy (NREP)
		Rural renewable energy policy (RREP)
		National mining policy
	Plan	None
	Other	Mining regulation (OG 1007)
		Procedure related to renewable energy policy (draft)
		Regulation on fuel consumption of agriculture machinery (OG 667)
Forest and rangelands	Law	Low on managing the jungle affairs (OG 1087)
		Low on managing land affairs (OG 958)
		Rangeland law (OG 795)
		Wildlife conservation and hunting law (OG 795)
	Framework	None
	Strategy	None
	Policy	Policy and strategy for forest and range management sub sector national forestry management policy (NFMP)
	Plan	Sustainable rangeland management plan (SRMP)
	Other	None
Resilience and	Law	Law on disaster response, management and preparedness (OG. 1089)

disasters	Framework	None
	Strategy	Disaster management strategy
	Policy	Food management policy and strategy (draft)
	Plan	National disaster management plan
		Strategic national action plan for disaster risk reduction (SNAP)
	Other	National emergency guidelines
Water	Law	Water law (O.G.980)
	Framework	Strategic policy framework for the water sector
	Strategy	Water sector strategy
	Policy	Draft policies on ground water, trans-boundary water and capacity building for water sector are being developed
	Plan	Procedure for developing national water master plan and river basin master plan (draft)
	Other	Regulation on water usage in agriculture (O.G. 500)
		Regulation on control and safeguarding water quality (O.G. 1212)
		Water resource territory and infrastructure regulation (O.G. 1178)

1.2.4 Priority innovation, adaptation to climate change

According to Afghanistan's NDC, its vision for addressing climate change through adaption aims to protect the country and its population by enhancing adaptive capacity and resilience, effectively respond to the vulnerabilities of critical sectors, and efficiently mainstream climate change considerations into national development policies, strategies and plans. This necessitated the development of a national climate change adaption strategy that include community level vulnerabilities to build up adaptive capacity within emphasis on the following medium-and long priority actions:

A. Reducing vulnerability of the country and its population through enhancement of adaptive capacity and resilience, and development of disaster risk reduction approaches.
B. Integrating climate change consideration into the national planning processes.
C. Promoting economic development and sustainable livelihoods through sustainable management of environmental resources and increase access to modern forms of efficient and sustainable energy services.
D. Improvement of technical capacity in governmental institutions.
E. Adaptive and integrated land and water management.
F. Improving access by rural communities and farmer to water to support food security, reduce poverty and improve agriculture productions.

G. Raising awareness for people of Afghanistan on climate change impacts and adaption measure.

In addition, the Table 1.2 shows that the NAPA identifies a number of short- and medium-term priority projects for building adaptive capacity and resilience, based upon the most vulnerable sectors identified. From a long-list of 50 projects proposed in stakeholder consultation workshops was done in 2007 at Kabul, a preliminary list of 11 priority projects was selected following their analysis and impact weighting (GEF,NEPA and UNEP, 2009).

Table 1.2: NAPA semi- final priority projects

Priority	Project title	Outline of project concept
1	Improved water management and use efficiency	Improved water management and use efficiency through the introduction of drip and sprinkle irrigation, improved physical structures and increase public awareness.
2	Land and water management at the water shed level	Land and water management at the water shed level community-based forest management and afforestation projects in ways that conserve land, water recourses and wood production realize afforestation of catchment area and stabilization of unstable slopes, soil conservation techniques.
3	Development of Horticulture	Development of Horticulture through use of improved varsities, establishment of nurseries and plant protection
4	Improved terracing agro-forestry and agro-silvi pastoral system	Terracing agro- forestry and agro-silvi pastoral system that reduce soil erosion and runoff on steep slopes, conserve, and land water resources and wood production, soil conservation techniques.
5	Agriculture research	Research into drought resistance seeds , different varieties of plants and livestock and plant protection, including establishment of agriculture farms.
6	Rangeland management	Rangeland management including the development and implementation system of rotational grazing and production of improved fodder along grazing routes (mixed grasses, legume).
7	Development of disaster management strategy	Disaster management strategy- planning for food security and emergency supplies for vulnerable communities.
8	Improved food security	Improving food security measures through diversification, promotion of household's level, industries, including chicken farms, beekeeping and silk farms, and development of market potentials for agriculture products.
9	Improved livestock production	Improved livestock production through the creation of livestock unions, cooperatives, and associations, introduction of improved species and veterinary services.

10	Creation of Off-farm employment	Create more off-farm or cash earning job opportunities for farmers who are affected by crop loss due to climate change effects.
11	Climate related research and early warning system	Installation of agro metrological stations, early warning systems, hazard mapping, survey assessment and protection of the impact of deep wells on the water table and future water supplies, build capacity and expertise for assessment of climate change adaption including technical capacities to monitor and analyse climate trends, plan and implement adaption activities, improve forecasts and inform policy makers.

Source: NEPA&UNEP.(2009). National Capacity Needs Self-assessment for Global Environmental Management (NCSA) and National Adaptation of Action for Climate Change (NAPA).

1.3 Assessing Vulnerability to Climate Change in the country

Assessing vulnerability to climate change is important for defining the risks posed by climate change and provides information for identifying measures to adapt to climate change impacts. It enables to identify practitioners and decision makers to identify the most vulnerable areas, sectors and social groups.

Afghanistan's NAPA identifies the country's key areas most vulnerable to climatic changes impacts: agriculture, water resources, forestry and rangeland, biodiversity, health, energy, and waste, through countrywide consultations with key stakeholders. The details presented in the coming issues.

1.3.1 Climate Change vulnerability in Afghanistan

This section attempts to identify the more vulnerable spots in the country from a climate change perspective. The Table 1.3 highlighted that the northern parts of Afghanistan are more susceptible to extreme events in the form of floods and consequently land-sliding causing damage to crops and livestock, however across the Northern provinces; the once dominant pistachio belt is seen to have weakened significantly.

Table 1.3: Climate change impacts and vulnerability

No.	**Climate change impact**	**Vulnerable province**
1	Desertification	Kandahar and Farah (aridification)
2	Forest and biodiversity loose	Especially in Kunar and Nuristan
3	Extreme Events	Northern Afgahnistan Provinces, especially Jawzjan, Sar-e-Pul, Balkh, Samangan, Kunduz, Takhar and Badakhshan, have a high incidence of earthquakes, landslides and Floods. Nuristan (Avalanches)
4	Human health	Epidemics in Baghlan, Badakhshan, Takhar and Samangan

5	Food insecurity	Food insecurity has increased across Afghanistan. However, Central Highland Region are particularly vulnerable.
6	Water scarcity	Southern and Western Provinces of Afghanistan

Source : (The methodology has been adapted from "Mapping South African Farming Sector Vulnerability to Climate Change and Variability", IFPRI Discussion Paper 00885, Agust 2009).

In the south western and southern parts of the country, threats arise from desertification and aridification. The impacts are again felt on the food security as well as biodiversity losses. As discussed in the paper on the National Adaption Plan (NAP), the action plan will include the development of more detailed and forward-looking assessments of vulnerability to climate change. The methodology for these assessments of vulnerability would be based on three parametric considerations; the degree to which a region is exposed to climate change impacts, sensitivity of the region to these impacts, and the adaptive capacity of the community.

Afghanistan has prepared the most detailed and advanced climate change projections to date. These new projections serve to help better in understanding the anticipated impacts of climate change and refine priority actions for building adaptive capacity. Nevertheless, Afghanistan continues to face a number of challenges related to assessing vulnerability to climate change, such as the country's sporadic and poor-quality socio-economic data that makes it difficult to conduct econometric modelling or robust cost/benefit analyses of adaptation and mitigation policy. Poor national security also restricts the ability to undertake structured fieldwork to assess potential mitigation and adaptation options (Hansen et al., 2010).

Through the development of its National Adaptation Programme of Action (NAPA) Afghanistan identified priority action programs on the most vulnerable sectors in Afghanistan. This process has identified the most vulnerable sectors, as well as the country's institutional strengthening needs to better address climate change. Afghanistan urgently needs to enhance the capacity of government and national experts to ensure that the best practice climate assessments, adaptation approaches and low carbon development strategies could be applied in Afghanistan in order to build the country's adaptive capacity. Mainstreaming climate change into Afghanistan's development processes is an essential step towards building institutional capacity; however, Afghanistan also needs external investment and technical support to overcome these challenges. As of 2017, the country's most salient vulnerability and adaptation needs are summarized in the NDC, which focuses on the technological capacity and financial support required for bolstering climate action.

The Global Adaptation Index ranks it as the most vulnerable country in the world, taking into account the country's exposure, sensitivity and ability to cope with climate related hazards. Climate change scenarios for Afghanistan suggest temperature increases of up to 4°C by the 2060s (from 1970-1999 averages), along with corresponding decrease in rainfall. The biophysical effects of climate change are expected to be significant; droughts are likely to be the norm by 2030 leading to associated dynamics of desertification and land degradation. Coping with the impacts of climate change is a major challenge for development in Afghanistan assumed that its negative effects are likely to be most severely felt by the poor

and marginalized due to their high dependence on natural resources and limited capacity to cope with the impacts of climate variability and extremes.

1.3.2 Climate Change Impacts:

Afghanistan is highly sensitive to climate change. Current models indicate significant warming across all regions of Afghanistan. Warming is most rapid in spring/summer with this trend being more significant in the north and the central plains of Afghanistan. It's all projections indicate substantial increases in the frequency of 'hot' days and nights in the context of the current climate, particularly during summer months. It must be noted that the range of potential annual temperature increase is noticeably influenced by global emission scenarios (Knuerr and Samim, 2017).

Figure 1.1 shows the trends in mean annual temperature for Afghanistan of seven different regional climate models and the representative concentration pathway 4.5 (green) and 8.5 (red). The lines are the model means. and the band of uncertainty of all models is depicted in brighter colors. The average rainfall is projected to show a small increase, although by little more than about 10-20 mm, in the short term. In the mean annual rainfall changes indicate generally drier conditions (by between 10-40 mm) through most of Afghanistan. This drying is attributed to spring rainfall. The South will experience significantly drier winters. Projections for mean annual rainfall from a range of models are consistent about decreases (Aich *and Khoshbeen,* 2016).

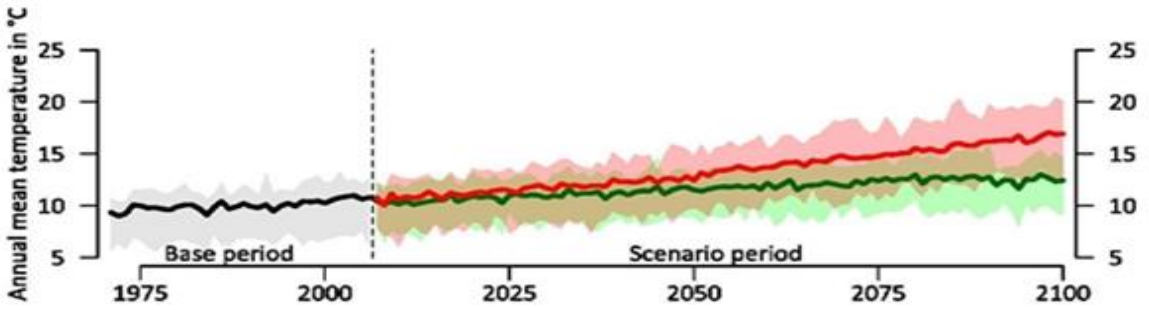

Figure 1.1: Trends in mean annual temperature for Afghanistan
Source: (Aich ,V. & Khoshbeen, A.J. (2016). Afghanistan: Climate Change Science Perspectives, P.18).

Figure 1.2 shows the trends in annual precipitation for Afghanistan of seven different regional climate models and the representative concentration pathway 4.5 (green) and 8.5 (red). The lines are the model means, and the band of uncertainty of all models is depicted in brighter colors. Based upon climate change projections, Afghanistan's environment will experience considerable changes over the remainder of this century. Climate change, based on sound scientific analysis of climatic changes and uncertainties, must be mainstreamed into sectoral planning to reduce the negative impacts of climate change in Afghanistan and increase resilience, both in rural and urban areas *(Aich and Khoshbeen, 2016).*

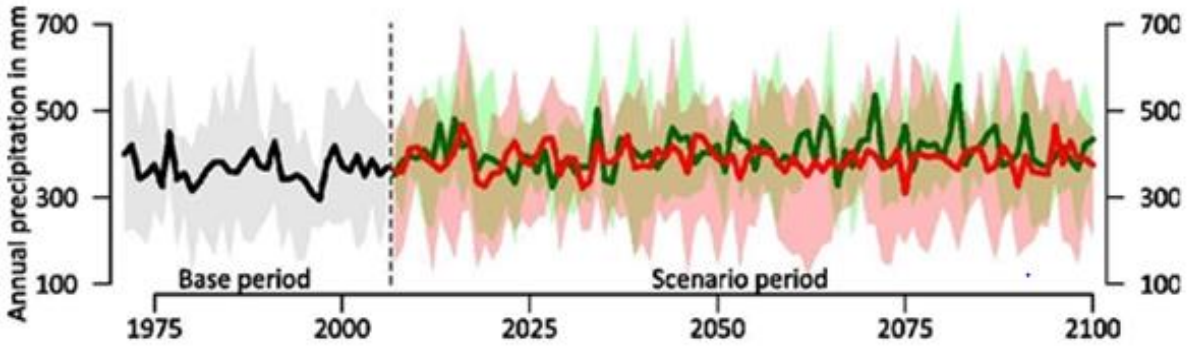

Figure1.2: Trends in annual precipitation for Afghanistan
Source: (Aich,V. & Khoshbeen, A.J. (2016). Afghanistan: Climate Change Science Perspectives,p.20).

Climate change in Afghanistan will have severe consequences for socio-economic development. The combined impact of drought, erratic and heavy rainfall, poor agricultural productivity and degraded lands make the rural population very vulnerable. Adaptation in these areas is therefore seemed as an immediate priority.

Forest resources and biodiversity are also strongly affected by climate change, which is again exacerbated by the low levels of livelihood security amongst rural Afghans, contributing to a vicious circle of further damage and rising vulnerability. The other drivers are illegal and hunting, which often worsen the impacts of drought and other climate- related exigencies.

Water Resources: Climate change is leading to scarcer water resources in Afghanistan. Development efforts are struggling to keep up with the challenges. As mountains are the major sources of water, widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the twenty-first century, reducing water supplies and hydropower potential as well as changing the seasonality of flows in basins supplied by melt-water from snow and ice. Further, more rapid and earlier spring snow melt, creates risks of flash flooding.

Further, an increase in evapotranspiration (that is, water demand for crops) also has an impact on irrigation. An average1.4°C increase in temperature represents an average increase in standard evapotranspiration of less than 3.5 percent, and an average increase by 5°C (that is, the high scenario for the 2090s) would represent a nearly 13 percent increase in evapotranspiration. This will demand more water to produce the same number of crops (HDRA, 2011).

Water shortages from changes in snow-melt and droughts will increase pressure on Afghanistan to claim the greatest possible share of regional water sources in the medium term. Water disputes have plagued central Asian countries for years and will likely continue if climate change furthers water scarcity in the region. Any efforts by Afghanistan to increase its share of water use in the region may have regional security or diplomatic implications (DFID, 2010).

Agriculture: Drier conditions are predicted throughout Afghanistan, as well as annual temperature increase by between 2.8 °C and 5°C. Both scenarios will have consequences for farmers relying exclusively on rain-fed agriculture, particularly farmers in the northern

and western river basins, where more than 60 percent of the rain-fed land is located. Increased soil loss, reduced river flow from earlier snow melt, and less frequent rain during peak cultivation seasons will impact upon agricultural productivity and crop choice availability. Livestock numbers may be reduced by up to 50% during the periods of drought due to outward migration and starvation, reduced availability of animal feed, less funds available for livestock husbandry. By 2060, large parts of the agricultural economy will become marginal without significant investment in water management and irrigation.

Livestock numbers are estimated to have been reduced by 50% during the prolonged period of drought due to outward migration and starvation. The effects of environmental degradation and lower agricultural output reduce the availability of animal feed, and the funds available for livestock husbandry. This is especially true for the more vulnerable Kuchi nomadic group. Reduced agricultural and pastoral productivity has the potential to impact heavily on livelihoods and distribution effects are greatest for the poorest and most vulnerable. Impacts on human health, like increased prevalence of disease affect labor available for agriculture and other non-farm rural economic activities.

Forest, Rangeland and Biodiversity: Climate change can impact enormously on forests and forest resources in Afghanistan with temperature changes. Warmer winters would imply reduce snow cover and less carryover of water to the growing season, leading to drought-induced forest decline. A combination of climate change with deforestation, land use change, habitat degradation and fragmentation present a significant threat to biodiversity. Climate change can affect biodiversity either directly, by changing the physiological responses of species, or indirectly, by changing the relationships between species. This assessment, however, employs a general approach with no specification to clarify the impact of climate change to Afghanistan's biodiversity, demanding more in-depth assessment in future.

Livelihood and Social Protection: Eradicating extreme hunger and poverty by 2020 is a GIRoA goal. The severity of climate change impacts depends not only on changes in temperature and precipitation patterns but on a host of other factors related to the various dimensions of poverty. According to the latest estimate, 36% of Afghanistan population lives below the poverty line, and are highly vulnerable to the climate risks as they are the most exposed with least means to adapt. A significant percentage of people (almost 20%) dependent on the agriculture economy live slightly above the poverty line and are extremely vulnerable to climate shocks so eradicating extreme hunger and poverty will be more challenging, widening the economic gap between rich and poor. Food security issues may be pronounced leading to malnutrition, high dependence on food aid, and reduced dietary diversity and consumption.

Human Health: Climate change will continue to impact upon the spread of food, water, and vector-borne diseases in Afghanistan. Climate change will undermine Afghanistan's ability to achieve its goals in reducing malaria morbidity and mortality by 50% and 80% within the next 5 years. Women and children, mainly because they are not involved in paid income are also highly vulnerable to the climatic shocks. Human health is a key issue for all the

population and particularly for poor groups in Afghanistan. According to the, National Malaria Strategic Plan, 2006-2010 (MPH), the WHO estimated 2.5-3 Million cases of Malaria in 2002 and 85,000 deaths per year from diarrhea in children under 5 years of age. Climate change will continue to impact upon the spread of food, water, and vector-borne diseases in Afghanistan. Correlations between climate change and disease propagation suggest these trends will worsen in the near- to mid-term (e.g., for Malaria, temperatures of 16-18 °C are necessary for the parasite to form, and higher temperatures cause faster development). Climate change will undermine Afghanistan's ability to achieve its goals in reducing malaria morbidity and mortality by 50% and 80% within the next 5 years (DFID, 2010). Women and children, mainly because they are not involved in paid income are also highly vulnerable to the climatic shocks. For example, children are widely responsible for realizing small scale livestock herding and collection of firewood (NAPA).
The Table 1.4 shows the current sectoral strategies, institutional capacities and the state of response to climate change impacts at early stages in Afghanistan.

Table 1.4: Impacts of Climate Change in Afghanistan-regional distribution.

Impacts	**Intensity**	**Affected Region**	**Susceptible Sectors**
Diminishing Surface Water level	Low to medium	All provinces	Agriculture, water availability
Floods	High	All, but especially South, West and North	Life and livelihoods, human health
Land degradation/Soil losses	High	Northeast, Central highlands and Southern Province	Agriculture livelihoods
Drought	High	West, North and Southeastern Provinces	Agriculture livelihoods
Decreasing agriculture productivity	High	All Provinces	Agriculture livelihoods
Landslides	Medium to High	North and Northeastern provinces	Agriculture human health
Desertification/Aridification	Medium to High	Southern Provinces	Agriculture livelihoods water availability
Deglaciation	Medium		Agriculture water availability
Human health	Medium	All provinces	

Source :(National Adaptation plan for Afghanistan,2009)

Because climate affects all sectors and regions, it is important that the many responsible government ministries and agencies, other public institutions and development partners are

able to work together to evolve concerted actions to mitigate or adapt to the impacts of climate change.

1.4 Sector Selection for TNA Process

The many uncertain effects of climate change pose significant risks for sustainable development and require coordinated action across numerous sectors to ensure that development progress is not undermined. Afghanistan is already highly vulnerable to natural hazards and the changing climate is likely to exacerbate their impacts unless measures are taken to increase the country's adaptive capacity. Presently, Afghanistan's legislative frameworks and sectoral policies and strategies make slight mention of climate change. However, in the long term, for climate change adaptation to be effective, it must be supported by an integrated and crosscutting policy approach that mainstreams climate change into national development planning.

1.4.1 An overview of expected climate change and its impacts in sectors vulnerable to climate change

Afghanistan is facing impacts of climate change due to increase in mean annual temperature, decrease in precipitation and a rise in sea level. This changing climate obviously has bearings on the productivity and efficiency of climate sensitive sectors of agriculture and water.

The Fifth Assessment report of the Intergovernmental Panel on Climate Change (IPCC) has pointed towards a definite rising of global temperatures and reduced precipitation, as a direct impact of climate change. The IPCC has considered ways to limit global emissions in order to restrict temperature rise to 2 ºC above pre-industrial levels, acknowledging the clear possibility 2 ºC temperature rise globally.

Afghanistan has been endowed with abundant natural wealth, such as water resources, forest resources and mineral wealth hydrocarbons. It has semi-arid and continental type of climate. Over the last 50 years, climatic changes in the country, was in the forms of variations in each season, uncertainties in precipitation levels and the increased prevalence of extreme events has necessitated action on climate change, for a variety of ecological, developmental and human reasons. These are enumerated as follows.

First, climate change directly affects agricultural productivity to ensure the rural economy. Secondly, action to address climate change promote sustainable forestry and re vegetation, which in turn protect pastures and sustains animal husbandry, a key means to securing rural livelihoods. Third, reducing climate vulnerability could lower the impacts of disasters (floods, drought, landslides and avalanche) and more gradual climate change process such as desertification and aridification (IPCC, 2013).

Finally, as has been observed in developed in similar developing countries, action on climate change act as a broad basis to develop specific programs in key areas for sustainable development, such as renewable energy, energy efficiency, disaster management and agriculture reforms. In the context of Afghanistan, where nationally coordinated action is yet to be functionally active, a robust institutional framework to address climate change could

lead to mainstreaming of relevant actions within a national governance and development frameworks.
In the past, Afghanistan has developed and submitted its Initial National Communication (INC) to the UNFCCC in 2013. In addition, the National Needs Self - Assessment (NCSA) and the National Adaption Programme of Action (NAPA), were prepared with the support of UNEP and financial assistance of GEP. UNDP has developed the Framework Document for a Comprehensive Climate Change strategy (2012), the precursor to the present document.

The Afghanistan climate change strategy and action plan seeks to establish the following:

1. Policy direction for addressing climate change in Afghanistan.
2. An institutional framework for taking action on climate change, through the creation of a nationally coordinated platform for action. The framework is designed as multi-tier inter- ministerial body with a National Executive Council supported by a Technical Advisory Panel.
3. Strategies for addressing climate change adaption and mitigation in Afghanistan.
4. An Action Plan, defining projects and programs to be adopted.

1.4.2 Process and result of sector selection:

In TNA process, sector selection is an important step towards priority technology identification and ranking which would finally lead to the construction of technology action plan for diffusion and adoption of prioritized technologies in its respective sectors with available sources of financing.
The process of sector selection started with an extensive desk review of relevant documents on climate change impacts on various sectors of the country and their degrees of vulnerability to these adverse impacts in the future along with consultation with different key experts. The process of research and deliberation helped in the selection of a set of six climate sensitive sectors: agriculture and livestock, water, health, urban development, transport and infrastructure. Due to highly vulnerability against climate change in special reference to country development priority and NEPA strategic plan agriculture and water sectors were selected.
The sector selection for agriculture and water were done in the inception workshop conducted during 13th, 14th and 15th of July 2019, at NEPA conference hall. The key stakeholders and experts were invited to workshop from government and non-government agencies at country level. All participants of the adaptation technologies working group were divided into two groups on the basis of their professionalism and interests in each sector.
The sample size contained nine participants for water sector and twelve participants for agriculture sector, of whom eight were women. Overall, they selected twelve technologies for agriculture and twelve technologies for water sector based on the contrary circumstances and current situation, after discussion and sharing of information among the group, finally the water group selected four technologies for water sector where as agriculture group selected six technologies from the total of twelve technologies accordingly.

In order to reach to the final selection of the most vulnerable sectors of the country to the impacts of climate change, out of six two most vulnerable climate sensitive sectors were assessed on the basis of following criteria:

1. Contribution to the sustainable development priorities of the country
2. Climate change impacts on Afghanistan and its degree of vulnerability
3. Contribution to minimize vulnerability to climate change
4. Sector specific adaptation needs of the country
5. Potential of technology innovation in the sector to improve the resilience of the human and natural systems.

1.4.3 The TNA Process

The Afghanistan TNA processes commenced with the training workshop for the Asian Region partner countries' Project Coordinators and the Consultants by the International Partner Organizations namely UNEP-DTU Partnership, Climate Technology Centre & Network and Asian Institute of Technology (AIT) in May 2019 in Delhi. This was followed by convening of the inception workshop in Kabul during (13-14 & 15 of July 2019). During the workshop after detailed discussion and based on consideration of the national circumstances and development needs; the following sectors where the strongest development and climate benefits are expected to be achieved were identified.

1. Adaptation: A) Water sector, B) Agriculture sector

The Table 1.5 shows the steps for priority sectors selection and prioritization of adaptation technologies, based on a set of criteria the most vulnerable sectors agriculture and water were selected and prioritized.

Table 1.5: Steps for priority sectors selection and prioritization of adaptation technology needs assessment in Afghanistan

Steps for priority sector selection	The outcome of the process
Step 1: Development priorities identification Methodology: Desk review of existing Climate Change Strategy and Action Plan documents, reports and complemented with expert consultations such as governmental and non-governmental agencies, climate change line department and so on in inception workshop.	The process done through inception workshop lunched in July 2014. Governmental and non-governmental agencies were participated based on prioritization 4 technologies were selected for water and 6 technologies for agriculture sectors respectively. The most important development priorities identified include: 1. Floods, Landslides and Avalanches 2. Gender empowerment 3. Drought and aridification 4. Food, water and energy security 5. Forest resources 6. Biodiversity 7. Buildings 8. Watershed planning and implementation

Step 2 Identify impacts and vulnerabilities of climate change on the country Methodology: Desk review of existing documents and reports on sector specific vulnerability and risk assessment studies	A super set of possible sectors under consideration: 1. Agriculture and food security 2. Sustainable irrigation and Water 3. Sustainable infrastructure 4. Human Health 5. Agriculture value chain 6. Food and grain management 7. Disaster risk management 8. Agriculture research 9. Gender
Step 3 Identify the most vulnerable sectors based on the degree of impact on meeting development priorities, contribution to minimize vulnerability to climate change, sector specific adaptation needs of the country, and potential of technology innovation in sectors to improve resilience of human and natural systems	NEPA and TNA inception workshop key stockholder prioritized under adaptation component most vulnerable sectors identified were agriculture and water
Step 4: Validation of the results in Stakeholder (TNA Inception) Workshop	Final selection and validation of sector prioritization for TNA process were: water and agriculture.

Source :National Adaptation plan for Afghanistan,2009

The results were validated in the first TNA Inception workshop and further endorsed by the members of the National TNA Committee (Appendix I provides the list of members who attended the TNA Inception Workshop).

The climate change profiles of these two sectors supported the fact that due to adverse impacts of climate change, these two sectors will be highly vulnerable in terms of losses in human, social and economic development gains in the long run than those of other sectors. Therefore, it is necessary to adapt to climate change by selecting suitable environmentally sound adaptable technologies that will help the country to achieve its goal of sustainable development in the face of climate change.

Chapter 2 Institutional arrangement for the TNA and stakeholder involvement

2.1 Institutional arrangement for the TNA

To provide an organization set up, Afghanistan has followed the instruction of UNFCCC/UNDP to develop a national TNA team for coordination of the work, and organization of stakeholders' involvement. The initial steps taken to establish an organizational structure for TNA are as follows:

a. Identify and establish a lead department for TNA project implementation
b. Explore objectives and scope of the Project through a consultation process
c. Identify relevant stakeholder agencies for the TNA Committee
d. Identify lead technical institutions and representing participants, and other technical experts from all the sectors
e. Decision taken for Appoint TNA coordinator and national consultants
f. Define a process for stakeholders' consultation by establishing the 'National TNA Committee' and 'Expert Sectoral Working Group' for the priority sectors. List of the expert working group composition (Appendix I-B), they meet once within a mount and they are taking decision on agriculture and water sectors related issues.

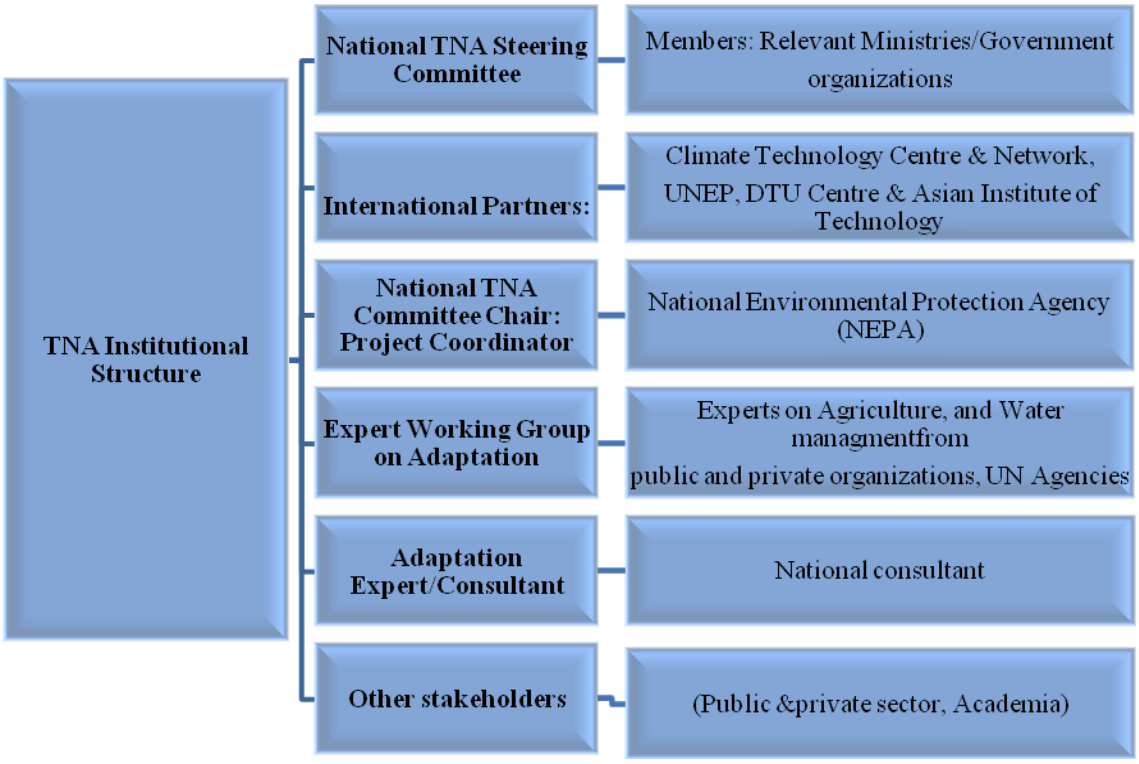

Figure 2.1: A Common institutional arrangement for the TNA project

Source: (UNFCCC/UNDP guidebook on the TNA process)

Afghanistan has used the existing national climate change institutional structures, wherever possible, to complement the TNA project implementation. Thus, National Environmental Protection Agency is designated as the lead and coordinating entity responsible for TNA. The National Climate Change Committee is assigned to serve as the TNA National Steering Committee; and the Adaptation Head of Climate Change Directorate of the National Environmental Protection Agency is nominated to act as the National TNA Project Coordinator. After this umbrella organizational setup, the TNA process is led by a team of national consultants and technical expert working group members identified during the process for sector and technology prioritization.

The Afghanistan National TNA structure is shown in Figure 2.2.

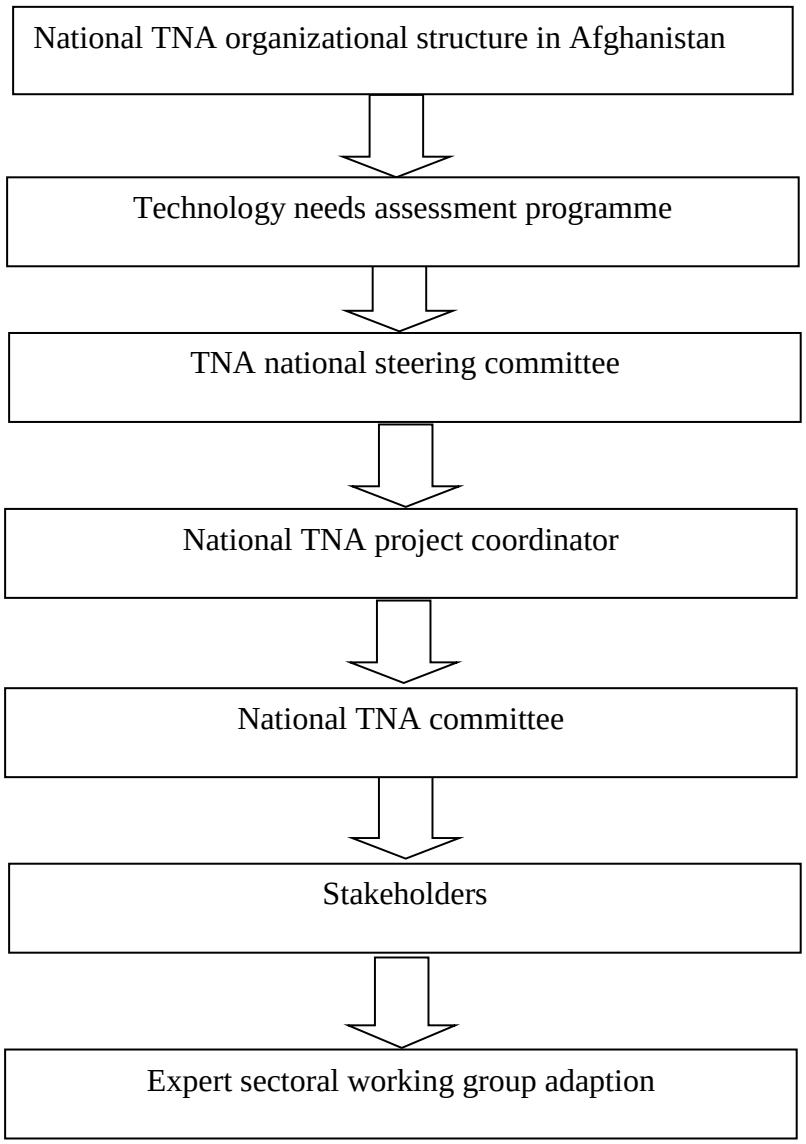

Figure 2.2: TNA organizational structure in Afghanistan

2.1.1 National Climate Change Committee (NCCC):

The Committee oversees the TNA process in the country and provides high-level guidance to the work of national TNA team. The National Committee for the Implementation of climate change Policy to oversee the implementation and mainstreaming of the National Climate

Change Policy is designated to act as the NCCC for the TNA project. (Appendix I) The role of this committee is to provide high-level guidance to the work of national TNA team and later to help secure political acceptance for the Technology Action Plan (TAP).

2.1.2 National TNA Committee:

This is the decision-making body acting as a core driving group. The committee is composed of 20 members from the National Environmental Protection Agency as well as Ministry of Rural Rehabilitation and Development, Ministry of Agriculture, Irrigation and Livestock, Ministry of Energy and Water are among others. (Appendix I provide the member list of the National TNA Committee).

The Committee performs specific responsibilities such as: identifying national development priorities and priority sectors for the Technology Need Assessment; assisting in the constitution of sectoral/technical expert working groups; define stakeholder consultation processes; review and approve technologies and strategies for mitigation and adaptation as recommended by expert sectoral working groups; review and approve the TNA report, report on barrier analysis and technology enabling environment.

2.1.3 The TNA Coordinator:

The National Environmental Protection Agency has designated its Adaptation Head of Climate Change Department as the national TNA Coordinator who is a lead focal point and a manager of entire TNA process. The Coordinator's role requires highly experience with country's mitigation and adaptation challenges in the context of national development objectives and sector policies.

The responsibilities of TNA Coordinator largely cover facilitation of communication with the National TNA Committee and consultants; coordination and communication with sectoral expert working groups and other stakeholders; formation of networks with across sectors and ministries for information acquisition; preparation of work plans and monitoring of the progress of the project etc.

2.1.4 Project Implementation Center (PIC):

The National Environmental Protection Agency has established a Project Implementation Center under its Adaptation Head for providing necessary support in project execution, especially to organize the expert working group discussion, stakeholder consultation at national and local level, and provision of administrative and logistic support to TNA team members.

2.1.5 National Consultants:

National consultant for adaptation technology is responsible for the research, analysis, and synthesis of the entire TNA process. Under the guidance of the TNA Committee and Coordinator, the consultants are required to provide the required technical expertise for adaptation, help identify, and prioritize adaptation technologies with the help of adaptation sector expert working group.

2.1.6 Sectoral Expert Working Group Adaptation:

This expert working group on adaptation is composed of a wide range of stakeholders with different backgrounds and expertise particularly in the area of agriculture, water resources,

climate change technologies and adaptation. The group includes relevant officials from ministries and line departments, provincial governments & their associated departments, civil society organizations, and international donor organizations (Appendix I shows the composition of Adaptation Working Group).

2.2 Stakeholders engagement process- overall assessment

A wide range of stakeholders have been engaged and consulted at each step of the TNA process through providing them an inclusive environment and space to share their insights, expertise, and knowledge to detect and manage external risks early on in the process. This inclusive process, induces legitimacy and enhances the chances of successful ownership of this whole process. The participants, who are engaged and consulted belong to government ministries such as Ministry of Energy and Water, Ministry of Agriculture, Irrigation and Livestock, Ministry of Rural Rehabilitation and Development and their associated wings/departments including Office of State Minister of Disaster Management, Afghanistan Meteorological Authority; representatives of international organizations, civil society, academic and research institutes, and private sector. They however, differed from each other on the basis of their interest in the TNA process, availability, and influence. The stakeholders holding higher tiers of management and leadership in TNA organizational structure such as those members of National Project Steering Committee and the National TNA Committee also hold higher level of authority and influence, though the numbers of their members are limited. On the other hand, sectoral technical expert working group's composition is more varied and flexible so more members can be added as per requirements.

The stakeholder engagement plan for the TNA carried the following building blocks.

1. Identification of the TNA national team including steering committee, national TNA committee, consultants and sectoral expert working groups;
2. Information disclosure about the role of the group, objectives to achieve, and communication method etc. This has taken place early in the process.
3. Stakeholder consultation and involvement in devising communication strategy, sector prioritization, resource selection and mobilization, and technology prioritization;
4. Establishment of a process for a continuous stakeholder engagement that would ensure that all stakeholders are kept updated on the level and type of activities going on through a continuous flow of information and sharing of materials such as the final TNA report.

2.3 Stakeholders Engagement for TNA project:

Agriculture Sector

- Ministry of Agriculture Irrigation and Livestock (MAIL)
- Ministry of Energy and Water (MoEW)
- Afghanistan Meteorological Authority (AMA)
- Ministry of Rural Rehabilitation and Development (MRRD)
- Ministry of Information and Culture (MoIC)
- Ministry of Public Health (MoPH)
- Ministry of Foreign Affairs (MoFA)

- Ministry of Woman Affairs (MoWA)
- Land, Water and Environment High Council
- International partners: United Nations Environment Programm (UNEP), United Nations Development Programm (UNDP), United Nations Food and Agriculture Organization (FAO), World Bank , Asian Development Bank (ADB), Centre for Integrated Development and Research (CIDAR), United States Agency of International Development (USAID) and German Agency for International Cooperation (GIZ)
- Academia: Faculty of Agriculture, Pol-e-technic University, Faculty of Geo Science
- Agency for Rehabilitation and Energy conservation in Afghanistan (AREA)

Water Sector:

- Ministry of Energy and Water (MoEW)
- Ministry of Agriculture Irrigation and Livestock (MAIL)
- Ministry of Urban Development and Housing (MUDH)
- Ministry of Women Affairs (MoWA)
- Land, Water and Environment High Council and Academy of Science of Afghanistan
- United Nations Environment Programme (UNEP),
- United Nations Development Programme (UNDP)
- United Nations Food and Agriculture Organization (FAO)
- World Bank, Asian Development Bank (ADB)
- Centre for Integrated Development and Research (CIDAR)
- United States Agency of International Development (USAID)
- German Agency for international Cooperation (GIZ) and European Union (EU)
- Academia: Poli-e-technic University, Faculty of Geo Science

2.4 Gender dimension

No policy response to climate change is gender neutral. Plans to implement gender-responsive climate action will vary both in terms of their commitment to adaption and rectifying inequities. In Afghanistan Climate change affects everyone. Women are change agents, leaders, and innovators in addressing this threat. They can bring different and innovative perspectives and experiences to political processes, to natural resource management, to adaptation, mitigation and technology and their opportunities and use in climate action. Yet women and men may experience the impacts of climate change differently, with women disproportionately affected due to gender inequalities in Afghanistan. Effective responses to climate change require an understanding of how such gender inequalities affect issues such as access to and control over-use of resources; institutional structures; social, cultural and formal networks and decision-making processes. Gender mainstreaming based on gender analysis therefore must be an integral part of the existing TNA process in Afghanistan.

Involvement of women in the process of selecting technology, prioritization, strategy for adaption, stockholder consultation process, sectoral working group, during presenting the TNA, process, familiarization with TNA process such as MCA, and so on has been

considered. The technologies mentioned under water and agriculture headline have the potential to address the gender inequalities and surely all the fact sheets contribute to achieve gender equality. Climate change impact on women: crop failure, fuel shortage, water scarcity, natural disaster, disease, displacement, conflict.

The TNA seeks to address gender issues as part of the overall adaption strategy, and also incorporates specific initiatives in this area. Most important will be an analysis of the ways in which climate change is impacting the lives of women in Afghanistan how this is likely to unfold in the future and options for adapting to these impacts and increasing the ability of women to adapt to changing conditions. Another potential activity would be the design of tailored educational programs for women on these issues through collaboration between NEPA and the Ministry of Women's Affairs (MoWA).

As women typically do not have direct control of financial resources, they are forced to ask family members for money, depriving them of financial independence. This is often exacerbated by customary restrictions on freedom of movement, educational opportunities, and access to health care. These restrictions on independent action have rendered rural women especially vulnerable to the impacts of climate change on livelihoods and human health, such as those caused by droughts, floods, and pests.

One of the key proposals in this TNA is to commission research into the ways that climate change impacts both already existing and anticipated, are likely to affect women in Afghanistan. This would include research and analysis at the national level, along with research initiatives that could apply to specific provinces on account of different local contexts. There is a significant correlation between gender and livelihood issues in the country, which is likely to be exacerbated by climate change. With special reference to gender equity and equality luckily during the stakeholder's consultation and technical working group's process there has been a decent and sizable representation of female professionals both from government and non-government institutions.
There were 8 women participants from various government institutions including NEPA. Their insights and synopsis during various stages of TNA process will remain fundamental and their role will remain vital during various stages of impending climate change TNA process.

By mainstreaming gender considerations in climate strategy and action, climate approaches will be more efficient, effective, and equitable by being responsive to and providing broader benefits to address the needs of women and men, including through compensation and shared benefits.

Chapter 3: Technology Prioritization for Water Sector

3.1 General information regarding water status of Afghanistan:

The Hindukush region is often referred to as 'water tower of Asia' as it stores large volumes of water in the form of ice and snow that is released gradually during the dry seasons. Nearly 61 percent of Afghanistan's total area is located within the Hindukush area and 4.4 percent of the Hindukush's total glaciated area is located in Afghanistan. As mountains are the major sources of water in Afghanistan, the impact of climate change on hydrology is likely to have significant repercussions not only in the mountains, but also in populated and lowland regions that depend on mountain water resources for domestic, agricultural, and industrial purposes as well as hydropower generation. Current climate change projections show that precipitation levels will remain relatively stable up to 2100 mm, but the overall increase in temperature across the country will lead to an increase in evaporation and evapotranspiration that will not be compensated by a sufficient increase in precipitation, thereby, has negatively impact on the water cycle and availability of water resources. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water supplies and hydropower potential as well as changing the seasonality of flows in basins supplied by melt-water from snow and ice. These changes will also occur in conjunction with a steady increase in population and demand for water. Warmer temperatures will also change seasonal precipitation patterns, likely causing earlier snow melt and causing more precipitation to fall as rain rather than snow. This will increase the risk of flooding during the spring and drought during the summer. These risks are further compounded by the degradation of forests and rangelands, where vegetation formerly helped stabilize watersheds and attenuate runoff, while also limiting desertification and soil erosion (UNDP, 2015).

The TNA process entered in its next step to identifying and prioritizing technologies for the most vulnerable sectors of the country once the sector prioritization process was completed. The process involved various sector specific key experts and practitioners for the sake of identifying the current status of adaptation technologies at local and national levels and specifically those with a successful replication potential in order to meet the crucial yet diverse demands of the technology users in the water sector of Afghanistan. This process of extensive consultation with experts and stakeholders ended up in short listing of four technologies out of a long list of 12 technologies initially identified through literature review, face-to-face meeting and table discussion.

The 'Technology Fact Sheets' were prepared for these short-listed technologies that covered: brief technology introduction, descriptions, adaptation benefits to the country, social, economic, and environmental benefits, the total cost of the technology implementation and recurring maintenance, current status in the country and implementation barriers (Appendix II). The Fact Sheets were presented in and discussed with the sectoral expert working adaptation group. After detailed discussions, the expert's group with slight modification endorsed four technologies options in water sector for further analysis through MCA, and also agreed on the analysis criteria and their weights (UNFCCC,2008a).

3.2 Climate change vulnerability and existing technologies in water sector:

Mountains are vital "water towers" for Afghanistan and the Central Asian region as a whole. However, climate change, the resultant melting of mountain glaciers, severe droughts and poor management of water resources are threatening water security. War-inflicted damage to large and small irrigation systems and the disruption of water supplies have reduced the accessibility of this essential resource. Improved access to safe drinking water for the urban and rural population is an important priority. Three in four Afghans 16.8 million women, men and children lack access to protected drinking water sources. Every hour, six children die because they have consumed unsafe water or because they have been exposed to poor sanitation practices. In year 2016 Agriculture sector accounts around 21.5 percent of gross national income and remains the mainstay of most individuals, families and communities (World Bank, 2017). Despite the importance of agriculture, the irrigation infrastructure performs poorly. While around 3 million hectares were irrigated in the 1970s, only an average of 1.8 million hectares is irrigated each year now. Furthermore, while farmers located in the upstream reaches of rivers and canals enjoy almost unlimited access to water, thousands of farmers toiling in downstream fields are often deprived of their water rights and, each year, are obliged to leave their fields fallow, missing out on a critical human development opportunity. Recurring drought and flooding propel thousands of households into coping and survival strategies that often deprive them of their most productive assets, such as livestock or land, thus sinking them deeper into poverty. Water crisis is affecting the most vulnerable: woman-headed households, the children involved in fetching water, impoverished farmers living in downstream canal areas, poor households in unplanned urban areas and refugee camps, and Kuchis and other pastoralist groups (UN, 2016).

There are several principal manifestations that define the nature of the water crisis in Afghanistan include:

a. Approximately 16.8 million Afghans drink unsafe water.
b. An estimated 23 million people enjoy only inadequate access to improved toilets and waste disposal facilities.
c. Increasing population growth rates mean more competition for less water per capita.
d. Drought and flooding are still causing early deaths, injury, the destruction of property, food shortages and lost earnings.
e. The danger of national and international disputes over water resources is growing.
f. Environmental degradation is exacerbating water scarcity.

Existing technologies in water sector

Afghanistan is not self-sufficient for its water needs nor is it removed from the effects of its neighbor's water needs. Indeed, it is a landlocked country that shares four out of its five river basins with other states. It provides the headwaters of four major rivers that flow into neighboring countries but itself uses only a small proportion of water that origination here.

Key challenges:

- Lack of reliable hydrologic, meteorological and water quality data.
- Inadequate infrastructure for water regulation.
- Availability of professional staff and capable staff.

- Financial resource to be committed- mainly donors are funding emergency type projects.
- Commitment of communities.
- Non compliance of rule and regulations.
- Security and political instability.
- Political well and supportive cooperative from all parties in the implementation of water resource management concepts.
- Commitment of the Government in supporting water sector.
- Lack of interests of capable international companies.
- Extreme natural hazards.

During the inception workshop, the agriculture working group selected 12 technologies which are mentioned as follows.

1. Early Warning System for Water Supply Management through Snowpack Monitoring.
2. Ground water mapping and modeling
3. Integrated Water Resource Management (IWRM)
4. Micro irrigation system for efficient water use and management
5. Rainwater Collection from Ground Surface
6. water saving(Reducing water leakages in water management facilities)
7. Small dams and micro catchment
8. Drip irrigation system
9. Water Users Associations
10. Wells for Domestic Water Supply
11. Water legislation improvement
12. Sprinkler irrigation system

From the totality of 12 technologies, four technologies were prioritized, described beneath.

1. Integrated Water Resource Management (IWRM)

Water is a key driver of economic and social development while it also has a basic function in maintaining the integrity of the natural environment. Thus, the water crisis in many countries like Afghanistan is not only caused due to shortage of water resources but also due to mismanagement. Water resources managers, whether in the government or private sectors, have to make difficult decisions on water allocation. More and more they have to apportion diminishing supplies between ever-increasing demands. Drivers such as demographic and climatic changes further increase the stress on water resources. The traditional fragmented approach is no longer viable and a more holistic approach to water management is essential. This is the rationale for the Integrated Water Resources Management (IWRM) approach that has now been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands.

2. Small Dams and Micro Catchment

As indicated in the Strategy for Agriculture and Water, the lack of technical capacity is one of the critical issues at the provincial level department of Agriculture and Water

Resources. With additional pressure from climate change this institutional capacity constraint worsen if not urgently and properly be addressed.
This technology can help to store and use water during low water periods and, therefore, increase water use efficiently as the system collects water from the nearby area and keeps it from flowing into rivers or other areas or from evaporating.

3. Rain water collection from ground surface

This technology would aim at supporting stakeholders within the target small reservoirs and micro catchments to adopt sustainable water management practices following a landscape-based approach in order to increase water conservation and productivity through innovative technologies and sound management practices. Small-scale collection infrastructure can contribute greatly to the volume of freshwater available for human use. This is especially an issue in arid and semi-arid regions, where the minimal rainfalls are usually very intense and often seasonal.
Sustainable and integrated small reservoirs and micro catchments management in order to ensure neutrality of degradation of natural resources, build the resilience of communities, institutions and ecosystems to prepare for, adapt to and mitigate the impacts of climate change.

4. Micro irrigation for efficient water use and management

Small scale micro irrigation for lifting, conveying and applying irrigation efficiently include gravity fed drip and pressurized sprinkler irrigation used to improve water use efficiency and food production. They may be gravity fed or pressurized system. Water source can be from borehole, reservoirs, field pond or potable source. This system deliver water onto the soil surface very near the plant or below the soil surface directly into the plant root zone. Producer, growers and landscapers have adapted micro irrigation systems to suit their needs for precision water application.
As both the climate hazards come with a high potential to compromise food, water and energy security of the country, therefore, TNA adaptation technologies mainly focus on these two subsectors of water i.e. flood protection and resource availability.

3.3 Decision context

Climate model predicate that global temperature will rise over the next 100 years, by extent ranging from 0.5 ºC to 5.8 ºC from pre-industrial levels. There is general consensus within the inter-governmental panel on climate change IPCC fifth working group that a 2 ºC increase would be a realistic scenario. Such temperature changes would significantly undermine the stability of the global hydrological system. Changing precipitation and temperature affect the stability of the ecosystem, natural resource availability, and human health and livelihoods for Afghanistan, existing criticalities in food supply, agricultural and livelihoods security are expected to worsen severely with climate change. The effects of climate change on agriculture and water resources in rural areas are particularly sever and these in turn affect rural livelihoods, primarily through the impacts on agricultural productivity, forestry, rangelands and biodiversity.
Climate change also affects agriculture (horticulture, animal husbandry, plant protection agronomy, soil and plant nutrition and water supply) and thereby infrastructure service deliver,

posing threats to densely populated settlements. In the current context, where almost 30 percent of the Afghan population is concentrated in the major cities, this could pose a major threat to overall quality of life and sustainability of the urban settlements. The fifth assessment report of the IPCC observes that climate change adaption choices and societal response in the near term will affect the risk of climate change through the 21 centuries. The IPCC acknowledges that some degree of mainstreaming that has taken place regarding the integration of climate change adaption and mitigation concerns into national policy, earlier the forth assessment report stated that effective adaption (as opposed to mitigation measures) is essentially the only tool available to protect against most of the impacts caused by emissions from historical process. In particular, even if measures are adopted to limit GHG emissions, it would still be impossible to revert all of the impacts of climate change caused by past emissions, as many are largely irreversible. Success in adapting to climate change depends on the availability of necessary recourses, including financing, technical capacity and institutional capacity.

All are critical constraints for Afghanistan, and more adequate institutional capacity is key requirement. The National Adaption Plan for Afghanistan (NAP) proposes a course of action on adaption from a medium to long term perspectives. It views adaption as a dynamic process, which would include equipping institutions, policy makers, and technicians in Afghanistan with the capacity to understand where and when to take actions to minimize climate change impacts and deal with extreme events (UNESCO, 2015). The NAP builds on, and is guided by, the border Afghanistan Climate Change Strategy and Action Plan (CCSAP) while the NAP focuses on adaptation priorities, the CCSAP considers both adaptation and climate change mitigation measures, across six broad thematic areas:

Desertification/Aridification and Water Management

- Agriculture and Food Security
- Forest Resource and Biodiversity
- Human Health
- Extreme Events and Disaster Management
- Gender Dimension

3.4 Adaptation technology options for water sector and their main adaptation benefits:

The NAP also addresses awareness and capacity development, both that at the national level and at provincial and local levels, to enable Afghan institutions to address climate change vulnerability and adaptation issues. In adaptation, the NAP deals with enabling elements, like building up infrastructure to combat climate change and to facilitate the implementation of adaptation measures. A four – pronged approach has been adopted in the development of the national adaptation plan, in line with the guidance provided by Least Developed Countries Expert Group (LDCEG) of the United Nations Framework Convention on Climate Change (UNFCCC).

Critical activities: These include ensuring clarity of vision of the NAP among key agencies entrusted with its development, stocktaking of existing activities and identification of gaps and synergies with other development process. Analysis of current and future climate scenarios for Afghanistan assessment of climate vulnerabilities, prioritization of adaptation options,

assessment of mainstreaming challenges and opportunities especially vis- a-vis other adaptation plans, such as the NAPA, and the overall national development strategy for Afghanistan. Implementation priorities: Critical activities: Prioritization of adaption actions, contributing to the development of a medium to long- term implementation strategy and plan: assessment and strengthening of institutional frameworks and capacities. Reporting, monitoring and review: Critical activities: Development of a monitoring framework and plan, setting criteria for periodic evaluation of progress, and related elements of the reporting and monitoring process (WHO, 2015).

Adaptation technology options for water sector and their main adaptation benefits. Water sector experts, practitioners, and stakeholder's members of Sectoral Expert Working Group agreed on the following four adaptation technologies options for water sector (Table: 3.1).

Table 3.1: Adaptation benefits of water sector technologies

Technology	The main climate change adaptation benefits
IWRM (Integrated Water Resource Management)	1. Effectively protection of the environment 2. Manage the resources for best utilization
Small dams and micro catchment	1. Allow for an increased abstraction of water during water stressed seasons 2. Water use for water supply or environment protection
Rain water collection from ground surface.	1.Reduce pressure on the surface and groundwater resources by decreasing household water demand 2. Mitigate or reducing the instances of flooding by capturing rooftop runoff during intense rainstorms 3. Provide a short-term security to households during periods of low rainfall or water scarcity
Micro irrigation system for efficient water use and management	1.Increase water use efficiency and effectiveness 2.Saving the water and decrease water wastage 3. Increase yield potential

3.5 Criteria and process of technology prioritization for water sector

3.5.1. Identifying adaptation technology options for water sector

Identification technology options were a critical initial part of the MCA process. After the endorsement of four short listed technology options in water sector by the 'Sectoral Expert Working Group-Adaptation' and detailed deliberations, the TNA process entered in its next step of identifying and prioritizing technologies for water sector through an extensive stakeholder engagement by utilizing the multi criteria decision analysis (MCA) tool. This tool helps in comparing adaptation technology options across a number of diverse criteria while taking into account the priorities and values of multiple stakeholders, thereby moving forward the formal decision making process in a transparent and consistent way.

Figure 3.1: Shows the process of water sector technologies prioritization

3.5.1.1 Characterization of short-listed adaptation technologies

All the short-listed technologies were categorized on the basis of its availability in time and applicability in scale. The categorization criteria were: short term, medium term, long term, small scale and large scale.

A. The short term implies that the technology is reliable, a commercially viable in a standard market mechanism and thus is available in the market in a shorter time period.
B. The medium-term technologies will approximately take 5 years to full market availability in the standard market context
C. A long-term technology would still be in a research and development (R&D) phase or a prototype
D. Small scale technologies are applied at the household and/or community level with potential to be scaled up into a program, and
E. Large scale technologies are applied on a scale larger than household or community level (Table 3.2).

Table 3.2: Characterization of short-listed technologies for the water sector

Technology	Scale of technology application	Availability of technology in time
IWRM	Large scale	Short and medium term
Small dams and micro catchment	Medium scale	Medium term
Rain water collection from ground surface	Large scale	Medium term
Micro irrigation system for efficient water use and management	Medium to Large scale	Short and medium term

3.5.2. Multi criteria analysis process

3.5.2.1. Determination of criteria and weightings

The criteria applied for evaluation of technologies were: cost of technologies, economic, social and environmental, and climate related benefits. Each of these benefit categories were judged against sets of sub-criteria selected by the Sectoral Expert Working Group-Adaptation

technology that helped in scoring and weighting of the technology options multi criteria analysis for adaptation technology needs assessment for water and agriculture sectors of Afghanistan.

Technology

Costs:

Establishment and maintenance cost

Benefit:

1. Economic
   1.1: Improvement economic performance
   1.2: Create jobs opportunity
2. Social
   2.1: Reduce poverty and inequality
   2.2: Improve health
3. Environmental
   3.1: Protect biodiversity
   3.2: Support environmental services
   3.3: Protect environmental services
4. Climate related:
   4.1: Reduce vulnerability

As a central element of the MCA analysis, scores were assigned to each criterion through stakeholder and consultation using technology option scoring justification table provided in the guidebook of MCA process by UNEP/ DTU (Table 8). The scoring scale of 0-100 was used where a score of '0' was given to the technology option which was least preferred under that criteria and 100 was given to the most preferred option under the same criteria. The technology scores are provided in the Technology Performance Matrix (Appendix III).

Table 3. 3: Technology option scoring justification table

Score	General Description
0	Used when information on a technology does not apply to the particular criteria
1-20	Extremely weak performance; strongly unfavorable
21-40	Poor performance, major improvement needed
41-60	At an acceptable or above level
61-80	Very favorable performance, but still needs improvement
81-100	Clearly outstanding performance which is way above the norm

Once the scoring process was complete, weights were assigned to the selected set of criteria including economic, environmental, social and climate related benefits while the sub-set of criteria, provided in the criteria were mention above, only used to fully comprehend the aspects of the selected criteria under consideration, so no disaggregated weights were assigned to the sub-set of the criteria. The purpose of this step was to determine the relative preference of a criterion over the others by giving a weight that represents relative strength of a criterion. The basic weights were showing in the following (Table 3.4).

Table 3.4: Weighting of criteria showing assigned base weight values

Performance Matrix		
criteria	Weighted value	
	Absolute value	Relative value
Cost	20	0.2
Economic benefits	25	0.25
Social benefits	15	0.15
Environmental benefits	15	0.15
Potential of reduction vulnerability	25	0.25
Total value	100	1

The weight assignment was done in two steps of assigning first a basic weight through consultation with stakeholders for each criterion for an option. In the step of consultation, the stakeholders gave marks for each criteria of each technology from 0 to 100.

Table 3.5: Scoring matrix giving marks to each criteria of the technology options.

technology options	Scoring matrix (for each criteria score should very from 0 to 100)				
	Criteria				
	Cost	Economic benefits	Social benefits	Environmental benefits	Potential of reducing vulnerability
Sprinkler irrigation system	25	70	56	60	80
Drip irrigation system	30	60	55	62	78
Early warning system for water supply management through snowpack monitoring	20	90	82	70	72
Ground water mapping and modeling	25	80	77	65	68
IWRM	77.8	88.9	66.7	100	100
Micro irrigation for efficient water use and management	50	100	66.7	67	100
Small dames and micro catchment	77.8	88.9	100	42.9	100
Rain water collection from ground surface	55.6	66.7	100	100	95
Water saving(Reducing water leakage in water management facilities)	40	60	70	75	72
Water use association	100	40	50	0	80

Wells for domestic water supply	45	62	70	62	75
Water legislation improvement	100	50	65	70	50
Scoring scale	0= for very high cost ;100 for low cost	0= for low benefits;100 = for high benefit	0= for low benefits;100 = for high benefit	0= for low benefits;100= for high benefit	0= for low benefits;100= for high benefit

Finally, to get the total aggregated score for each technology option, the scores for each criterion were multiplied with its respective relative weight calculated earlier. The new weighted scores for all the criteria for an option were added up to get an overall weighted sum of scores for each adaptation technology (Table 3.6).

Table 3.6: Decision matrix or weighted scores for the selected adaptation technologies in water sector

Technology Options	**Decision Matrix: Weighted scores**					Total weighted score
	Criteria					
	Cost	Economic benefits	Social benefits	Environmental benefits	Potential of reducing vulnerability	
Sprinkler irrigation system	5	17.5	8.4	9	20	59.9
Drip irrigation system	6	15	8.25	9.3	19.5	58.05
Early warning system for water supply management through snowpack monitoring	4	22.5	12.3	10.5	18	67.3
Ground water mapping and modeling	5	20	11.55	9.75	17	63.3
IWRM	15.56	22.225	10.005	15	25	87.79
Micro irrigation for efficient water use and management	10	25	10.005	10.05	25	80.055
Small dames and micro catchment	15.56	22.225	15	6.435	25	84.22
Rain water collection from ground surface	11.12	16.675	15	15	23.75	81.545

Water saving(Reducing water leakage in water management facilities)	8	15	10.5	11.25	18	62.75
Water use association	20	10	7.5	0	20	57.5
Wells for domestic water supply	9	15.5	10.5	9.3	18.75	63.05
Water legislation improvement	20	12.5	9.75	10.5	12.5	65.25
Criterion weight	0.2	0.25	0.15	0.15	0.25	1

On the basis of total weighted scores, the technology options were prioritized and ranked by the 'Sectoral Expert Working Group' from high priority to low priority order. According to the result, thus IWRM of (87.79%) and thus the most preferred option. According to MCA result, the top four adaptation technologies with the highest priority ranking in the water sector of Afghanistan are given in Table 3.7:

Table 3.7: Priority adaptation technologies in water sector of Afghanistan

Name of the technology	**Technology score (Output from the MCA)**	**Technology priority order**
IWRM	87.79	1
Small damas and micro catch ment	84.22	2
Rain water collection from ground surface	81.54	3
Micro irrigation for efficient water use and management	80.05	4

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

The prioritized technologies approved in consensus by the 'Sectoral Expert Working Group' were later on endorsed by the National TNA Committee and the TNA Steering Committee in their meeting held in July, 2019.

Chapter 4: Technology Prioritization for Agriculture Sector

4.1 General information about Agriculture status in Afghanistan

After the prioritization of agriculture sector as one of the two priority sectors selected for TNA process in Afghanistan was complete, the next step of the process was to identify and prioritize adaptation technologies in this sector. In the first stage of this process an extensive literature review of the relevant material helped in identifying 12 adaptation technologies. Next the process involved various sector specific key experts and stakeholders for the sake of identifying the current status of these adaptation technologies at local and regional levels and specifically of those ones with a successful replication potential in order to meet the crucial yet diverse demands of the technology users in the agriculture sector of Afghanistan. This stage finished with short listing of six technologies for the agriculture sector.

Figure 4.1: Shows the process of agricultural sector technologies prioritization

Technology fact sheets were prepared for each of the six technologies, which were presented in and discussed with the Sectoral Expert Working Group-Adaptation. The fact sheets covered different aspects of technology including brief technology descriptions, the total cost of the technology, implementation and recurring maintenance, current status and implementation barriers in the country, and the adaptation and other social, economic, and environmental benefits (Appendix II). After detailed discussions, the Sectoral Expert Working Group with a slight modification in technology titles endorsed six technology options in agriculture sector for further analysis through MCA, and also agreed on the analysis criteria and their weights.

As agriculture is the foundation of the country's rural livelihoods and supports the majority of the country's population, negative impacts on agricultural productivity would have myriad effects on the economy, stability, and food security. Most agricultural crops are highly dependent on specific climate conditions, and climatic changes can have both positive and negative impacts on the ways that crops are cultivated. For example, an increase in atmospheric CO_2 could prove beneficial for some crops, assuming that the sufficient levels of nutrients, water, and soil moisture are maintained. Likewise, a warmer climate could increase the duration of the growing season and accelerate plant growth. But for many grain crops,

faster growth may reduce the amount of time that seeds have to grow and mature, resulting in lower crop yields.

A warmer climate could also alter the range of pests and diseases, presenting additional challenges for crop species that previously would not have encountered such infestations or outbreaks. With a changing climate, rain-fed agriculture will be particularly vulnerable, possibly resulting in a widespread decrease in agricultural production and increase in need for irrigation, which would in turn put greater stress on the country's water resources. With warmer temperatures, forest and rangeland plant species are expected to see a shift in their geographic range to more northern latitudes and higher altitudes, thereby altering vegetation cover and increasing the risk of desertification, erosion, flooding, avalanches, and landslides. A warmer climate would also impact the biological diversity of plant species, as not all would be suited to a warmer climate. For example, weedy species with a high ecological tolerance will have an advantage over cold-adapted species, resulting in changes to countrywide vegetation land cover. While warming may have positive effects on the growth of some trees, new pests, diseases, and invasive plant species better suited to a warmer climate could also increase competition with native species resulting in alterations to the ecosystem. Warmer winters will also likely lead to reduced snow cover and less carryover of water to the growing season, which could lead to drought-induced forest decline (UNFCCC, 2008b).

4.2. Climate change vulnerability in agriculture sector

Agriculture sector is one of the largest sectors of the country that employs 68 percent of the total labor workforce and contributes about 70 percent to national exports. The past climate trends for Afghanistan show a warmer and shorter duration winter than summer season with large increase in night time temperature than day time. Similarly, summer season has also experienced a non-uniform rather a mixed trend of maximum temperature all over the country. The minimum temperature is increasing over central parts of Afghanistan, while extreme north and south have shown slightly cooling trend in some climatic zones. This change in temperature with difference in day length has serious implications for crop growth and productivity in future. It is estimated that with rise of temperature (+0.5-2°C), agricultural productivity will decrease by around 8-10% by 2040. Different simulation studies, using crop–growth simulation model estimated a decrease in yield of major crops specifically for wheat and rice, and the length of growing season in four agro-climatic zones of Afghanistan. The model predicted the largest decrease of around 14 days for 1°C rise in temperature in growing season length of wheat in northern mountainous region compared to southern Afghanistan. Climate change will severely affect two major crops of wheat and fine-maize in Afghanistan. It is estimated that, under IPCC,Scenario, wheat yield will reduce by 6% and fine maize will experience 15-18% decrease in yield in all agro-climatic zones by 2080 except in some areas of the north (World Bank, 2011).

4.3. Decision context

The food security in Afghanistan is inextricably linked with agriculture and water sectors and as such the need to adapt to climate change is duly acknowledged as an intrinsic element of Afghanistan future development. The 'Vision 2024' document provides guidelines to improve the productivity of the agriculture sector in order to attain food security. Some new initiatives

had been proposed and approved that include application of satellite, remote sensing and geological information system (GIS) technology for crop forecasting and estimation, value addition in agriculture – cluster development approach, and capacity building of agriculture extension services among the few (World Bank, 2017). Food security is clearly affected by reduced and irregular availability of water supplies, which reduces food production and livelihoods.

A number of projects Implemented by the Government of the Islamic Republic of Afghanistan have been aimed at addressing rural development issues in ways that would promote sustainable livelihoods, improve resilience, and reduce the incidence and impacts of natural disasters. While climate change adaptation may not have been a conscious motive behind the introduction of the interventions, some of these actions have had positive impacts. The brief description of ongoing and completed projects are show in (appendix IV).

4.4 An overview of possible adaptation technology options for agriculture sector and their main adaptation benefits

Adaptation benefits of selected technologies were identified with the help of key sector experts and desk review of research material on agricultural technologies.

During inception workshop agriculture working group selected 12 technologies which are mentioned as follows.

1. Crop growing under plastic mulches
2. Conservative agriculture
3. Crop diversification and new varieties
4. Ecological pest management
5. Green house crops (Cucumber, Tomatoes, capsicum)
6. Responsive Agricultural extension(Community based extension)
7. Application of windbreaks
8. Agro- forestry
9. Introduction of plant varieties resistant to expected climate changes
10. Land use planning
11. Pasture improvement
12. Seed and grain storage

Adaptation consultant provided 12 technologies from the secondary source of data (review of literature, research paper, interviews, group discussion and so on,) for each sector. During inception workshop all technologies fact sheets were distributed to each expert working groups for discussion and decision-making. After their discussion in account of MCA criteria, they have given marks to all technologies. Based on higher weighted average marks 6 technologies were selected for agriculture and 4 technologies were selected for water sector respectively.

Table 4.1: Adaptation benefits of agriculture sector technologies

Technology	The main climate change adaptation benefits
1. Crop diversification and new varieties	1. Maintenance of crop diversity for sustainable development 2. Increase production and productivity
2.Responsive	1.Message dissemination to targeted communities

agricultural extension	2.Increasing information and practical scale levels of targeted communities
3. Introduction of plant varieties resistant to climate change	1.Efficient use of crop varieties especially in drought prone areas or those with seasonal rainfall 2. Reduced demand for water by decreasing water evaporation losses 3. Improved crop health by easy fertilization in case of drip irrigation system, less leaching of nutrients from the root zone, and thus with lower probability of onset of diseases such as fungus
4. Land use planning	1.Protect fertile agricultural lands from encroaching by land mafia 2. Improve chances of availability of more land for increasing acreage of farming 3.Improve disaster management approaches and risk reduction
5. Conservative agriculture	1. Efficient use of available crop water in drought prone areas or those with seasonal rainfall 2. Reduced demand of water by minimized evaporation losses from the crop surfaces. 3. Improved food security
6. Agroforestry	1. Provide strong defense against twin problem of salinity and water logging in the soil and thus ensures good crop productivity 2. Help to achieve food security target in changing climate by bringing more area under cultivation

The Table 4.2 revealed that the pre-selected technologies were characterized further on the basis of their scale of application (small to large) and range of availability (short, medium and long terms).

Table 4.2: Characterization of short-listed technologies for the agriculture sector of Afghanistan.

Technology	Scale of technology application	Availability of technology in time
1.Crop diversification and new varieties	Large scale	Short and medium term
2.Responsive agricultural extension	Medium scale	Medium term
3.Introduction of plant varieties resistant to climate change	Large scale	Medium term
4. Land use planning	Medium to Large scale	Short and medium term
5. Conservative agriculture	Small to medium scale	Medium term
6. Agro forestry	Medium scale	Medium term

4.5. Criteria and process of technology prioritization for agriculture

In order to prioritize the adaptation technologies in agriculture sector of Afghanistan, a set of locally validated criteria were selected based on the framework proposed in the guidebook on MCA process from UNEP DTU. Based on the 'Technology Fact Sheets' and Sectoral Expert

Working Group members' preference and expertise, the technologies were quantified on the scale of 0-100 based on the technology scoring justification. A score of '0' was given to a least preferred technology option under that criterion, and 100 were given to the most preferred option under the same criteria. The remaining criteria were then given scores on a scale between these two values (See Appendix III for technology performance matrix). After scores were assigned, each criterion was assigned a base weight which represented the relative preference of a criterion over the other. Then calculated the total weighted score for each technology option at the end of the MCA process. In the first finding the criteria and the absolute and relative value to each criterion. Table 4.3 shows the base weight values of a criterion.

Table 4.3: Criteria assigned values

Performance Matrix		
criteria	Weighted value	
	Absolute value	Relative value
Cost	20	0.2
Economic benefits	25	0.25
Social benefits	15	0.15
Environmental benefits	15	0.15
Potential of reduction vulnerability	25	0.25
Total value	100	1

The Table 4.4 shows the Assigning scores to each criteria of an option through consultation with stakeholders. In the step of consultation, the stakeholders gave marks for each criteria of each option from 0 to 100.

Table 4.4: Scoring matrix

Technology options	Scoring matrix (for each criteria score should very from 0 to 100)				
	Criteria				
	Cost	Economic Benefits	Social Benefits	Environmental Benefits	Potential of Reducing Vulnerability
Crop growing under plastic mulches	30	28	60	43	25
Conservative agriculture	80	75	50	50	20
Crop diversification and new varieties	50	75	100	84.6	81.8
Ecological pest management	28	30	40	42	26
Green house crops(Cucumber, Tomato, Capsicum)	10	50	40	32	30
Responsive agricultural extension	40	95	87.5	40	63.6

Windbreaks	35	28	60	40	25
Agro-forestry	40	30	62.5	40	30
Introduction of plant varieties resistant to climate change	0	100	50	46.2	100
Land use planning	85	30	25	100	45.5
Pasture improvement	50	22	40	35	25
Seed and grain storage	10	40	35	15	20
Scoring scale	0= for very high cost ;100 for low cost	0= for low benefits;100= for high benefit	0= for low benefits;100 = for high benefit	0= for low benefits;100= for high benefit	0= for low benefits;100= for high benefit

When the scores are assigned to each criteria of the option, then the total weighted score was calculated for each technology option by multiplying the relative weight value of each criterion with its respective score and getting an aggregate weight for each technology option by adding up all the weighted scores (Table 4.5).

Table 4.5: Weighted scores for the selected adaptation technologies in agriculture sector

Technology options	Decision matrix: Weighted Scores					Total weighted score
	Criteria					
	Cost	Economic benefits	Social benefits	Environmental benefits	Potential of reducing vulnerability	
Crop growing under plastic mulches	6	7	9	6.45	6.25	34.7
Conservative agriculture	16	18.75	7.5	7.5	5	54.75
Crop diversification and new varieties	10	18.75	15	12.69	20.45	76.89
Ecological pest management	5.6	7.5	6	6.3	6.5	31.9
Green house crops(Cucumber, Tomato, Capsicum)	2	12.5	6	4.8	7.5	32.8
Responsive agricultural extension	8	23.75	13.125	6	15.9	66.77
Windbreaks	7	7	9	6	6.25	35.25
Agro-forestry	8	7.5	9.375	6	7.5	38.37
Introduction of plant varieties resistant to climate change	0	25	7.5	6.93	25	64.43
Land use planning	17	7.5	3.75	15	11.375	54.62

Pasture improvement	10	5.5	6	5.25	6.25	33
Seed and grain storage	2	10	5.25	2.25	5	24.5
Criterion weight	0.2	0.25	0.15	0.15	0.25	1

The technology with highest weighted score 76.89 Crop diversification and new varieties was ranked most preferred one. Followed by, 5 technologies received the highest degree of priority: a: Crop diversification and new varieties. b: Responsive agricultural extension, c: Introduction of plant varieties resistant to climate change, d: Conservative agriculture, e: Land use planning and Agro-forestry.

Table 4.6: Priority order of adaptation technologies for agriculture sector in Afghanistan

Name of the technology	**Technology score (Output from the MCA)**	**Technology priority order**
Crop diversification and new varieties	76.89	**1**
Responsive agricultural extension	66.77	**2**
Introduction of plant varieties resistant to climate change	64.43	**3**
Land use planning	54.62	**5**
Conservative agriculture	54.75	**4**
Agro forestry	38.37	**6**

Chapter 5: Summary & Conclusions

The constitution of the Islamic Republic of Afghanistan state that "the state shall be obligated to adopt necessary measures to protect and improve forests as well as the living environment." In 2007, both the houses of the parliament passed the Environment Law. It was then ratified by the president and provides the basis for the environmental governance in Afghanistan. The primary aim of the law is the conservation and management of the environmental resources and their sustainable use to improve the livelihood and protect health of human, flora and fauna; maintain ecological functions and evolutionary processes; secure needs of present and future generations; conserve natural and cultural heritage; and facilitate reconstruction and sustainable development of national economy. The National Environmental Protection Agency (NEPA) is an independent institutional entity, responsible for coordinating, monitoring conservation and rehabilitation of the environment, and the implementation of the law.

The National Environmental Protection Agency which is headed by the Director General has its central office in Kabul and already has established 32 provincial offices out of 34 provinces in Afghanistan. As per the Environmental Law, National Environmental Advisory Council has been established to advise NEPA on financial matter, regulatory matters, and environmental matters of public interest. In addition to NEAC, committee for Environmental Coordination (CEC) is constituted to promote the integration and coordination of environmental issues and fundamental principles of the law at central level as well as provincial councils and district and village councils.

GRIoA is party to many Multilateral Environmental Agreements including Rio Conventions (UNFCCC, UNCBD, UNCCD), CITES and as well as party to many more including Basel, Stockholm, and Rotterdam Conventions and Kyoto Protocol. These MEAs are also part of legal tools that support environmental governance in Afghanistan. NEPA has added Clean Air Regulation, EIA Regulation, National Environmental Action Plan, EIA policy, Waste Management Policy, and Regulation on Ozone Depleting Substances and is in the process of adding more regulation in waste management, noise control, and environmental requirements to promote the environmental governance in the country. Sectoral Laws and regulations including Mines law, Hydrocarbon Law, and others promote environmental conservation. Implementation of the provisions of the law and regulations and MEAs is a big challenge. Through institutional capacity building support provided by UNEP and other UN and donor agencies over the years, NEPAs role has now been recognized by sectoral development ministries. Afghanistan has established the procedures in mainstreaming environment in the development initiatives' which need to be further strengthened to mainstream climate change adaptation and mitigation.

There have been good initiatives in development of national policy plan and strategy to address environmental challenges, disaster risk reduction, water security, food security, protection of forest and rangeland, biodiversity conservation all having synergy to adaptation to the climatic risks.

Major programs and projects being implemented or already implemented in Afghanistan with support from donor communities that will help to build the adaptive capacity to the impact of the climate change in Afghanistan are briefly discussed here, these include: Multiannual program in (2011-2013) , National Solidarity Program (NSP) initiated in 2003 and implemented by MRRD, Energy for Rural Development Afghanistan (ERDA) in 2008- 2015 is supporting MRRS's Rural Energy and Enterprise Department, Irrigation Restoration and Development Project (IRDP), World Food Programme, Wildlife Conservation Society and so on.

For this TNA exercise, two key economic sectors of water and agriculture are identified, as these sectors are the most vulnerable to the adverse impacts of climate change, therefore technological interventions in these sectors are deemed necessary to adapt to climate changes for achieving sustainable socio-economic development in the country.

This TNA report, which is prepared with support from GEF, UNEP and AIT, is the outcome of extensive consultation process which led to the identification of prioritized sectors and technologies through the use of MCA tool. The adaptation technologies were prioritized based on a set of the following criteria group with varying weights;

1. Benefits contribution to economic & social and environmental goals.
2. Relevance to climate change potential to reduce vulnerability and built climate resilience.
3. Cost of technology implementation and maintenance

Agricultural expert working group selected 6 agricultural technologies based on the following reasons: higher vulnerability, in sufficient food security, speedy on planned urbanization, global warming, as well as social, economic, environmental development priorities and market potential.

Table 5.1 shows the prioritized technologies in water and agriculture sectors.

Prioritized Sectors	Prioritized Technologies
Water Sector	1. IWRM 2. Small dams and micro catchment 3. Rain water collection from ground surface 4. Micro irrigation for efficient water use and management
Agriculture Sector	1. Crop diversification and new varieties 2. Responsive agricultural extension 3. Introduction of plant varieties resistant to climate change 4. Land use planning 5. Conservative agriculture 6. Agroforestry

After the sector and technology prioritization processes for water and agriculture sectors were complete, it was presented to the National TNA Committee for the final approval. After approval by the Committee, the results were subsequently presented to and endorsed by the TNA Steering Committee during their meetings held during the month of July, 2019. This TNA report will lead the way to the next phase of the TNA, which is - Barrier Analysis Report, followed by the development of Technology Action Plans and Project Ideas.

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APPENDIX I

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APPENDIX II

A. List of adaptation technologies presented to the Adaptation Expert Working Group for prioritization in agriculture and water sectors of Afghanistan

i. Agriculture sector

Technology 1: Crop diversification and new varieties
Technology 2: Responsive agricultural extension
Technology 3: Introduction of plant varieties resistant to climate change
Technology 4: Land use planning
Technology 5: Conservative agriculture
Technology 6: Agro - forestry
Technology 7: Greenhouse crops (Cucumber, Tomato, Capsicum)
Technology 8: Wind breaks
Technology 9: Ecological pest management
Technology 10: Crop growing under plastic mulching
Technology 11: Pasture improvement
Technology 12: Seed and grain storage

ii. Water Sector

Technology 1: Integrated water resource management
Technology 2: small dames and micro catchment
Technology 3: Rain water collection from ground surface.
Technology 4: Micro irrigation system for efficient water use and management
Technology 5: Drip irrigation system
Technology 6: Wells for domestic water supply
Technology 7: Ground water mapping technology and modeling
Technology 8: Early warning systems for water supply management through snowpack monitoring
Technology 9: Water saving technology (reducing water leakage in water management facilities)
Technology 10: Water legislation improvement
Technology 11: Water user association
Technology 12: sprinkler irrigation system

A. Technology Fact sheets for Agriculture sector

Technological Fact Sheets (1)



Sector	Agriculture
Sub – Sector	Food
Technology name	Crop diversification and new varieties
Option name	Cultivation of (Cotton, Saffron, Sugar cane, Beat root, fruits)
Scale	large – Scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

This technology will promote crop diversification in rain fed area with improved verities adoptable in climate change and drought resistant. The Introduction a greater range of varieties in a particular agro-ecosystem leads to diversification of agricultural production, which can also increase natural biodiversity, strengthening the ability of the agro-ecosystem to respond to these stresses. The introduction of new cultivated species and improved varieties of crop is a technology aimed at enhancing plant productivity quality, health and nutritional value (Khanam *et al,* 2018). As well as Increasing population and income growth demands more food and agricultural production. Increasing productivity in specific ecosystems is the only option as the pressure for agriculture lands is increasing. Further, decrease natural resources due to excessive and inappropriate usage and climate change would alter the ecosystem composition. Hence, diversification of crops would be needed to face emerging threats while maintaining the growth of agriculture production (Gefta, 2006). Rainfall pattern and intensity and over and inappropriate use would deplete available ground water. Increasing air temperature can directly affect productivity in certain ecosystems. These changes must be tested and demonstrated in the farm in order to effectively utilize the natural resources and to stabilize the production and profitability. In addition, it reduces levels of water, fertilizer, pesticide, and labor use, and assures quality produce. It impossible to harvest good crops with bad seeds (FAO, 2011).

Merits of the technology

- By introducing new crop verities farmers will be able to cover production losses made by climate change impact with increased yield and quality.
- Crop diversification provides better conditions for food security and enables

farmers to grow surplus products for sale at market and thus obtain increased income to meet other needs related to household well-being.

- The process of farmer experimentation and the subsequent introduction of adapted and accepted varieties can potentially strengthen the farmers cropping systems by increasing yields, improving drought resilience, boosting resistance to pests and diseases, as well as by capturing new market opportunities.

Demerits of the technology

- The costs of new varieties, as well as costs for cultivation can be higher than others.
- Farmers may need to be provided with necessary capacity building and awareness raising activities in order to adapt new technology.
- Farmers may also face risk from poor economic returns if crops are not selected based on a market assessment.

Implementation Assumptions (How the technology will be implemented and diffused across the sub sector)

MAIL and NEPA will be responsible for overall implementation of the project, and the Deputy Minister responsible for crop science and natural resources will be designated as the main focal point for preparing and implementing the project, given the fact that the project would involve a few departments.

Costs

a. Capital costs over 10 years:

Financial requirements of diversification revolve around the costs involved the varieties to be cultivate and training in the management of diversified systems. These activities could be provided by existing Agricultural Research Institutions in the regions. Approximate costs for whole process will be around 10-20 million USD. Preliminary feasibility study and assessment of vulnerability of currently used species in different regions with different ecosystems are also to be considered in the financial requirements. There would be a need for assessment of currently used varieties in countries with relatively hot climate. This may be done through a pilot project covering all agricultural regions of the country. The approximate cost of such a project will be around 7-8 million USD. Infrastructure and marketing costs should also be considered. Costs of farmer experimentation are generally low, but results may only have local applicability. Capital investment will relate to the purchase of new seed varieties (if not available 'wild 'locally) and labor time. In total, capital costs over 10 years will be around 50-60 million USD.

b. Operational and maintenance costs over 10 years:

There might be a need for operational and maintenance costs for purchased equipment, but it will not be a significant amount and could be provided using local resources.

c. Other costs over 10 years:

Additional costs will be needed to provide necessary capacity building activities for local farmers. Consulting services could be provided by the existing Regional Agricultural

Advisory Centers. There will be need for an additional 1.5 million USD to organize necessary capacity building activities, including awareness raising activities publication of different information materials and training activities.

Impact statements (How the options Impact countries development priorities)

Countries social development priorities

- Minimized health problems from environmental pollution, resulting from indiscriminate resource use
- Increased returns to resource use and improving the attractiveness of farming, particularly to youth, through adoption of high-tech methods.
- Contributes to food security priority by increasing productivity
- Leads to increase in income of rural population

Countries economic development priorities

- Increases crop yield, quality and efficient use of farm inputs and labor would reduces cost of production
- Ensure productivity and food security
- Leads to improvement of economic condition of rural population
- Contributes to the diversification strategy of countries economy by increasing weight of agricultural sector within economic system

Countries environmental development priorities

- Prevents soil degradation in cultivable land.
- Reduction of chemical use in crop production
- Efficient use of water resources and other natural resources
- Reduces GHG emission as demand driven fertilizer management systems emit low NOx and other gases
- Reduces negative impact of forecasted climate change

Other considerations and priorities such as market potential

The technology is naturally suitable for large-scale adoption. In fact, some elements of the technology must be adopted as a general practice for optimum results and unit costs of certain crop diversification techniques would significantly lower with widespread use by farmers. Also, some elements of the technology package have the public-good nature requiring state patronage in its expansion.

Technological Fact Sheets (2)

Sector	Agriculture
Sub – Sector	Crop production
Technology name	Responsive agricultural extension
Option name	Community based extension
Scale	Small – Scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Public sector commitment is essential to promote extension and communication for rural development and food security. The community based rural agricultural extension model is based on the idea of providing specialized and intensive technical training to selected people in rural communities to promote a variety of technologies and offer technical services with support and review from an extension organization (Rivera *et al*, 2002). The model is demand based in those farmers' groups or community to provide specific information and related service contacts the service provider. The community-based extension model can contribute to climate change adaptation through the training of service providers in climate data collection; analysis and dissemination within their areas of operation to enable communities select appropriate response strategies. It strengthens farmer's capacity to demand services and resources appropriate to their needs through the countervailing power (Samuel *et al,* 2012). The lack of information and feedback on different farmer group's needs and priorities hinders the design of relevant and effective extension programs (Anderson and Feder, 2007).

Merits of the technology

The technology has the potential of increasing access to extension services by a lot more farmers and in a timely manner. The implementation of this technology is least cost able and the rural people are more active and involve in the adoption of technology.

Demerits of the technology

A major disadvantage of the model is the probability of rolling out poorly trained agents. Also, another disadvantage could be inadequate supervision and technical support from the main extension service.

Implementation Assumptions (How the technology will be implemented and diffused across the subsector)

The technology will be implemented by NEPA and MAIL related staff at the target communities, including community development council.

Costs

a. Capital costs over 10 years

The capital cost of this model will be low. The model aimed at reducing cost of extension service provision. Approximately 10-20 million USD

b. Operational and maintenance costs over 10 years

Costs are therefore expected to be low and will depend on the coverage area.

c. Other costs over 10 years

Additional costs will be needed to provide necessary capacity building activities for local farmers. The existing provincial agricultural, irrigation and livestock directorate could provide consulting services. There will be need for an additional 1500,000 USD to organize necessary capacity building activities, including awareness raising activities, publication of different information materials and training activities.

Impact statements (how the options influences countries development priorities)

a) Countries social development priorities

- Income: Source of extra income for the community extension agents whilst supporting increases in household incomes at the community level.
- Learning: Creates opportunity for increased group and individual learning at community level
- Health: The technology has the potential reducing health risks within communities through improved flow of information and training.

b) Countries economic development priorities

- The implementation of the model will create on site jobs for people within their own communities.
- Requires low investment when compared to training and use of regular extension staff.
- Reduce public and private expenditures on climate related disaster management through its support to building community resilience
- Increase efficiency of resource use overall.
- Promote rural development and resource conservation.

c) Countries environmental development priorities

- Community based extension model would assist in producing environmental benefits through the promotion and training of farmers on technologies that support environmental sustainability.

d) Other considerations and priorities such as market potential

- This is a non-market technology, which is called org technology (capacity development).

Technological Fact Sheets (3)


Sector	Agriculture
Sub – Sector	Plant resistant varieties
Technology name	Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes
Option name	Introduction of plant varieties resistant to climate change
Scale	Large – Scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Agriculture is of great importance to Afghanistan, accounting for a large portion of employment, rural livelihoods, food security, and rural growth. However, the sector is highly climate sensitive and there exist potential adverse changes in temperature, precipitation, and frequency of extreme events (e.g. droughts, heat waves, floods) with climate change. New plant varieties more resistant to high temperatures and droughts will enable farmers to sustain or increase productivity. Resistance to drought, salinity and flooding are the most common climate related traits for which crop varieties are bred (FAO,2011).

The introduction of new cultivated species and improved crop varieties is a technology aimed at enhancing plant productivity, quality, health and nutritional value and/or building crop, resilience to diseases, pest organisms and environmental stresses (Souza *et al*,1994). Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm, taking into account the different returns from value-added crops with complementary marketing opportunities. New and improved crop species can be introduced through farmer experimentation with new varieties. Agricultural researchers and extension agents can help farmers identify new varieties that may be better adapted to changing climatic conditions, and facilitate farmers to compare these new varieties with those they already produce. In some cases, farmers may participate in crossing select seeds from plant varieties that demonstrate the qualities they seek to propagate, in order to develop new varieties with the characteristics they desire.

Plant breeding and varietal extension methods consistently provide access to newer and better varieties at frequent intervals (Witcombe *et al*,2015). Varieties that are developed to resist water and heat stress will help to ensure that agricultural production can continue and even improve despite uncertainties about future impacts of climate change. Varieties with improved nutritional content can provide benefits for animals and humans alike, reducing vulnerability to illness and improving overall health.

Advantages

- By introducing new crop species farmers will be able to cover production losses made by climate change impact with increased yield and quality.
- Crop diversification provides better conditions for food security and enables farmers to grow surplus products for sale at market and thus obtain increased income to meet other needs related to household well-being.
- The process of farmer experimentation and the subsequent introduction of adapted and accepted varieties can potentially strengthen the farmers cropping systems by increasing yields, improving drought resilience, boosting resistance to pests and diseases, as well as by capturing new market opportunities.

Disadvantages

- The costs of new species, as well as costs for cultivation can be higher than others.
- Farmers may need to be provided with necessary capacity building and awareness raising activities in order to adapt new technology.
- Farmers may also face risk from poor economic returns if crops are not selected based on a market assessment

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

Such technology will be applied mainly in arid and semi- arid zones of the country. Assessment of vulnerability should be provided in the areas with most risk to negative impacts of climate change. Agricultural research institutions must be involved in the process in order to provide analyses and experiments with new species.

Costs

a) Capital costs over 10 years

Financial requirements of introduction of plant varieties resistant to climate change revolve around the costs involved in researching the species to be planted and training in the management of diversified systems. Existing Agricultural Research Institutions in the regions could provide these activities. Approximate costs for researching would be around 25-35 million USD. Preliminary feasibility study and assessment of vulnerability of currently used species in different regions with different ecosystems are also to be considered in the financial requirements. There would be a need for assessment of currently used species in countries with relatively hot climate (e.g. species currently applied in Egypt or southern part of Turkey) as the forecasted temperature increase would be similar. This may be done through a pilot project covering all agricultural regions of the country. The approximate cost of such a project will be around 10-12 million USD. Infrastructure and marketing costs

should also be considered. Costs of farmer experimentation are generally low, but results may only have local applicability. Capital investment will relate to the purchase of new seed varieties (if not available 'wild 'locally) and labor time. In total, capital costs over 10 years will be around 70-80 million USD.

b) Operational and maintenance costs over 10 years

There might be a need for operational and maintenance costs for purchased equipment, but it will not be a significant amount and could be provided using local resources.

c) Other costs over 10 years

Additional costs will be needed to provide capacity building training to researcher and for local farmers. Consulting services could be provided by the existing provincial Agricultural Advisory Centers. There will be need for an additional 2.5 million USD to organize necessary capacity building activities, including awareness raising activities, publication of different information materials and training activities

Impact statements (how the options impact countries development priorities)

A. Countries social development priorities

- Contributes to food security priority by increasing productivity
- Leads to increase in income of rural population
- Minimized health problems from environmental pollution, resulting from indiscriminate resource use.

B. Countries economic development priorities

- Leads to improvement of economic condition of rural population.
- Contributes to the diversification strategy of countries economy by increasing weight of agricultural sector within economic system.
- Ensure productivity and food security.

C. Countries environmental development priorities

- Reduces negative impact of forecasted climate change.
- Reduction of chemical use in crop production.
- Efficient use of water resources and other natural resources.

D. Other considerations and priorities such as market potential

- Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets

Technological Fact Sheets (4)


Sector	Agriculture
Sub – Sector	Crop production
Technology name	Land use planning
Scale	Small – Scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Land-use planning refers to the process by which land is allocated between competing and sometimes conflicting uses in order to secure the rational and orderly development of land in an environmentally sound manner to ensure the creation of sustainable human settlements. Competition for land is increasing as demand for multiple land uses and ecosystem services. Food security issues ,renewable energy and emerging carbon markets are creating price signals for the conversion of agricultural land to other uses (Metternicht,2017).In Afghanistan, due to not having land use planning, agricultural lands are often been encroached for residential development, pockets of farmland remain between residential communities.

A fundamental part of land use planning is a systematic land evaluation/ assessment process, which has been used widely for determining the suitability of land for various uses. Land use planning proved valuable for developing and developed countries with substantial areas of underexploited land in guiding coordinated efforts to put economic development plans into effect (FAO, 2017). The land use planning is to support decision maker and land users in selecting and putting into practices, those land uses that will best meet the needs of people while safeguarding natural resources and ecosystem services for current and future generating (FAO, 2014).

Merits of the technology

- Land use planning systems also benefit farmers by reducing cost of cultivation.
- By reducing the number of times, the farmer travels over the field, farmers make significant savings in labor.
- Labor inputs for land preparation and weeding are also reduced once the system becomes established.
- Minimizing subdivisions and wasteful use of productive farmland.

Demerits of the technology

- No proper planning inside Afghanistan.
- Low funding availability.

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

Land-use planning should be considered as an integral part of the process of national growth and development. Among other things, this process seeks to identify, articulate and satisfy the basic social/human needs of a country's population within the context of available economic/financial resources and technical knowledge.

Costs

a) Capital costs over 10 years
   - Approx. cost = USD 180000 for the development of land use planning
   - Policy analysis of other development activities US 75000. Total: (USD 2550000)

b) Operational and maintenance costs over 10 years
   Approx cost of policy advocacy and awareness raising; (USD 312500)

c) Other costs over 10 years
   Additional costs will be needed to provide necessary capacity building activities for local farmers. Consulting services could be provided by the existing provincial Agricultural Advisory Centers. There will be need for an additional USD 50000 to organize necessary capacity building activities, including awareness raising activities, publication of different information materials and training activities.

Impact statements (how the options impact countries development priorities)

A. Countries social development priorities
- This will ensure utilization of land resources in an efficient and ethical way.
- Will reduce social and political conflict of establishing control over land resources for commercial purpose.
- Minimized health problems from environmental pollution, resulting from indiscriminate resource use.

B. Countries economic development priorities
- Contributes to diversification of economic activities priority of the country.
- Leads to improvement of economic condition of rural population.
- Leads to increase in agricultural productivity.

C. Countries environmental development priorities
- Support conservation of local level biological resources.
- Stop expansion of shrimp farms in the crop lands which in turn stop intrusion of saline water in the crop land areas.
- Will reduce level of pollution in the environmentally fragile areas and protect both the aquatic and terrestrial biodiversity in different agro-ecological zones.

D. Other considerations and priorities such as market potential
- Land use planning will increase production per unit of land leading to decrease

in the dependence of imported agricultural products at local markets

- There will be a need for wide range capacity building activities to increase knowledge of farmers on applied technology
- Technology application will create demand for specific agricultural machinery

Techno logical Fact Sheets (5)

Sector	Agriculture
Sub – Sector	Crop production
Technology name	Conservative agriculture
Option name	Conservative tillage
Scale	Small – Scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Conservation Agriculture is a set of technologies, including minimum soil disturbance, permanent soil cover, diversified crop rotations, and integrated weed management (Reicosky and Saxton,2007), conservative agriculture improve soil water use efficiency, enhances water infiltration and increases insurance against drought (Colmenero *et al*,2013).

This is a system of land preparation using a ripper where only planting holes/farrows (ripping) are made whilst the land remains unploughed. Conservation tillage refers to a number of strategies and techniques for establishing crops in a previous crop's residues, which are purposely left on the soil surface. Conservation tillage practices typically leave about one-third of crop residue on the soil surface. This slows water movement, which reduces the amount of soil erosion. Conservation tillage is suitable for a range of crops including grains, vegetables, root crops, fruits and wines. Tillage helps to modify soils physical, chemical and biological properties which improves condition for crop growth resulting in higher crop yields (Farooq *et al*,2011). Conservation tillage practices reduce risk from drought by reducing soil erosion, enhancing moisture retention and minimizing soil impaction. In combination, these factors improve resilience to climatic effects of drought and floods. Improved soil nutrient recycling may also help combat crop pests and diseases.

Merits of the technology

- Conservation tillage systems also benefit farmers by reducing fuel consumption and soil compaction.
- By reducing the number of times, the farmer travels over the field, farmers make significant savings in fuel and labor.
- Labor inputs for land preparation and weeding are also reduced once the system becomes established.

- In turn, this can increase time available for additional farm work or off-farm activities for livelihood diversification. Additionally, once the system is established, requirement for herbicides and fertilizers can be reduced.
- This technology embraces soil erosion control.
- Moisture conservation and soil fertility improvement
- Improving crops yield and quality of the produce.

Demerits of the technology

- Conservation tillage may require the application of herbicides in the case of heavy weed infestation, particularly in the transition phase, until the new balance of weed population is established.
- The practice of conservation may also lead to soil compaction over time; however, this can be prevented with chisel plows or subsoilers.
- Initial investment of time and money, along with purchases of equipment and herbicides, will be necessary for establishing the system.
- Higher levels of surface residue may result in increased plant diseases and pest infestations, if not managed properly.
- There is a strong relationship between this technology and appropriate soil characteristics. This is detrimental in high clay content and compact soils.

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

Such technology will be applied at agricultural cultivated lands with low fertility.

Costs

a) Capital costs over 10 years

It is impossible to immediately shift from traditional cultivation methods to conservative tillage, as this process will take decades. Therefore, the process could be launched by pilot initiatives in all agricultural regions in order to initiate application of technology among local farmers. The most important cost for farmers will be machinery and fuel. There will be a need for specific agricultural machinery. Such machineries may be purchased by the government and provided to Agro-leasing Service Centers that currently provide services in all regions of the country. Farmers may use services of the Center or buy the machinery on leasing terms. Approximate costs for such machineries are about USD 140,000-160,000. Considering that pilot initiatives should be launched in all agricultural regions (there are about 50 regions in the country), overall capital costs for 10 years will be USD 8,400,000.

b) Operational and maintenance costs over 10 years

There will be a need for maintenance costs for purchased machinery. It will add 10% per year to the overall price of the machinery.

c) Other costs over 10 years

Additional costs will be needed to provide necessary capacity building activities for local farmers. Consulting services could be provided by the existing Regional Agricultural

Advisory Centers. There will be need for an additional USD 2,200,000 to organize necessary capacity building.

Impact statements (how the options impact countries development priorities)

A. Countries social development priorities

- Conservation tillage reduces fuel consumption and soil compaction reduced since no tractor travels over the field.
- Farmers make savings in labor to create more time for additional farm work or off-farm activities for livelihood diversion.
- Application of Herbicides and fertilizers can be reduced.
- Contributes to food security priority by increasing productivity.
- Leads to increase in income of rural population

B. Countries economic development priorities

- Contributes to diversification of economic activities priority of the country
- Leads to improvement of economic condition of rural population
- Leads to increase in agricultural productivity

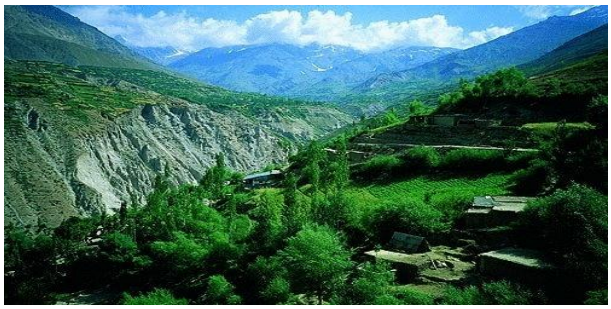
C. Countries environmental development priorities

- Reduces greenhouse emission
- Increases land fertility
- Decrease soil erosion

D. Other considerations and priorities such as market potential

- Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets
- There will be a need for wide range capacity building activities to increase knowledge of farmers on applied technology
- Technology application will create demand for specific agricultural machinery activities, including awareness raising activities, publication of different information materials and training activities.

Technological Fact Sheets (6)



Sector	Agriculture
Sub – Sector	Forestry
Technology name	Agro- forestry
Option name	Cultivated crops under irrigated area
Scale	Medium – Scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Agro-forestry is used in almost the whole world where agriculture is practiced. It is practiced in the agriculture zones which are found in all the provinces. Agroforestry has potential for simultaneously satisfying three important objective: protecting and stabilizing the ecosystem; producing a high level of output of economic goods; and improving income and basic material to rural population (Dhyani *et al*,2009). World Agro forestry Center defines the technology as an integrated approach to the production of trees and of non-tree crops or animals on the same piece of land. The crops can be grown together at the same time, in rotation, or in separate plots when materials from one are used to benefit another.(Anitta and pryia,2012). Reported that agroforestry is a land use option that increase livelihood security and reduce vulnerability to climate and environmental change.

Agro-forestry systems take advantage of trees for many uses: to hold the soil; to increase fertility through nitrogen fixation, or through bringing minerals from deep in the soil and depositing them by leaf-fall; and to provide shade, construction materials, foods and fuel (De Baets *et al*,2007).

Merits of the technology

- Agro-forestry systems make maximum use of the land and increase land-use efficiency;
- The productivity of the land can be enhanced as the trees provide forage, firewood and other organic materials that are recycled and used as natural fertilizers;
- Agro forestry is appropriate for all land types and is especially important for hillside farming where agriculture may lead to rapid loss of soil.
- Agro-forestry promotes year-round and long-term production;
- Employment creation - longer production periods require year-round use of labor;
- Protection and improvement of soils (especially when legumes are included) and water sources;

- Livelihood diversification;
- Provides construction materials and cheaper, more accessible fuel wood;
- Agro-forestry practices can reduce needs for purchased inputs such as fertilizers.

Demerits of the technology

- Agro-forestry systems require substantial management.
- Incorporating trees and crops into one system can create competition for space, light water and nutrients and can impede the mechanization of agricultural production.
- Management is necessary to reduce the competition for resources and maximize the ecological and productive benefits.
- Yields of cultivated crops can also be smaller than in alternative production systems, however, agro-forestry can reduce the risk of harvest failure.

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

This technology will be applied at agricultural cultivated lands with high risk of erosion.

Costs

a) Capital costs over 10 years
   - The cost of 1 hectare of agro forestry is approximately USD 500. This will require a huge amount of investment. The process is long-term and should be applied step-by-step. The source of investment could be government budget, financial institutions and international financial organizations.

b) Operational and maintenance costs over 10 years
   - Operational and maintenance costs for technology will be approximately USD 300 per hectare per year.

c) Other costs over 10 years
   - No incremental costs required to adapt because this technology was adapted itself.

Impact statements (how the options impact countries development priorities)

A) Countries social development priorities

- It increases the income earned and inputs saved through improvements in the farm resource base and products for sale.
- Through increased yields, it provides significant savings for households on fire wood, forage and fertilizer purchase.
- Agro forestry practices would improve local knowledge about the technology and increased income would increase school attendance.
- It can improve medicinal plant conservation, domestication, and propagation, provides nutritious agro forestry foods, including fruits and leaves, promotes changes in ecosystem structure and function that affect disease risk and transmission.

B) Countries economic development priorities

- Creation of jobs in seedling preparation, land preparation, plantation, maintenance and harvesting.

- Can create investment in forestry production inputs, equipment's and production transformation industry.
- Can reduce public expenditure on subsidized fertilizers and irrigation systems.

C) Countries environmental development priorities

- Increasing water infiltration and slowing runoff flow, stabilizing and protecting stream banks from erosion, filtering pollutants from runoff water, shading streams for controlling.
- Ensuring sustainable use of land and environmental protection.

D) Other considerations and priorities such as market potential

- Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets.
- Fruit production will be increased as well creating additional income source for local farmers.
- The technology has a national wide potential.

B. Technology Fact Sheets for Water Sector

Technological Fact Sheets (1)

Sector	Water
Sub – Sector	Water management
Technology name	Integrated Water Resource Management (IWRM)
Scale	Small/Medium– Scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Water is a key driver of economic and social development while it also has a basic function in maintaining the integrity of the natural environment (Amarasinghe *et al*,2004). Thus, the water crisis in many countries like Afghanistan is not only caused due to shortage of water resources but also due to mismanagement. Water resources managers, whether in the government or private sectors, have to make difficult decisions on water allocation. More and more they have to apportion diminishing supplies between ever-increasing demands. Drivers such as demographic and climatic changes further increase the stress on water resources. The traditional fragmented approach is no longer viable and a more holistic approach to water management is essential (Molden *et al*,2001). This is the rationale for the Integrated Water Resources Management (IWRM) approach that has now been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands (Mitchell ,2005).

Merits of the technology

- Increase water resource efficiency
- Decrease climate changing risk

Demerits of the technology

- Long process that takes time to feel impact
- Lack of internationally-agreed on performance indicators

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

Such technology will be applied at agricultural lands with irrigation water scarcity, as well as areas with potential risks of droughts and high temperatures.

Costs

a) Capital costs over 10 years

IWRM's capital & operational cost is the same cost of managing and maintaining the water resources but at a reduced cost (savings) due to sound management. The cost may include Opinions of Probable Construction Cost (OPCC) for major capital projects included in the Integrated Plan.

b) Operational and maintenance costs over 10 years

c) Other costs over 10 years

Additional costs will be needed to provide necessary capacity building activities for local farmer's activities.

Impact statements (how the options impact countries development priorities)

A. Countries social development priorities

- Contributes to food security priority by increasing productivity
- IWRM will increase income for water sector, for example water tariff collection
- Reduces migration to urban areas from rural communities
- Afghanistan is in a good and relatively advanced status with regard to Human and Informational Requirements/Institutional and Organizational requirements for IWRM
- IWRM will reduce public and private expenditure on water and will increase water tariff collection.

B. Countries economic development priorities

- IWRM has a big economic return due to effects of sound water policies on the economy.
- Economics applied to IWRM:
  - Helps to assess the economic implications of different water policies (at different levels)
  - Supports the selection of policy targets
  - Assists in the choice of the optimal water resources management strategy
  - Supports the achievement of policy objectives by providing implementation tools & instruments
- It provides indirect opportunity for Small and Medium Enterprises (SMEs) to supply auxiliary services to areas under improvements in the water sector
- IWRM provide employment for additional staff to augment the human and institutional readiness.

C. Countries environmental development priorities

- Will strengthen capacities of water entities to develop the needed mechanisms and strategies on adaptation of the water sector and management of potential risks in the context of IWRM. This may include training in new approaches, systems, and tools to enable appropriate planning and implementation of climate change adaptation.
- IWRM is the foundation upon which the implementation of adaptation strategies, based on a sequence of climate change projections, and impact assessments can be realized.

- It is important to consider appropriate adaptation measures to ensure sustainable water security for social, economic and environmental needs.
- There is a high need for inclusion of potential climate change impacts and associated uncertainties in the national water planning and management plans as well as strategies and polices. This is highly needed so that climate change may become part of the national policies and decision-making routine to foster a acclimate-resilient IWRM.

D. Other considerations and priorities such as market potential

- It does not have solid local market potential but has much high potential in some western countries

Technological Fact Sheets (2)

Sector	Water
Sub – Sector	Water for agriculture
Technology name	Small dams and micro catchment
Scale	Small/Medium-scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

As indicated in the Strategy for Agriculture and Water, the lack of technical capacity is one of the critical issues at the provincial level department of Agriculture and Water Resources. Water resources will steadily decline because of population growth and expected climate change due to the problem of global warming. The new techniques which dealing with water problem s are highly needed. Micro catchment is one of the direct water harvesting system where small structures are constructed across land slops, which capture surface runoff and stores in plant zones for subsequent use (Ali *et al,* 2017). Micro catchment water harvesting can be used to capture rainwater to improve soil moisture and vegetation, increase crop productivity and diversity, decrease soil erosion and rehabilitate degraded lands (Ali and Yazar,2007). In many tropical, subtropical and Mediterranean climate, dry season agricultural and the pre rainy season establishment of food and cash crops cannot be under taken without large quantities of water. To rely upon stream flow at a time when temperatures and evaporation are often at a peak can be unrealistic and risky. It may become essential for a dame to be constructed on a river or stream to allow for off season storage of vital water supplies (Stephens, 2010).

Merits of the technology

Technology can help to store and use water during low water periods and, therefore, increase water use efficiently as the system collects water from the nearby area and keeps it from flowing into rivers or other areas or from evaporating.

Demerits of the technology

There are a number of socio-political barriers that often limit successful implementation of water reclamation and reuse programs. In many cases, public opposition to the use of reclaimed water for any application to which humans might be exposed (especially for potable reuse) can hinder progress.

Lack of communication and collaboration between stakeholders is also another significant socio-political barrier to water reclamation and reuse programs. The first step in the design and implementation of water reclamation and reuse initiatives should be to identify these institutional gaps and to forge the necessary links among agencies.

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

The province program of dams and water basins building across territory of Afghanistan should be developed. Among a number of other predictions made by the Intergovernmental Panel on Climate Change, it is anticipated that climate change will lead to increased periods of drought, reduced freshwater storage, and sea level rise. Such changes can have drastic impacts on both the quantity and quality of the world's water resources.

Costs

a) Capital costs over 10 years
   The financial requirements for implementing water reclamation and reuse programs will vary significantly based on the type of application that is planned for the reclaimed water. The approximate costs for application of pilot project will be around USD 60,000-80,000.

b) Operational and maintenance costs over 10 years
   Operational and maintenance costs will be around USD 10,000-15,000 per year.

c) Other costs over 10 years
   Additional costs (around USD 50,000 over 10 years) will be needed to provide necessary capacity building activities.

Impact statements (how the options impact countries development priorities)

A. Countries social development priorities

- Reliable water supply
- Reduction of water dependency risks
- Improved water safety
- Increased community welfare

B. Countries economic development priorities

- High value agricultural development
- Impacts on water supply
- Increased water security
- Support to development stability

C. Countries environmental development priorities

- Increase water use for agricultural sector
- Wetlands rehabilitation
- Creation of the nature restoration zones.

D. Other considerations and priorities such as market potential

- Saved water can be used in different areas of economy.

Technological Fact Sheets (3)

Sector	Water
Sub – Sector	Water supply
Technology name	Rainwater Collection
Option name	Rainwater Collection from Ground Surface
Scale	Medium-scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Rapid population growth, combined with urbanization, industrialization, and agricultural intensification and water intensive life styles is resulting in a global water crisis. Water security is becoming a major national and regional priority in many areas of the world (Bangre *et a*l, 2016). Small-scale collection infrastructure can contribute greatly to the volume of freshwater available for human use. This is especially an issue in arid and semi-arid regions, where the minimal rainfalls are usually very intense and often seasonal.

Sustainable and integrated small reservoirs and micro catchments management in order to ensure neutrality of degradation of natural resources, build the resilience of communities, institutions and ecosystems to prepare for, adapt to and mitigate the impacts of climate change (Ali *et al*,2017).

Merits of the technology

- Storage of water for further use
- Ground water recharging
- Increase water use efficiency
- Avoiding from evaporation
- Decreasing high temperature adverse effects

Demerits of the technology

- Initial cost of the system is higher
- Cost of establishment of infrastructure is higher
- Rainfall can affect the entire system

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

Rainwater collection can also contribute greatly to the stabilization of declining groundwater tables. Additionally, widespread rainwater storage capacity can greatly reduce land erosion

and flood inflow to major rivers.

This technology covers collection, storage and use of rainwater that lands on the ground, utilizing "micro-catchments" to divert or slow run- off so that it can be stored before it evaporates or enters. This technique often includes an earthen or other structure to dam the watercourse and form "small reservoirs" collection and storage infrastructure can be natural or constructed and can take many forms small reservoirs with earthen bunds or embankments to contain run-off or river flow.

Costs

a) Capital costs over 10 years

Implementation of medium scale rainwater harvesting programs should include a survey of current reservoir capacity and location. It is difficult to find specific data on the construction and implementation costs of rainwater collection projects.

Many factors, including the scale of the project, location, etc. Will strongly affect costs. The program cost for implementation in one community (50 ha or greater) may be around USD 10,000.

b) Operational and maintenance costs over 10 years

There might be a need for operational and maintenance costs of about USD10,000-11,000 per year.

c) Other costs over 10 years

Additional costs will be needed to provide necessary capacity building activities for local residents, which will cost approximately USD 9,000 per year per project.

Impact statements (how the options impact countries development priorities)

A. Countries social development priorities

- Reliable water supply
- Reduction of water dependency risks
- Improved water safety
- Increased community welfare
- Create job opportunity

B. Countries economic development priorities

- High value agricultural development
- Impact on water supply
- Increase water security
- Support to development stability

C. Countries environmental development priorities

- Increase water use for agricultural sector
- Wetlands rehabilitation
- Creation of the nature restoration zones

D. Other considerations and priorities such as market potential

- This technology well implemented in every level of the stockholders. The collected water can be used in different areas of economy such as agriculture sector, industrial sector and so on.

Technological Fact Sheets (4)

Sector	Water
Sub – Sector	Food crop sector
Technology name	Micro irrigation system for efficient water use and management
Scale	Small/Medium scale
Availability	Available
Technology to be included in Prioritization	Yes

Background/ notes

Small scale micro irrigation for lifting, conveying and applying irrigation efficiently include gravity fed drip and pressurized sprinkler irrigation used to improve water use efficiency and food production (Suryawanshi,2000). They may be gravity fed or pressurized system. Water source can be from borehole, reservoirs, field pond or potable source. This system deliver water into the soil surface very near the plant or below the soil surface directly into the plant root zone. Producer, growers and landscapers have adopted micro irrigation systems to suit their needs for precision water application.

Merits of the technology

- Reduce deep percolation
- Reduce non-beneficial evaporation from the area not covered by canopy.
- Improves distribution efficiency slightly and improved production on marginal land.
- Weed and disease reduction

Demerits of the technology

- It can be difficult to combine micro irrigation with mechanized production as tractors and another farm machinery.
- Root development may be restricted by the limited soil area wetted.
- Regular maintenance inspections are needed to maintain system effectiveness.
- Limited regulations for the distribution and allocation of water as a mechanism for conflict resolution.
- Irrigation equipment may be stolen from fields.

Implementation Assumptions (how the technology will be implemented and diffused across the subsector)

MAIL, MEW and NEPA will be responsible for overall implementation of the project, the fact that the project would involve a few departments including community development council (CDC).

Costs

a) Capital costs over 10 years
   Estimated cost of implementing the micro-irrigation technology per beneficiary USD 350.

b) Operational and maintenance costs over 10 years
   Operational and maintenance costs will be around USD 40 -50 per year.

c) Other costs over 10 years
   Additional costs will be needed to provide necessary capacity building activities for local farmers to adopt the technology in their field.

Impact statements (how the options impact countries development priorities)

A. Countries social development priorities

- Increase crop yield and quality increase crop intensity, thus improving farm income.
- Education reduces family labor thus leaving more time for other activities: education and health
- Micro irrigation reduces disease pressure as foliage are kept dry.
- It presents no health risk. Micro irrigation allows application of low volume of water to plant roots and hence optimal growth conditions

B. Countries economic development priorities

- Employment opportunities for technical experts and community support workers;
- May spur investment in ground water assessment and protection services; and
- Generate investment in enterprises such as small-scale hydropower, domestic water supply, food production etc.

C. Countries environmental development priorities

- It helps to optimize use of water resources/can be employed in conjunction with other adaptation measures such as integrated nutrient management.

D. Other considerations and priorities such as market potential

- With water becoming scarce, farmers are concern with the need to optimize use of water. Benefits of micro-irrigation have been demonstrated to growers for production of high value crops. Suppliers of equipment are available locally. With water becoming scarce, there is need to scale up this technology in the north, west, south and east of the island to optimize of water use, irrigate more land area and increase productivity by at least 20- 30 %.

APPENDIX III

A: Criteria and measurement scales used in MCA process during technology prioritization

Criteria	Weight (%)	Indicators	Measurements scale
Cost	20	Cost of setup and maintenance	Likert scale 0 (high cost of setup and maintenance) - 100 (low cost of setup and maintenance)"
Economic benefit	25	Improve economic performan Create job	Likert scale: 0 (lowest improve/creation) – 100 (highest improve/creation)
Social benefit	15	Reduce poverty and inequality Improve health	Likert scale: 0 (lowest benefit) - 100 (highest benefit)
Environmental benefit	15	Protect biodiversity Environment and resources	Likert scale: 0 (lowest benefit) - 100 (highest benefit)
Climate related Benefit	25	Potential to reduce vulnerability and build climate resilience	Likert scale: 0 (lowest resilience) – 100 (highest resilience)

B: Performance matrix

Performance Matrix			
criteria	Preferred value	Weighted value	
		Absolute value	Relative value
Cost	Low	20	0.2
Economic benefits	High	25	0.25
Social benefits	High	15	0.15
Environmental benefits	High	15	0.15
Potential of reduction vulnerability	High	25	0.25
Total value	100		1

C. Scoring Matrix of MCA for Water Sector of Afghanistan

technology options	Scoring matrix (for each criteria score should very from 0 to 100)				
	Criteria				
	Cost	Economic benefits	Social benefits	Environmental benefits	Potential of reducing vulnerability
Sprinkler irrigation system	25	70	56	60	80
Drip irrigation system	30	60	55	62	78

Early warning system for water supply management through snowpack monitoring	20	90	82	70	72
Ground water mapping and modeling	25	80	77	65	68
IWRM	77.8	88.9	66.7	100	100
Micro irrigation for efficient water use and management	50	100	66.7	67	100
Small dames and micro catchment	77.8	88.9	100	42.9	100
Rain water collection from ground surface	55.6	66.7	100	100	95
Water saving(Reducing water leakage in water management facilities)	40	60	70	75	72
Water use association	100	40	50	0	80
Wells for domestic water supply	45	62	70	62	75
Water legislation improvement	100	50	65	70	50
Scoring scale	0= for very high cost ;100 for low cost	0= for low benefits;100 = for high benefit	0= for low benefits;100 = for high benefit	0= for low benefits;100= for high benefit	0= for low benefits;100= for high benefit

D. Scoring matrix of MCA for agriculture sector

3212Technology options	Scoring matrix (for each criteria score should very from 0 to 100)				
	Criteria				
	Cost	Economic Benefits	Social Benefits	Environmental Benefits	Potential of Reducing Vulnerability
Crop growing under plastic mulches	30	28	60	43	25
Conservative agriculture	80	75	50	50	20
Crop diversification and new varieties	50	75	100	84.6	81.8
Ecological pest management	28	30	40	42	26
Green house	10	50	40	32	30

crops(Cucumber, Tomato, Capsicum)					
Responsive agricultural extension	40	95	87.5	40	63.6
Windbreaks	35	28	60	40	25
Agro-forestry	40	30	62.5	40	30
Introduction of plant varieties resistant to climate change	0	100	50	46.2	100
Land use planning	85	30	25	100	45.5
Pasture improvement	50	22	40	35	25
Seed and grain storage	10	40	35	15	20
Scoring scale	0= for very high cost ;100 for low cost	0= for low benefits;100= for high benefit	0= for low benefits;100= for high benefit	0= for low benefits;100= for high benefit	0= for low benefits;100= for high benefit

Appendix: IV

A: Ongoing and completed national programmes and projects on climate change

Ongoing and Completed National Programmes and Projects on Climate Change		
Project Name	Executing Agency	Brief Description
National Adaptation Programme of Action for Climate Change and National Capacity Needs Self-assessment for Global Environmental Management	NEPA (with support from UN Environment)	Afghanistan completed its NAPA/NCSA in 2009 in order to identify the country's priority capacity needs for the implementation of the Rio Conventions (UNFCCC, UNCBD and UNCCD) and the key activities to mitigate the negative impacts of climate change in the country. As the first comprehensive report on climate change in Afghanistan, the information in the NAPA/NCSA has thus informed further climate change programming in the country and facilitated Afghanistan's access to global climate financial resources, particularly from the GEF.
Preparation of Afghanistan's Initial National Communication under the UNFCCC	NEPA (with support from UN Environment)	All countries signatory to the UNFCCC are required to submit periodic National Communications that summarize their implementation of the convention. In 2012, NEPA published Afghanistan's INC as the country's first official communication to the UNFCCC, which became the country's foremost official document on climate change.
Building Adaptive Capacity and Resilience to Climate Change in Afghanistan	NEPA (with support from UN Environment)	This four-year project, launched in May 2013, is the first full-sized GEF climate change adaptation project granted to Afghanistan. This project's four objectives are to: i) strengthen Government capacity on climate change monitoring and forecasting; ii) mainstream climate change adaptation into policies and planning; iii) promote ecosystem management for climate change adaptation; and iv) increase knowledge and awareness of climate adaptation and best practices at the national, provincial, and community levels.
Developing Core Capacity for Decentralized MEA Implementation and Natural Resource Management in Afghanistan	NEPA (with support from UN Environment)	This three-year GEF project, launched in late 2014, aims to strengthen Afghanistan's fulfillment of its obligations under the UNFCCC, UNCDB, and UNCCD. This project's objectives are to: i) improve inter-ministerial coordination of climate change, biodiversity, and land degradation objectives; ii) build stakeholder participation in MEA implementation; iii) support the translation of MEA commitments into practice; and iv) strengthen national financial and execution mechanisms for the UNFCCC, UNCDB, and UNCCD.

Second National Communication under the UNFCCC	NEPA (with support from UN Environment)	In 2014, NEPA and UN Environment launched a new project for the preparation of the SNC, which builds upon the outcomes and successes of the INC. The SNC aims to strengthen the information base and technical capacity in Afghanistan, integrate climate change priorities into development strategies, and increase the awareness of climate change, as well as increase information exchange and cooperation between all stakeholders across government, civil society, non-governmental organizations, academia and the private sector.
Action on Climate Today (ACT)	Oxford Policy Management	ACT is a five-year project, launched in 2014, working across Afghanistan, India, Nepal and Pakistan in order to support the integration of climate change into national policies, plan and budgets. Specific areas of work include: i) support the design and delivery of climate resilience; ii) promote investments for climate compatible development; iii) build the knowledge base of decision makers; and iv) attract further climate change investment from the public and private sector.
Strengthening the Resilience of Rural Livelihood Options for Afghan Communities to Manage Climate Change Induced Disaster Risks	MAIL (with support from UNDP)	This five-year project was launched in January 2015 and is Afghanistan's second full-sized GEF climate change adaptation project, which aims to reduce livelihood vulnerability in drought- and flood- prone communities through the rehabilitation and sustainable management of critical rangelands and watersheds, while enhancing and diversifying rural incomes and livelihood opportunities.
Climate Technology Centre and Network	NEPA (with support from UN Environment)	Afghanistan's first CTCN Technical Assistance began in early 2015, at the request of NEPA, and focuses on capacity building and identifying technical needs and priorities in the three key sectors of agriculture, energy, and water. The CTCN is a global initiative hosted by UN Environment that aims to enhance the development and transfer of climate smart technologies in order to promote adaptive capacity and climate change mitigation efforts in developing countries.
Strengthening the Resilience of Afghanistan's Vulnerable Communities Against Natural Disasters and Climate Change	Afghanistan Resilience Consortium (ARC)	This five-year project, launched in early 2015, aims to address the root causes of vulnerability to natural disasters and climate change through a combination of institutional strengthening, sectoral coordination, and community-based resilience-building activities. This project is accredited by the UK's International Climate Fund (ICF), and includes components on climate early warning, climate-smart agriculture, and integrated watershed management across of Afghanistan's most disaster-prone provinces.

Building the Resilience of Communities Living Around the Northern Pistachio Belt and Eastern Forest Complex of Afghanistan through and EbA Approach	NEPA (with support from UN Environment)	This is Afghanistan's third full-sized GEF climate change adaptation project, granted in late 2015, with the aims of: i) strengthening the capacity of national and local Government and other stakeholders to address climate change risks by improving water- shed functioning; ii) improving community-based watershed management through the restoration of degraded forest ecosystems; and iii) increasing knowledge of the role of ecosystem-based adaptation in improving watershed functioning and building climate resilience.
Community-based Sustainable Land and Forest Management in Afghanistan	MAIL (with support from FAO)	This three-year GEF project with the overall objective of reducing GHG emissions by promoting community forestry, and removing barriers to sustainable bio- mass energy, while laying the groundwork for climate change mitigation in Afghanistan. In particular, this project will focus on training, awareness raising, capacity building, and piloting of community-based natural resource management projects related to forestry and renewable energies.
Adapting Afghan Communities to Climate-Induced Disaster Risks	MAIL (with support from UNDP)	This is Afghanistan's fourth full-sized GEF climate change adaptation project, which began in 2017. The project will promote adaptation to the impacts of climate change by building capacities for decision-making and implementation of climate-induced disaster risk reduction measures, establishing community-based early warning systems, promoting climate-resilient livelihood options (with a focus on marginalized groups), and enhancing capacities of government institutions to integrate climate change into development planning.

Source: (SNC, final report,2017)

B: Ongoing and completed programmes and projects supportive to climate change

Ongoing and Completed Programmes and Projects Supportive to Climate Change		
Agro-Meteorology (Agromet) Project	MAIL & USGS	The Agromet project was established as a collabo- ration between MAIL and the USGS to generate and disseminate climatic data relevant to agricultural production. Agromet's objectives include assisting the government in the collection and analysis of meteorological and agricultural data relevant to crop production, irrigation, water supply, and energy, as well as building national capacity on agro- and hydro-meteorology, statistical monitoring and assessment of droughts and floods, and the dissemination of meteorological data for the agriculture sector. As of June 2014, USGS ended its involvement in the Agromet Project, and it has since been integrated fully into MAIL.

Famine Early Warning System Network (FEWS NET)	MAIL	FEWS NET is a project that aims to deliver early warnings of hazards, food insecurity and famine. FEWS NET is embedded within MAIL in order to generate, analyses, and share critical data to monitor rising or waning food insecurity situations, including harvests, food prices, market factors, population movements, and climate and weather data in order to help decision-makers deploy resources in advance of famine.
National Area-Based Development Programme (NABDP)	MRRD	NABDP was established in 2002 with the goal of contributing to a sustainable reduction of poverty and an improvement of livelihoods in rural Afghanistan. NABDP is based on the Social and Economic Development pillar of the ANDS and is aligned with the NPPs in the ARD cluster. In terms of rural development, NABDP's scope covers a number of community-based activities: the construction of roads and bridges; provision of rural electricity systems; construction of culverts; retaining walls and gabions in flood-prone areas; provision of clean drinking water facilities; construction of agriculture and irrigation infrastructure; construction of community and government buildings; economic empowerment and cottage industry initiatives for rural women; and the provision of temporary labour for rural income generation.
Rural Water Supply, Sanitation and Irrigation Programme (Ru-WatSIP)	MRRD	Ru-WatSIP was established in 2003 in order to develop policies, formulate strategies and plans, and implement activities for rural water supply, sanitation, and hygiene. Major activities of this project include the establishment of a national policy framework for water sector, construction of water wells and pumps to provide clean drinking water to rural communities, construction of sanitation facilities to improve hygiene in rural communities, and provision of capacity building trainings on water, sanitation and hygiene to government staff, NGOs, private sector companies, and local communities.
Review and Update of Afghanistan national Biodiversity strategy and Action	NEPA (with support from UN Environment)	In 2014, Afghanistan began the process of updating its NBSAP in order to assess progress made towards the achievement of national biodiversity targets as well as provider greater assessment of the drivers of biodiversity loss in the country as well as the recommended steps to be taken for the greater protection of the country's natural heritage.
Comprehensive Agriculture and Rural Development-Facility (CARD-F)	MAIL, MRRD, MCN & MoF	CARD-F is a joint entity established in 2009 under the ARD cluster ministries in order to facilitate growth in legal rural income and employment by strengthening licit agricultural markets and minimizing adverse incentives to revert to opium production by supporting commercially viable agricultural value chains (poultry, dairy, cotton, honey, grapes and vegetable) as well as improvements in rural infrastructure (irrigation, rural access roads, and food storage facilities).

Ecosystem-based Disaster Risk Reduction (Eco-DRR)	NEPA & UN Environment	This four-year project, launched in 2012, aimed to promote ecosystem management for disaster risk reduction in order to achieve sustainable and disaster resilience development. This included the mainstreaming of ecosystem-based adaptation approaches into disaster and resilience planning, and working directly with local communities in the Shah Foladi Protected Area on community-based natural resource management pilot demonstrations, including landscape-level planning, community nursery establishment, and forestry initiatives for landslides and avalanche risks, and integrated watershed management.
Afghanistan's National Biodiversity Strategy and Action Plan (NBSAP)	NEPA (with support from UN Environment)	NEPA developed Afghanistan's NBSAP was in 2013, with the goal of conserving all aspects of the country's biodiversity and ensure that future utilization of biodiversity resources is sustainable. The NBSAP also identifies short-, medium-, and long-term actions that need to be taken, institutional responsibilities, and financial needs for the identified actions and implementation of the UNCBD. The NBSAP identifies climate change as a serious risk to biological diversity in Afghanistan, particularly as a result of drought and desertification, but also notes "climate change has not been a consideration in the national or sectoral plans of the Government."

Source: (SNC, final report, 2017)