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TECHNOLOGY NEEDS ASSESSMENT

VOLUME 1 – Climate Change Adaptation in Mongolia

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Coordinated by Climate Change Coordination Office of the Ministry of Environment and Green Development, Mongolia

MONGOLIA, 2013

"This document is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP-Risoe Centre (URC) in collaboration with the Regional Centre Asian Institute of Technology, Bangkok for the benefit of the participating countries. The present report is the output of a fully country-led process and the views and information contained herein are a product of the National TNA team, led by the Ministry of Environment and Green Development of Mongolia.

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FOREWORD

Climate change is an inevitable fact in today's industrial world having serious impacts on countries around the world, particularly developing nations. It increases social, environmental, health and economic risks, to which developing countries are exposed and vulnerable to.

Mongolia is no exception. It is experiencing the impacts of climate change as much as other nations, if not more so. In Mongolia, the annual mean temperature has increased by 2.14°C between 1940 and 2008. This is considerably higher than global averages. Its vulnerability is due in part, to its heavy reliance on its agricultural (arable farming and livestock) sector. One third of the population is employed in this sector and are exposed to the risks of climate induced events and poverty. This reinforces the environmental, economic and social consequences of climate change on the general population. Furthermore, the Mongolian energy sector is very carbon intensive which has caused serious air pollution in urban centers.

As a result, the Mongolian Government is placing greater emphasis on climate resilient, environmentally friendly, green development. Within the new Government, established in August 2012, the former Ministry of Nature, Environment and Tourism has been restructured as the Ministry of Environment and Green Development with the status of a core Ministry.

After a difficult period of transition to a free market economy with limited financial resources, Mongolia is moving forward setting its goal on sustainable economic growth with strong emphasis on environmental protection. With expected rapid economic growth in Mongolia for the coming years, and with the need to achieve sustainable development, Mongolia is aiming for a Green future that is environmentally friendly and resilient to climate change. It hopes to do so through cooperation with and support from developed economies and the introduction of advanced technologies and know how.

The Ministry of Environment and Green Development of Mongolia through the Climate change coordination office, has assessed and prioritized the technologies that needs to be introduced most urgently both for mitigation and adaptation. The "Technology Needs Assessments and Technology Action Plans Report for Climate Change Mitigation/Adaptation in Mongolia" is the first comprehensive report providing information on the required technologies to adapt to the changing climate, and mitigate

GHG emissions along with the action plan to introduce those technologies. We believe that this report will provide valuable guidance for policy makers, budget planners, investors, technology developers, scientists, intelligence and donor communities in Mongolia for making investment decisions and formulating policies and programs for the aim of green development that are resilient to the changing climate and reducing GHG emissions.

In conclusion, I would like to note that this report was prepared by a team of national experts with advice and assistance from international experts, along with the guidance of a Steering Committee led by the Ministry of Environment and Green Development (former Ministry of Nature, Environment and Tourism) and benefited from consultation with a broader set of stakeholders in the TNA process throughout its preparation. I wish to congratulate all the people who involved for their hard work and contribution.

OYUN Sanjaasuren, Ph.D
Member of the State Great Khural (Parliament) and
Minister for the Environment and Green Development of Mongolia

PREFACE

The report on Technology Needs Assessment for Climate Change Adaptation in Mongolia is the main output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP-Risoe Centre (URC) in collaboration with the Regional Centre Asian Institute of Technology. It has 4 sections as below:

1. Section 1: Technology Needs Assessment Report describes key adaptation technologies in priority sectors for Mongolia such as a system of wheat intensification; vegetable production system with drip irrigation and mulches, potato seed production system; seasonal prediction and livestock early warning system; high quality livestock through breeding and animal disease management; sustainable pasture management.

2. Section 2: Barrier Analysis and Enabling Framework Report accesses the barriers and measures identified for all six technologies in two sectors that have been selected.

3. Section 3: Technology Action Plan (TAP) Report describes Action Plans for each technology. During the preparation of TAP, measures have been assessed taking into account their priorities, time scale, related stakeholders, key indicators of outputs, implementation and funding resources.

4. Section 4: Project Idea Report provides project ideas for each technology including concrete actions for realization of the Technology Action Plans for each selected technologies.

The present report is the result of a fully country-driven process and the views and information contained herein are the product of the National TNA team, led by the Ministry of Environment and Green Development (MEGD) of Mongolia.

We extend our appreciation to the adaptation team, the leading authors of this report, Dr. Gomboluudev Purevjav (team leader), Mrs.Bolortsetseg Bold, Dr.Natsagdorj Luvsan, Mrs.Erdenetsetseg Baasandai, Dr.Davaa Gombo, Dr.Davaadorj Gochoo, Dr.Binye Bataa and Dr.Togtokhbayar Norovsambuu, all of whom made valuable contribution to the chapters on specific issue areas. Also we would like to thank Ms.Tsendsuren Batsuuri, head of CDM National Bureau, Climate change coordination office, MEGD, for all her coordination efforts. Without the generous time and efforts of all authors and contributors, the report could not have been produced.

This report has benefited from discussions with an expert team, stakeholders, and officials from the Mongolian government. So we extend our appreciation to all stakeholders for their constant support and valuable comments throughout the development of this report. We would also like to thank Ms.Catherine Tulloh for her assistance on improving the language of the report and Ms.Gereltuya Puntsagdash, Dr.Gerelmaa Shaariibuu and Ms.Undarmaa Khurelbaatar, officer of CDM National Bureau, Climate change coordination office, MEGD who assisted in consolidating all the reports into a single report. Our sincere gratitude is extended to the GEF and UNEP for the financial and technical support as well as UNEP-Risoe Centre (URC) and Asian Institute of Technology (AIT), specifically to Mrs.Xianli Zhu from URC and Dr.Prabhat Kumar from AIT for their constant support, guidance and comments for all the reports without which the development of these reports would not have been possible.

D. Dagvadorj

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ABBREVIATIONS

AIACC	Assessment of Impact and Adaptation for Climate Change
CCCO	Climate Change Coordination Office, Mongolia
DSSAT	The decision support system for agrotechnology transfer
EU	European Union
HadCM3	Model developed by Hadley Center, UK
HQL	Technology –High quality livestock
GDP	Gross Domestic Product
GEF	Global Environmental Facilities
GHG	Greenhouse gases
GIS	Geo-Information System
IMH	Institute of Meteorology and Hydrology, Mongolia
MARCC	Mongolia: Assessment Report on Climate Change
MCA	Millennium Challenge Account, Mongolia
MCDA	Multi criteria decision analysis
MDG based CNDS	Millennium Development Goals- based Comprehensive National Development Strategy
MEGD	Ministry of Environment and Green Development, Mongolia
MIA	Ministry of Industry and Agriculture, Mongolia
NAMHEM	National Agency of Meteorology, Hydrology and Environment Monitoring
NAPCC	National Action Plan for Climate Change of Mongolia
NCC	National Climate Committee of Mongolia
NCCSAP/NCAP	Netherland Climate Assistant Program
NEMA	National Emergency Management Agency
NGO	Non government organization
PSPS	Technology – Potato seed production system
R&D	Research and Development
SNC	Second National Communication of Mongolia
SPLEWS	Technology –Seasonal prediction and livestock early warning system
SPM	Technology –Sustainable Pasture Management
SRES A2	Special Reports on Emission Scenarios, IPCC
SWI	Technology: System of wheat intensification
TAP	Technology Action Plan
TFS	Technology fact sheet
TNA	Technology Needs Assessment
UNEP	United Nations Environmental Program
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States` Dollar
VPS	Technology- Vegetable production system
WB	World Bank

SECTION I

Sector and Technology Selection

EXECUTIVE SUMMARY

The Technology Needs Assessment (TNAs) for climate change adaptation in Mongolia has been a set of activities to identify and determine the adaptation technology priorities of the country. TNAs are central to the work of the Parties to the Convention (art. 4.5 UNFCCC). The TNA will lead to the development of a national Technology Action Plan (TAP) that prioritizes technologies, recommends an enabling framework for the diffusion of these technologies, and facilitates identification of suitable technology transfer projects and their links to relevant financing sources.

The Mongolia TNA project has been led by the National Climate Change Coordination Office, Ministry Environment and Green Development (MEGD) and has covered two areas: mitigation and adaptation. The technology needs assessment on adaptation is being completed for the first time in Mongolia. However, Mongolia conducted vulnerability assessments and identified priority adaptation sectors and activities in the Second National Communication (SNC) and National Action Program for Climate Change (NAPCC) in 2010. The TNA for adaptation is an opportunity to determine the highest priority sectors and technologies for adaptation.

Mongolia is a developing country with a small population and vast territory where traditional nomadic livelihoods coexist with modern urban lifestyles. In recent years, climate change related challenges have become a major risk for the country's development. Ecosystems within the country are fragile to climate changes and livelihoods of people are directly impacted by weather and the environment. This assessment has demonstrated that climate change will affect the well-being of people and the country's socio and economic development.

The Parliament and the Government of Mongolia passed several important policies and drafted key strategic documents for long term sustainable development. There are 177 national programs and projects with 60 of them being implemented in the area of socio economic development (Norovdondog Ts, 2011). The main policies and strategies of development have clearly stated the importance of adaptation of major sectors such as agriculture, animal husbandry and water to climate change and include objectives to cope with climate change related risks.

The following major steps have been followed in the assessment:

- ✓ Established an organizational structure and facilitated stakeholders engagements
- ✓ Defined implications of climate change for the country's development priorities and strategies
- ✓ Prioritized sectors and subsectors
- ✓ Identified technologies as high priorities for climate change adaptation

The TNA process was participatory which ensured the involvement of cross sectoral experts and stakeholders in sector and technology prioritization. Consequently stakeholder engagement was one of the key aspects of the project. Different entities including ministries, research and educational institutions, international and national NGOs, private enterprises, and representatives of farmers and herders were involved in the process in different ways.

Based on the research and Multi Criteria Decisions Analysis (MCDA), arable farming and animal husbandry sub sectors were identified as the sectors most vulnerable to climate change and their social, economic and environmental losses due to climate change impacts are expected to be higher than those of other sectors. The agriculture sector is a major economic sector in Mongolia with the livelihoods of the majority of people heavily dependent on its production. Many of the Government's development policies focus on sustainable development of this sector.

Water is a cross cutting issue which is related to other sectors and sub sectors including arable farming and animal husbandry. Consequently, the water sector was not prioritized, however water saving technology options have been included within the arable farming and livestock subsectors.

Climate change impacts on prioritized sub sectors and the current status of technology applications have been defined based on research into existing studies and documents. 17 potential adaptation technologies with detailed information (Technology Fact Sheet) have been developed and discussed through an intensive stakeholder engagement process. Prioritization of adaptation technologies was completed and the following six technologies which contribute to reduced agriculture sector vulnerabilities, have been prioritized:

Arable farming:

- System of wheat intensification (SWI): System of wheat intensification that integrates the conservation tillage practices and holistic plant management is a viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability.

- Vegetable production system (VPS) with drip irrigation: The technology aims to intensify vegetable production through a set of water saving equipment such as drip irrigation, and low cost green house or mulch.

- Potato seed production system (PSPS): comprises the development of varieties, producing mini tubers or elite seeds, multiplying seeds, and storage and delivery systems. The technology can improve the supply of good and healthy potato seeds and increase the potato production per area. The technology will be basis of sustainable supply of potato seed of adapted potato varieties and free of virus infections.

Animal husbandry:

- Seasonal to Inter-annual Prediction and Livestock Early Warning system (SPLEWS): The current livestock sector is based on the traditional nomadic pasture system and herder families' livelihood is highly dependent on and influenced by weather and climate. SPLEWS integrates main components such as risk knowledge, monitoring and predicting, disseminating information and response. Precise seasonal prediction and proper preparation for *zud* would result in saving about 80 % of animals' losses every winter.

- High quality livestock (HQL) through selective breeding and animal disease management: Improving animal quality rather than quantity is the best method to ensure high production and livestock development in Mongolia. The livelihoods of about 160 thousand herding families depend on livestock. HQL technology aims to improve the quality of all animals based on selective breeding using these core herds as well as improved animal health services. Diffusion of the technology would enable Mongolia to control livestock numbers within its pasture carrying capacity and to reduce overgrazing and desertification.

- Sustainable Pasture Management (SPM): Pastureland is the backbone of Mongolian agriculture. Pasture degradation and desertification are among the most serious environmental problems. Comprehensive sustainable pasture management will conserve natural resources and thereby increase livestock productivity.

The next steps would include conducting a barrier analysis, defining enabling frameworks and developing Technology Action Plan based on the Technology Needs Assessment report.

1. Introduction

1. 1 About the TNA project

Climate change and the accompanying degradation of terrestrial biological systems are among the most daunting environmental problems in the world, posing socio economic, technical and environmental challenges. Currently, Mongolia is facing climate change challenges along with issues derived from its geographical and environmental peculiarities. The mean air temperature has increased by 2.14 ^{0}C in the period from 1940 to 2008, 3 times greater than the global average temperature increase. The 100-year linear warming trend (1906- 2005) was 0.74 ^{0}C (UNFCCC Fact sheet, 2011).

Climate change has noticeably and adversely affected natural resources, animal husbandry, pastureland, agriculture and other socio-economic sectors in Mongolia. Consequently, the vulnerability of the country to climate change needs to be reduced to ensure sustainable development. This will require adaptation measures in order to increase the country's resilience in areas like: health and social systems; agriculture; biodiversity and ecosystems; production systems and physical infrastructure, including the energy grid. Within this overall development and climate policy context, a key step is to select technologies that will enable the country to achieve social equity and environmental sustainability, and to follow a low emissions and low vulnerability development path (Technology Needs Assessment for Climate Change, 2010).

Technology Needs Assessments (TNAs) are a set of country-driven activities that identify and determine the mitigation and adaptation technology priorities of a country. TNAs are central to the work of the Parties to the Convention (art. 4.5 UNFCCC). They present a unique opportunity for countries to track their needs for new equipment, techniques, services, capacities and skills necessary to mitigate GHG emissions and reduce the vulnerability of sectors and livelihoods to climate change.

TNA development is a key component of the Poznan Strategic Programme on Technology Transfer supported by the GEF. UNEP, on behalf of the GEF, is implementing a new round of TNAs with objectives that go beyond identifying technology needs. The TNAs will lead to the development of a national Technology Action Plan (TAP) that prioritizes technologies, recommends an enabling framework for the diffusion of these technologies and facilitates identification of good technology transfer projects and their links to relevant financing sources. The TAP will systematically design practical actions necessary to reduce or remove policy, financial and technological related barriers. UNEP DTIE in collaboration with the UNEP Risoe Centre provides targeted financial, technical and methodological support to assist 36 countries in conducting TNA projects. Mongolia is one of 21 countries selected in the last quarter of 2010.

The Mongolia TNA project is led by the National Climate Change Office, Ministry of Nature, Environment and Tourism (MNET) and covers the two areas of mitigation and adaptation. Technology needs assessments for adaptation has had limited emphasis in the past; previous TNAs and NAPA of Mongolia primarily focused on mitigation of GHGs and the energy sector. However, Mongolia has conducted a vulnerability assessment and identified priority adaptation sectors and activities in the Second National Communication (SNC) and National Action Program for Climate Change (NAPCC) in 2010.

The TNA for adaptation has given Mongolia an opportunity to determine the highest priority sectors and technologies for adaptation. Also, the project gave methodological and capacity building support to the country team to identify the most suitable technologies for effective climate change adaptation and vulnerability reduction. Project outcomes of the Technology Needs Assessment, barrier analysis, Technology

Action Plan and Enabling Frameworks will provide background to accelerate the development and transfer of the priority technologies in the country.

1.2 Existing national policies about climate change adaptation and development priorities

Mongolia is a developing country with a small population and wide territory where traditional nomadic livelihoods coexist with modern urban lifestyles. Since 1990, Mongolia has been working toward building a strong civil and democratic society. The country experienced various challenges during the 1990's in transitioning from centrally planned socialism to a market economy with major changes occurring in socio economic and political lives of the country in the past 20 years.

In recent years, climate change related challenges have become one of the main risks for the country's development. Ecosystems of the country are fragile to climatic changes and livelihoods of people are dependent on the weather and environment. Climate change impact assessments have demonstrated that climate change will impact on the well-being of people and socio economic aspects of the country.

The Parliament and the Government of Mongolia passed several important policies and strategic documents of long term sustainable development. There are 177 national programs and projects with 60 of them being implemented in the area of socio economic development (Norovdondog Ts, 2011). The main policies and strategies of development have clearly stated the importance of adaptation of major sectors such as agriculture, animal husbandry and water to climate change and include objectives to cope with climate change as outlined below.

Table 1: Major development strategies and policies of Mongolia related to climate change adaptation

Policy	Description and relation to climate change adaptation
National Security Concept of Mongolia	The National Security Concept of Mongolia was adopted in 2010. In the Concept, the integrated security strategy was defined: 'National security shall be assured through the interrelationship among the "security of the existence of Mongolia", "economic security", "internal security", "human security", "environment security" and "information security"'. Chapter 3.5.2 is about the adaptation policy of climate change and negative consequences of land degradation. Measures include establishing institutional structures and capacity, improving the legal environment for pasture management, decreasing land degradation through natural conservation and irrigation technologies, enhancing animal husbandry practices and public awareness (National Security Concept of Mongolia was approved in 2010).
Millennium Development Goals-based Comprehensive National Development Strategy (MDG-based CNDS)	The MDG based CNDS was endorsed in 2008. The Strategy is being implemented in two phases for 2007-2015 and 2016-2021. Six priority areas have been defined. The fifth development priority is: 'To create a sustainable environment for development by promoting capacities and measures on adaptation to climate change, halting imbalances in the country's ecosystems and protecting them'. Under the priority 6 strategic objectives were identified and the sixth objective is 'to promote capacity to adapt to climate change and desertification and to reduce negative impacts'. Relevant measures are scientific assessment and future scenario, implementation of policy compliant with sustainable development, identification of risk areas, adaptation methods and technologies in crop farming, managing livestock within pasture capacity, intensification of animal husbandry along with nomadic livestock, and increasing public awareness and participation.
State Policy on Environment and Nature	In the State Policy on Environment and Nature (1997), reducing climate change negative impacts was one of the aims of the Policy's directions (The State Policy on Environment and Nature, 3.11.7).
National Programme for Food Security	The National Programme for Food Security is being implemented from 2009 to 2016 in two phases. It has 4 priority pillars and 13 main objectives to ensure sustainable food security. Under four pillars priority areas such as enabling environment, food security, food safety and nutrition, 27 high priority projects were summarized. Several of them were related to climate change adaptation. For example: meat production, milk production, irrigated crop production, crop diversification, renovation of crop equipment, prevention of food borne disease and drinking water supplies etc.
National Mongolian Livestock Program	The National Mongolian Livestock Program's goal is 'to develop a livestock sector that is adaptable to changing climatic and social conditions and create an environment where the sector is economically viable and competitive in the market economy, to provide a safe and healthy food supply to the population, to deliver quality raw materials to processing industries, and to increase exports'. The program's implementation period is 2010-2021 and includes two phases. Five priority areas have been identified in the Program and the fourth priority area is, 'developing livestock production that is adaptable to climatic and ecological changes with strengthened risk management capacity'. Under the fourth priority area, 4 major measures such as improving pasture management, increasing hay and fodder production, livestock water supply and livestock risk management were stated.
'Water' National Program (2010-2021)	The National Program on Water was endorsed as a supporting program to the MDG based CNDS in 2010. The program aims to support development through protecting water resources from depletion and pollution, to implement the state policy toward providing a healthy and safe environment for the population. The program proposes two-phases of implementation and 6 priority objectives. Water resource related adaptation measures have been included in the program. For example: establishing water ecosystem monitoring, construction of a water harvesting system in mountain areas of the cryosphere, and awareness raising among the public including youth.

National Action Program on Climate Change (2011–2021) (NAPCC)	The program was updated in 2010 and its main goal is to adapt socio economic development, to reduce vulnerability and risks of sectors, to support green economy development and growth through GHGs emission. The program has two implementation phases. Climate change adaptation is one of four strategic objectives of the program. The entity responsible for the implementation is the interagency and intersectoral National Climate Committee (NCC).
National Action Program for Combating Desertification	The program was adopted in 2010. In coordination with the National Program on climate change, and implementing adaptation measures to reduce land degradation and desertification at local level has been stated in the program.

2. Institutional arrangement for the TNA and stakeholders' involvement

As noted in the National Program on Climate Change, the Head of the Ministry of Environment and Green Development (MEGD), National Climate Committee (NCC) and members of Government Cabinet are responsible for climate change policy making.

The National Climate Committee (NCC) which is the implementing unit of climate change related programs and activities at the national level bears the duty to coordinate and integrate sectors and agencies, monitor implementation and performance, and provide technical support and recommendations to stakeholders on climate change related issues.

The Government agencies responsible for finance, economy, foreign affairs, food, agriculture, light industry, minerals, energy, transportation, city construction, health, education, culture and science matters should implement climate change activities along with sector policies, programs, plans, the Government action plan and the annual planning and budget of Mongolia's socio economic development and report to the Government through the NCC. Stakeholders and their duties are shown in Table 2.

Table 2: Stakeholders and their obligations under the NAPCC

Stakeholder	Obligations
Individuals/ Citizens	✓ Change their current behaviour for the protection and preservation of the environment and natural resources by saving energy, winterizing shelters, reducing heat loss, producing less garbage, re- using waste materials, limiting consumption of luxury goods, using public transportation as much as possible, and supporting environment friendly services and production. ✓ Actively engage in actions and movements of environment conservation, climate change mitigation and adaptation and monitoring of government functions and natural resource users ✓ Transfer gained knowledge, experience and skills about climate change mitigation and adaptation to children, family members and communities
Enterprises & organizations	✓ Plan to introduce and implement low emission technologies, environmentally friendly, energy and raw material efficient production and services ✓ Educate their staff and workers about company's legal responsibilities on environmental protection, climate change and its accomplishments

Civil society & NGO	✓ Partner with government organizations in climate change and environment activities and measures ✓ Raise public awareness and mobilization of communities in monitoring of natural resource usage
Government institutions	✓ The Central Government institutions for sectors such as finance, foreign affairs, and environment: facilitate implementation of climate change related activities in their sectors and report to the Government. ✓ National Climate Committee: facilitate the implementation of climate change programs and activities, ensure coordination between sectors and agencies, deploy international resources and financial mechanisms, deliver necessary information to decision makers and the public, develop initiatives to reform policy and the legal environment, report according to duties under international conventions and contracts and report to the Government through the Ministry for Nature, Environment and Tourism (MNET). ✓ Local government: roll out NAPCC and implement activities for climate change adaptation and mitigation, and improve waste management in their respective areas.

2.1 National TNA team

A National TNA team has been established in order to achieve objectives of the TNA project. The National TNA structure is displayed in Figure 1.

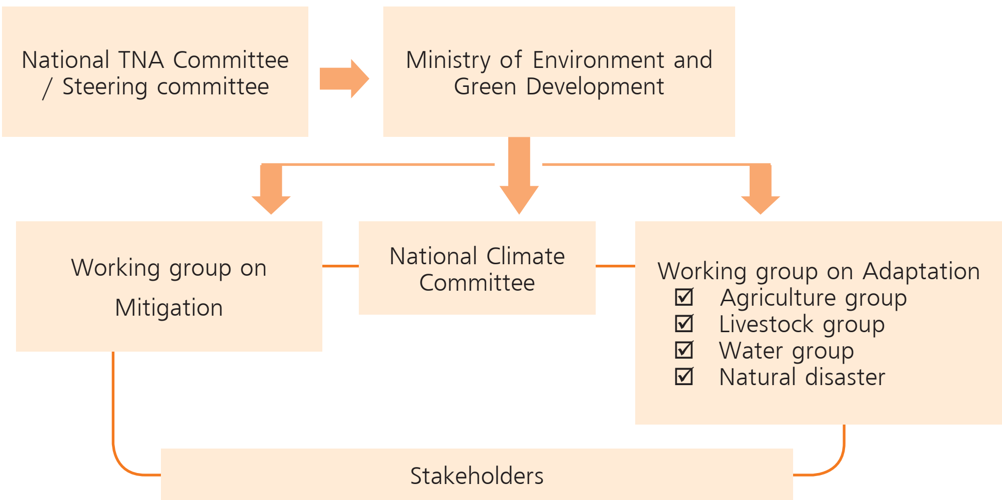


Figure 1: National TNA Structure

In July 2011, an inception workshop was conducted with specialists and experts from different sectors participating in the discussion. Based on the workshop results, working groups were formed in order to cover major sectors of Mongolia. The TNA committee and groups' roles and composition are shown in Table 3.

Table 3: National TNA groups roles and composition

Group name	Roles	Composition
Steering committee	• Review of major outcomes of TNA project • Endorse major outcomes and TAP	• **Head**: Vice Minister of MEGD • **Secretary**: Head of CDM National Bureau, MNET **Members**: • Director of Energy Policy Dep. MMRE • Deputy Director of Fuel Policy Dep. MMRE • Deputy Director of Livestock Policy Implementation & Coordination Department • Director of National Renewable Energy Centre • Director of Secretariat for National Committee on Air Pollution Reduction • Deputy Director of Road and Transport Policy Dep. MRTUD • General Secretary of Energy Association • Director of Afforestation and Reforestation Division, Forestry Agency • Project Coordinator for Environment Reform Project
National Climate Committee	• Provide overall management of TNA project implementation • Submit outcomes to the Steering Committee	• **Project manager**: Dr. D. Dagvadorj, CCCO, MEGD • **Secretary**: Tsendsuren, Head of CDM National Bureau, MEGD
Working Group on Adaptation	• Conduct TNA assessment and prepare major outcomes of TNA • Facilitate stakeholder workshops • Compile results and prepare reports	• **Leader**: Gomboluudev (PhD)- climate change specialist, IMH • **Secretary**: Bolortsetseg (MSc) – CCNS NGO **Agriculture expert:** • Davaadorj (PhD), crop specialist • Bayarsukh G (PhD), Research Institute of Planting and Arable Farming **Livestock experts**: • Biney B (PhD), livestock specialist, MIA • Erdenetsetseg (MSc), pasture specialist, IMH **Water experts**: • Davaa (PhD), water resource specialist, IMH **Natural disasterexpert**: • Natsagdorj (PhD), independent consultant
Stakeholders	• Provide inputs to sector and technology prioritization and implementation; and barriers analysis	• Specialists from different sectors • Herder and farmer representatives

Working group members have different sector experiences and knowledge of technologies and country development needs and context. Sharing experiences and knowledge of technologies as well as stakeholder engagement was important during the TNA process.

2.2 Stakeholder Engagement Process followed in TNA – Overall assessment

Stakeholder engagement was an important aspect of the TNA process. In addition to working group members, potential stakeholders for TNA Adaptation have been identified as follows (Table 4).

Table 4: Stakeholder groups and institutions

Stakeholder group	Institutions/ groups
Government institutions	• Climate Change Coordination Office, Ministry of Environment and Green Development • Livestock Policy Department of Ministry of Industry and Agriculture • National Water Committee • Department of Animals Epidemics, National Emergency Management Agency • Forestry Department, Institute of Botany • Institute of Meteorology and Hydrology • National Development and Innovation Committee • National Remote Sensing Centre, National Agency of Meteorology, Hydrology, Environment and Monitoring
Academic & research institutions	• Institute of Livestock, Mongolian State University of Agriculture • National University of Mongolia • Research Institute of Crop and Agriculture, Agriculture University of *Darkhan* • Desertification Study Centre, Institute of Geo-ecology
International projects, programs	• Green Gold project, Pasture Management project funded by Swiss Agency for Development and Cooperation • Environment Reform project, WB and MNET joint project • Peri-urban Land project, Millennium Challenge Account of Mongolia
National NGO	• Policy Research Institute • 'Climate Change, Nature and Society' NGO Pasture Management Association
Private enterprises/ companies	• 'Evergreen land' company (importer of agriculture equipments) • 'Greenhouse' company (importer of greenhouse materials)
Community/ citizens	• Small farm in semi urban area • Farmers • Herders

Identified stakeholder groups were mapped by key experts in order to define an appropriate communication plan (way and frequency) and involvement in different processes of the TNA.

Stakeholders with high influence in decision making processes played key roles in sector and technology prioritization which comply with the country development priorities. Stakeholders with medium influence who are generally educational institutions had good information and experience in exploring potential technologies of climate change adaptation. Stakeholders with low influence however have had medium and high interest and have crucially engaged in technology prioritization and feasibility of implementation in the country context.

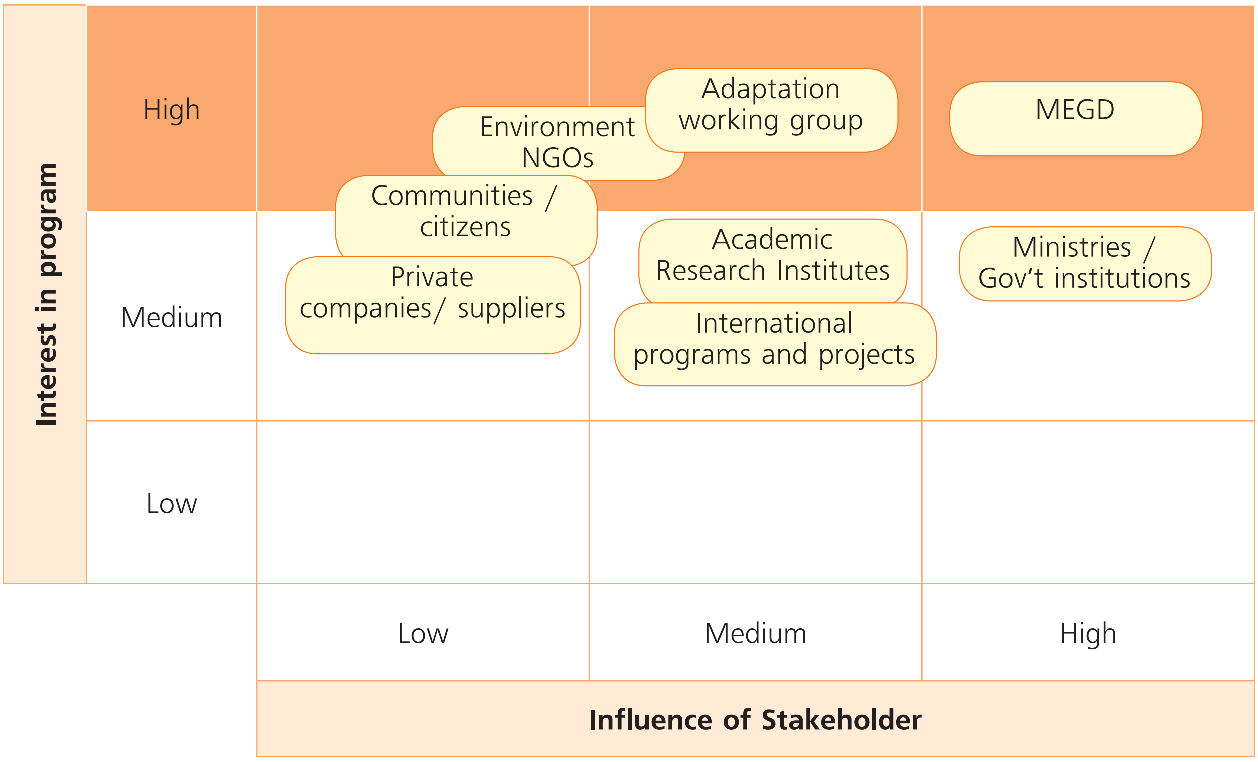


Figure 2: Stakeholder Map

Stakeholder engagement methods include:

✓ Project workshops (Table 5)

✓ Informal discussion meetings with stakeholders (About 1-2 meetings every month)

✓ Workshops and seminars of other related projects such as Climate change risk assessment (UNDP project); Climate change adaptation project (UNEP and MEGD projects); and climate change and human health (Ministry of Health).

✓ Sharing resources such as reports, assessments, and evaluations with other related projects such as Green Gold project; Carbon project; and Land Management project of MCA etc.

✓ Key Informant Interview with representatives of farmers, herders and agriculture suppliers

Table 5: Facilitated workshops in TNA process and topics

Workshop	Date	Topic	Participants
Inception Workshop 1	July 2011 1 day	✓ Introduction of TNA project ✓ Sectors presentations (Agriculture; water; forestry; human health; livestock) ✓ Potential technologies (briefly)	About 30 people including key 6 experts, representatives of MEGD, MIA and research institutions
Workshop 2	Sep 2011 1 day	✓ Presentation about TNA report and stakeholder engagement ✓ Initial sector prioritization using a questionnaire ✓ Current technologies ✓ TFS preparation guides	About 26 people including key 5 experts and stakeholders from ministries such as MEGD, MIA; research institution IMH,

Workshop 3	Mar 2012	✓ Presentation about barrier analysis, enabling framework, and TAP ✓ Finalizing sectoral prioritization ✓ TFS presentation ✓ Initial technology prioritization by stakeholder groups of agriculture and livestock ✓ Draft report presentation	About 23 people including stakeholders from MIA and research institutions such as IMH, Institute of Livestock, Institute of Pasture and Forage, University of Agriculture, international projects
Workshop 4	Jun 2012	✓ Final technology prioritization ✓ Presentation of TNA report after review	About 10 people including 6 key experts and stakeholders from research institutions

3. Sector selection

3.1 An Overview of Expected Climate Change and Impacts

Mongolia is one of the largest landlocked countries in the world, located in a transition zone between northern Asia and Boreal Arctic regions where Siberian Taiga meets the Asian deserts and the steppe. The country has a severe climate due to its long distance from oceans, the large mountains which surround it, a high elevation of more than one and a half km above sea level, and its proximity to the arctic (Batima P and etc., 2006). The main characteristics of the climate are that it has four distinctive seasons, large fluctuations in temperature, low precipitation and distinct climate differences in different latitudinal as well as in altitudinal zones.

Annual mean temperature varies from -9.0 to 7.0 ^{0}C over Mongolia (Figure 2). Total annual precipitation ranges from 50 to 450 mm (Figure 3). Most precipitation falls in summer mainly due to convection.

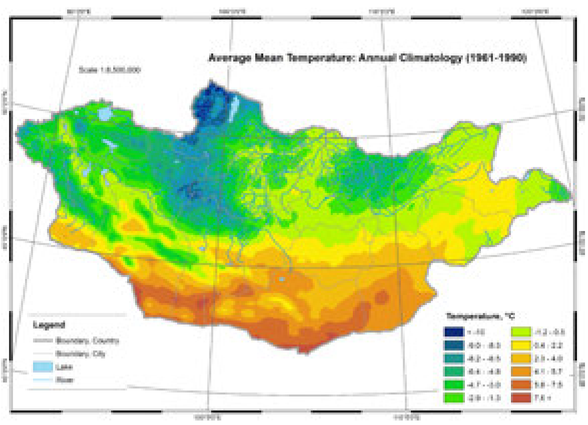


Figure 3: The annual mean temperature pattern, ^{0}C

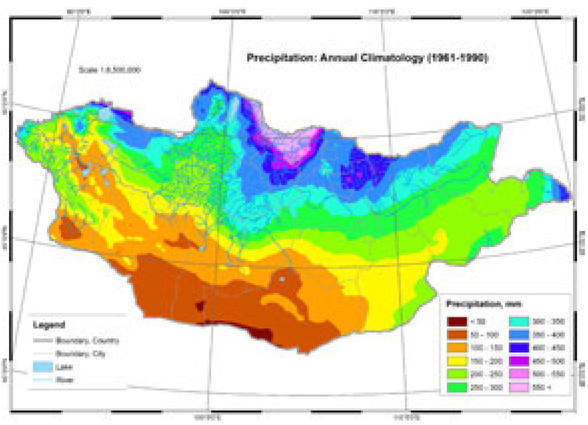


Figure 4: The annual precipitation pattern, mm

Source: *MARCC, 2009*

Climate change: According to observation data at meteorological stations since 1940, the annual mean air temperature near the surface has increased by 2.1^{0}C ($p<0.05$) and annual precipitation decreased by 10 percent in the last 70 years (Figures 4 and 5). Thus, the dryness index which is defined as a ratio of temperature and precipitation increased.

Mongolia is considered to be a disaster prone country, which frequently experiences natural disasters such as *zud* (severe winters), droughts, heavy snow fall, floods, snow and windstorms, extreme cold and heat waves etc. In recent years, the magnitude and frequency of natural disasters show increased trends due to climate change (Second National Communication, 2010).

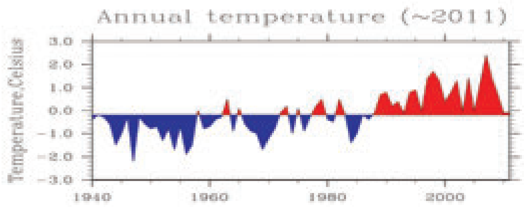


Figure 5: Annual mean air temperature, (⁰C)

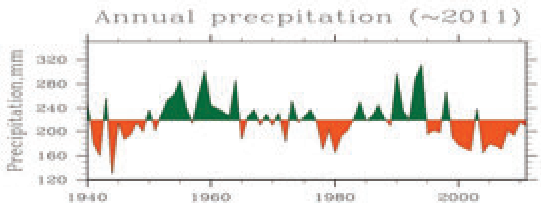


Figure 6: Annual mean precipitation change (mm) from the baseline of 1971–2000 over Mongolia

Climate change projection: The observed climate change trend in Mongolia is anticipated to continue in the future. According to the climate change projection assessment (MARCC, 2009), winter temperatures are expected to increase by 2.6⁰C in 100 years and summer temperatures will increase by 2.4⁰C from the mean of 1971-2000 in 100 years (red curve in Figure 6). The temperature increase in winter is expected to be greater than that in summer.

The annual winter precipitation will increase by more than 40% and summer precipitation will increase only by 3% (blue curve in Figure 7). Winter precipitation will increase signifcantly more than summer precipitation. The precipitation is expected to continue rising up to 2070 and after that it would stabilize.

Mongolia's winter would be mild and snowy, and its summer is expected to be drier and hotter based on estimates of overall climate change projection assessment. Dryness will be more intense due to high evaporation and only small increases in summer precipitation.

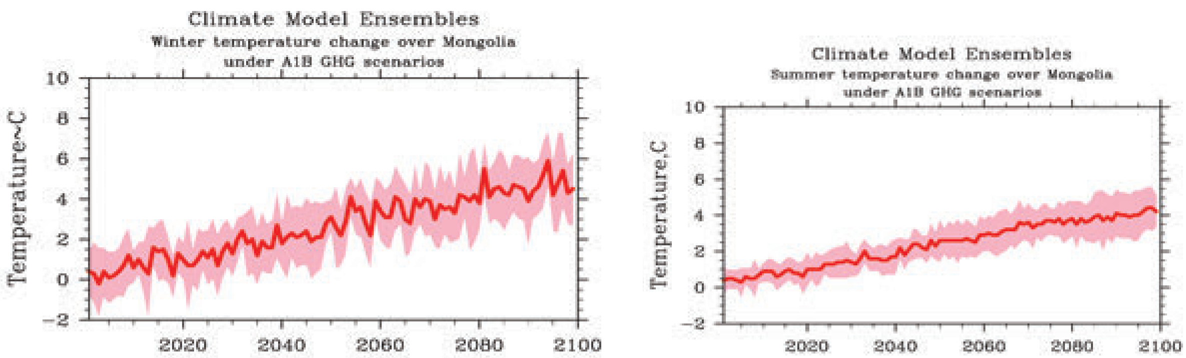


Figure 7: Winter and summer temperature change trends of Mongolia according to estimation of A1B, GHG emission scenarios, ⁰C, 2011–2099

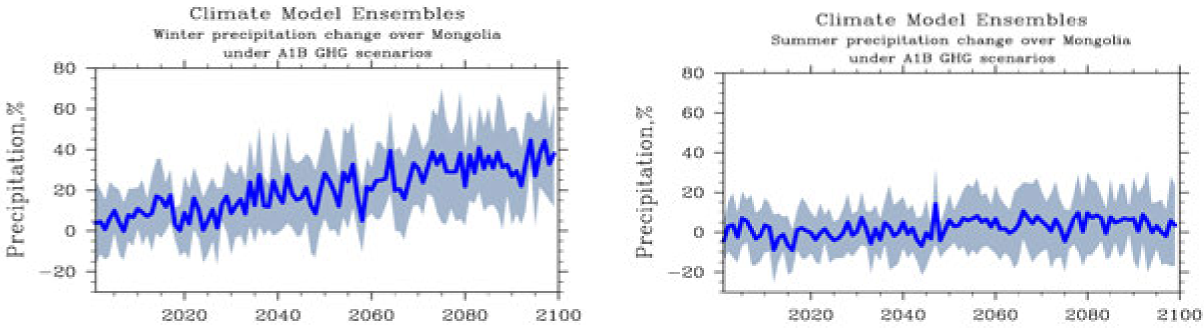


Figure 8: Winter and summer precipitation change trends of Mongolia according to estimation of A1B, GHG emission scenarios, ^{0}C, 2011–2099

Detailed results of climate change studies were provided in the following publications: Observed Climate Change in Mongolia, AIACC project; Climate Change Studies in Mongolia, NCCSAP; Mongolia Assessment Report on Climate Change MARCC 2009, Second National Communication 2010 and National Adaptation Strategy 2010.

Mongolia is very sensitive to climate change due to its geographic location, unique ecosystems and socio economic conditions. As a result of climatic variability and the impacts of climate change, in the last forty years, Mongolian ecosystems have notably altered. Impacts of climate change on ecosystems have been studied and written in several policy documents and research papers (Climate Change Studies in Mongolia, 2000, NCCSAP; Climate change Vulnerability and Adaptation in the Livestock Sector of Mongolia, 2006, AIACC; Mongolia Assessment Report on Climate Change, MARCC 2009; Davaa G. and etc., 2007; and Second National Communication, 2010). Table 6 summarizes impacts of climate change on ecosystems and natural resources.

Table 6: Impact of climate change on ecosystems and natural resources of Mongolia

Biophysical components	Impacts
Natural zones	*Observed change*: Satellite images show that the area without vegetation cover has increased by 46 percent in 2002 compared to the situation 10 year previous (MARCC, 2009). *Expected change*: Natural zones including the high mountains, the forest steppe, the steppe and the desert steppe are expected to change because of climate change. Ecosystems of the forest steppe and the high mountains are very likely to decrease and the steppe and the desert steppe are expected to expand (SNC Mongolia, 2010). However, ecosystem shift is obviously a comprehensive process over many years and there are many uncertainties in future changes in precipitation and other factors.
Rangeland	*Observed change*: It is estimated that around 70% of the total pasture land is degraded due to the increase in number of livestock (almost doubled in the past 20 years) and the radical impact on the composition of herds and changes to the traditional methods and technology for the use of pasture, in the nomadic lifestyle of herders. Pasture species edible for livestock has decreased and the pasture biomass has dropped by approximately 20-30% in the last 40 years (SNC Mongolia, 2010). There is clear evidence that plant composition has changed and spring on-set of pasture has been delayed in many areas (Climate Change Studies in Mongolia, 2003). Warming and grazing have led to changes in plant communities especially forbs and soil organic matter levels (Brenda. C and etc., 2009). *Expected change*: Studies on the impact of vegetation biomass change show that the biomass of pasture will decrease significantly in all regions, especially in the forest-steppe and steppe regions, except in the desert areas. The increases in livestock and herbivorous grazing and some human activities such as mining, road construction and land use will also bring much stress to the pasture condition in future in addition to climate change.
Spread of insects and rodents	*Observed change*: In the past decade, the incidence of some insects and rodents has increased due to climate change, drought and extreme weather events. In particular, rodents and grasshoppers became widespread in the dry years of 2000 to 2002 and caused extensive damage to pasture. For example: the distribution area of *Steppe vole* (*Laciopodomus brandti)* has spread because of pasture degradation, frequent droughts and the increase in livestock (SNC Mongolia, 2010). *Expected change*: Rodents and grasshoppers distributions are expected to increase due to increased temperatures in the future.
Permafrost	*Observed change*: Currently, the permafrost extends to 63 percent of the country's territory. Over the past 30 years, a seasonal thawing in the active soil layer in the permafrost region has increased by 0.1-0.6 cm in the *Khentii* and *Khangai* Mountains, by 0.6-1.6 cm in the *Khuvsgul* Mountains. The seasonal depth of freezing in an active layer has decreased by 10-20 cm in the eastern part of Mongolia in the last 30 years. Permafrost phenomenon such as thermocarst, solifluction, thermoerosion and icing has intensified over the last 50 years. *Expected change*: Three climate change models clearly demonstrate that the size of the permafrost area is decreasing from year to year and that the type of permafrost is shifting from one type of permafrost to another. For example, between 2010 and 2039, the mountains that are currently continuous permafrost, will become the discontinuous common patchy, rare patchy permafrost. Between 2040-2069 and 2070-2099, the current continuous permafrost in the *Altai, Khuvsgul* and *Khangai* Mountains will likely become discontinuous common patchy, rare patchy permafrost (MARCC, 2009). The thawing or disappearance of permafrost has both positive and negative implications.

Glaciers/ Snow cover	*Observed* change: Winter snow cover plays unique roles with positive and negative implications for water resources and livestock in Mongolia. The change in the average depth of snow cover over the last 30 years shows that the snow depth has decreased in the northern mountainous regions of Mongolia (SNC Mongolia, 2010). The area of glaciers has already decreased by about 30 % since the mid 1940s and in the *Mongol Altai*, the lower edge of the glaciers is retreating (Davaa G. etc, 2007). The shrinkage of glaciers seriously affects the regime and resource of surface water bodies which originate from glaciers. *Expected change*: The area with snow cover lasting for more than 50 days during the winter accounted for about 62% of the total territory of the country in the second half of the 20th century; this proportion is expected to shrink to about 46% in the first half of this century and about 35% -in the middle of this century, respectively. Glaciers are expected to continue to shrink in the future due to climate change.
Water resources	*Observed change*: The combined effects of climate warming and human activities will dry out many surface water bodies including small lakes and streams. There were 5216 lakes with a total surface area of 15,372 km^2 during the 1940s in Mongolia. But a survey conducted during the period of 1999-2002 indicates that there were 5166 lakes with a total surface area of 15,034 km^2 (Davaa G. et al., 2007). *Expected change*: Changes in river runoff and the volume of open surface water bodies clearly indicate the impacts of climate change on water resources. River runoff is expected to decrease to some extent in most regions of Mongolia and some slight increase will be observed in high mountain areas of the *Khentii* mountains (Batima P. et al., 2005).
Natural disasters/ climate extremes	*Observed change*: Annual economic losses caused by **weather-**related natural disasters have increased in Mongolia. During the last decade the frequency of weather-related natural disasters has almost tripled and economic damages were estimated to be US$10–15 million every year (excluding damage caused by drought and harsh winter –*zud*) (Natsagdorj L et al., 2003). *Expected change*: The tendency for increased frequency of climate extremes is expected to continue in the future (MARCC, 2009). As a result, drought and harsh winter (*zud*) is highly likely to occur more frequently, bringing risks for agriculture, and nomadic livestock. Also, there is clear evidence of drought intensification in Mongolia under global climate change.
Forests	*Observed change*: Mongolian forests, which grow at the edges of the Central Asian desert and the central Siberian taiga and along water divide of the biggest three river basins, plays a cruicial role in regulating river runoff, reducing soil erosion, moderating climate, absorbing greenhouse gas emissions, creating favourable conditions for flora and fauna, and maintaining permafrost and balance of ecosystems. In the past decade, forest area has decreased by 2.6% (Dorjsuren Ch., 2011) due to forest fires, harmful insects, and excessive pressure from human activities and livestock. One of main factors contributing to increased fires and spread of harmful insects is climate change. Forests are degraded in terms of covering area as well as the quality, including species and non-wood products (Yakhanbai H., 2010). The area of forest affected by insects had increased nearly three-fold from 2002-2006 compared to the period of 1995-1999. Studies show there is some correlation between the size of forest area affected by pests and insects and the drought index. Research on the frequency and aerial extent of forest and steppe fires, found no clear change in fire frequency or synchronicity in recent decades (Hessl, A.E., and etc, 2010). *Expected changes*: An increasing intensity of drought will result in larger distribution of harmful forest insects in the near future in Mongolia. The risks of forest fire is expected to increase due to higher temperatures and extended dry seasons of spring and autumn. Althougth CO_2 concentration in the athmosphere may generate positive impacts on forest growth, Mongolian forest area is likely to decrease because of water and moisture deficit as major constraining factors.

Climate change has direct and indirect impacts on economic and social sectors in Mongolia. Impacts and vulnerability have been summarized in Table 7.

Table 7: Impact of climate change on socio economic sectors of Mongolia

Sector/ Area	Impacts and vulnerability
Animal husbandry	Considerable research on the impact of climate change has been carried out and revealed results on different aspects such as herder livelihoods, livestock and the coupled system of traditional herder groups and landscapes they use (Chuluun T., 2008). Animal weights and sizes have decreased in recent decades because of increased drought frequency and pasture production decreases (Climate Change studies in Mongolia, 2003). The average weight of an adult cow, sheep and goat have decreased by 13.8, 4 .0 and 2.0 kg respectively, in the forest-steppe region during the period of 1980-2001. Consequently, livestock productivity has declined over the same period. For example: sheep wool productivity has decreased by more than 8%, while cashmere productivity has decreased by about 2% over the last 20 years. Results of studies show that summer-autumn weight of sheep will decline by 10-27% during 2011-2039 and 24-38% from the level of 1961-1990 in the forerst-steppe and the steppe regions (Climate Change Vulnerability and Adaptation in the Livestock Sector of Mongolia, 2006). Due to climate change, an increasing number of very hot summer days has the potential to shorten the animal grazing period. It is expected that droughts and harsh winters will occur more frequently. If the necessary adaptation measures are not taken, by the middle of this century, the annual rate of livestock loss could reach 8 to12% on average.
Arable farming	Climate change has direct impacts on crop production including spring wheat, which is the main crop in Mongolia. Water availability is the main constraint factor for crop production in Mongolia because spring wheat is mostly grown in rain fed fields. Another factor causing yield declines is the rising number of hot spells during critical stages of crop growth. A climate change impact study revealed a significant correlation between the number of days with temperatures higher than 26^{0}C, and the critical period July, for wheat crops. In climate change impacts study, the decision support system for agrotechnology transfer (DSSAT) 4.0 model was used to assess future trends of spring wheat yield. Due to faster crop growth under higher temperatures, the spring wheat growing period could be shortened by 3-5 days. Spring wheat yield would decline by 1-30% (on average 13%) over the period 2011-2030 from the current average yield under *A1B* emission scenario as run by the *HadCM3* model (SNC Mongolia, 2010). Other factors such as spread of crop pests and diseases, hot spells and frequency of heavy rains would have an impact on crop production in future.
Human health	Some research initiatives were conducted in Mongolia in order to assess the impact of climate change on human health. Major findings include: • Cardiovascular disease mortality and morbidity have increased. There is a correlation between cardiovascular disease incidence and heat waves. • There is a correlation between angina pectoris and weather parameters, and between respiratory diseases, air pollutants and weather parameters. • There is correlation between climate parameters and water borne diseases. Drinking water quality which is one of the main drivers of water borne diseases has changed due to climate change. • Infectious diseases such as dysentery and tick borne encephalitis tend to increase (Burmaajav. B., 2010). Also climate change could have an impact on human health and injury through natural disasters, food safety and water sanitation. In addition, the outbreak of some tropical diseases may occur in Mongolia. For instance, researchers have confirmed that the virus of the Western Nile has been found in *Khovd* and *Gobi-Altai aimags.*

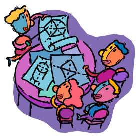
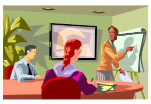
Human health	Also, cholera occurred for the first time in Mongolia in 1996. Human deaths caused by forest acarus, which did not exist in Mongolia previously, have been recorded in the past few years (SNC Mongolia, 2010). A comprehensive assessment and scientific study is required to provide evidence based conclusions about climate change impacts on health in Mongolia.
Infrastructure	Due to temperature increases, the heating season for buildings could be shortened in Mongolia. For example, the heating season may be 6-7 days shorter in the first 30 years of this century and by the middle, the heating period may be 10 days shorter, which can save energy use. Issues regarding heat loss from buildings is mainly considered as an option for climate change mitigation. Permafrost melting is causing problems in towns and every year the country has to spend significant resources to reconstruct and repair damaged roads in cities. The government has plans to extend paved road networks in many permafrost regions and therefore impacts of permafrost thawing on infrastructure due to climate warming needs to be considered. Heavy rainfall, strong wind and flash floods, which are becoming more intense and frequent due to climate change, also cause damage to infrastructure. Wet snow followed by freezing damages telecommunication and power transmission lines. However, detailed scientific studies are needed in order to assess and reduce the negative impacts of climate change on infrastructure in Mongolia.

The current and future impacts of climate change have been investigated in the Mongolian Assessment Report on Climate Change, 2009 (MARCC, 2009) and summarized in the recent Second National Communication in 2010 (SNC Mongolia, 2010), as well as in detailed research reports (for example AIACC, 2004, 2005, 2006, NCCSAP 2000).

3.2 Process, criteria, and results of sector selection

We have employed the following steps in the sector prioritization process.

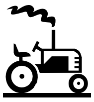
Table 8: Steps for sector prioritization and outcomes

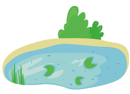
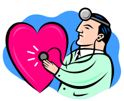
Steps	Outcomes of each step
 Step 1. Review existing documents and reports about **the impacts and vulnerabilities of climate change by key experts**	The most vulnerable sectors were identified, including: • Arable farming • Animal husbandry • Water resources • Human health • Infrastructure • Forestry
 Step 2. Identify impacts on each sector through consultation of key experts with stakeholders	Potential impacts have been identified for each sector: • List of impacts per sector provided in Annex 1.
 Step 3. Identify the most vulnerable sectors based **on the degree of impact, confidence level of source information and likelihood level, and validate in a stakeholder work-shop**	Sectors with impacts with the highest likelihood have been identified (Table 8). The major climate changes were: - increase of air temperature, - decrease of summer precipitation - increase of winter precipitation, - increased evapotranspiration - intensification of extreme events (heat wave, flood, and convective precipitation).
 Step 4. Define the criteria **for (sub) sectors prioritization and multi criteria analysis through discussion with discussion with key experts**	Six criteria were selected for MCDA. • Economic loss - assets; business & market activity • Social loss - health & livelihoods; employment • Environmental loss - biodiversity; ecosystem services
 Step 5. Conduct multi criteria analysis for sectors with key experts and discussed with stakeholders A three-level (high, medium and low) scoring system was used, converted to a score out of 100 and normalized. Finally, swing weight, weight and normalized weight are estimated for each criterion.	Overall scores for sectors were determined using MCDA (Table 10).
 Step 6. Identify the (sub) sectors most vulnerable to climate change and the sectors where social, economic and environmental losses due to climate change impacts are expected to be higher than those of other sectors.	The prioritized sector is Agriculture. Identified sub sectors with the highest scores are: • Arable farming/ Water • Animal husbandry/ Water

A desk review of climate change studies was done by key experts and six sectors including arable farming, animal husbandry, water, human health, infrastructure and forestry were assessed in previous researches on climate change impact and vulnerabilities.

Key experts identified around 150 impacts of climate change on the above mentioned sectors (Annex 1) and assessed these impacts based on risks, information sources and likelihood along with stakeholder consultations. These impacts were defined as detailed as possible and avoiding to duplicate several impacts or consequences because impact and consequences have complex correlation with each other and are difficult to quantify and rank. Climate change impacts with the highest scores per sector were validated in stakeholder workshop. In total 36 climate change impacts for environment and socio economic sectors have had the highest scores and are listed in Table 9.

Table 9: Potential climate change impacts which have the highest likelihood

Climate change	Potential impacts	Consequences in sector
 **Arable Farming**		
Decrease in summer rain	Decrease in soil moisture content	Decrease in crop yields
Increase in rain intensity variation coefficient in the growing season	Unstable soil water availability	Unstable crop production
Higher average temperature during the warm season	Extended growing season; earlier planting of crops	Crops adapted to warm climates need to be planted. Agriculture land can be expanded.
Earlier melting of stable snow cover	Dried soils during planting	Early planting would be limited.
Increased evaporation from land	Unstable soil moisture levels	Decreased crop yields, required irrigation
Increased frequency of hot spells	Slower rate of photosynthesis in crops; more intense drought period	Heat stress in crops and reduced yields; lower wheat grain yields and reduced harvests
Higher cumulative heat during the growing period.	More crop pests and insects	Reduced crop yields
Reduced rainfall and increased temperature	Unstable soil moisture levels	Decreased soil fertility; reduced levels of soil organic carbon and nitrogen
 **Animal husbandry**		
Decreased summer rain	Reduced soil moisture levels	Decreased pasture biomass
Higher rain variation coefficient during the growing season	Unstable soil moisture availability	Varying pasture biomass stock
Increased winter precipitation	Deeper snow coverage on pasture	Greater risk of harsh winter/ *zud*

Higher air temperatures in the warm season	Increase in potential evapotranspiration; Higher plant transpiration; Increased evaporation from water surface	More intense dryness Improved biomass Scarce open water sources
Increased number of hot days	More intense drought; heat stress limits animals grazing; Heat stress in pasture plants	Degraded pasture; Lower animals' weight gain; changed pasture plant composition
Decreased summer rain and increased air temperatures	More intense drying	More intense desertification; self accelerating desertification in the steppe region; Reduced soil organic matter
Increased precipitation and air temperatures during the cool season.	Increased humidity; increased density of snow coverage	Risk of different types of *zud* (white and iron *zud*); difficult for sheep and goats to graze because hooves too injured to dig snow.
Increased cumulative heat for crops during the warm season.	Increased probability of pasture pests and insects outbreaks	Decreased pasture biomass
 **Water resources**		
Decreased summer rain	Reduced soil moisture content	Deeper ground water levels
Increased precipitation in the cool season	Increased snow in water basins	Increased water resources in rivers; spring flood risks escalated in mountainous areas
Increased rain intensity in the summer	Less water infiltrating the forest and soil	Greater risk of river and flash floods
Increased air temperature	Melting permafrost	Increased run off of rivers in permafrost areas; rising lake water levels of lakes in permafrost areas
Increased number of days with temperatures above 0°C	Melting glaciers in the *Altai* mountains	Increased run off of rivers in the Altai mountains.
Increased air temperature in the warm season.	Increased water surface evaporation; Higher air temperatures in the warm season.	Decreased water in basins and lakes in the steppe and Gobi regions.
 **Human Health**		
Increased rain intensity in the summer	Increased risks of river and flash flood	Increased risk of human death and injury
Increased precipitation in the cold season	Increased frequency of *zud*	Limited access to health services for herders due to disaster.
Increased air temperature and absolute humidity in the warm season	Greater spread of flies, mosquitoes and insects that carry infections	Possible new disease or infection outbreaks
Increased frequency and intensity of hot waves	Increases in cardiovascular diseases	Increase in human mortality

Increased instability condition of the atmosphere	More frequent atmosphere related disasters	Increased vulnerability of the population
Infrastructure		
Increased amount and intensity of heavy rain in the warm season.	Greater risk of flooding because water cannot infiltrate into the soil in time	Risk of road and urban areas being flooded
Increased precipitation in the cold season	Deeper snow cover	Blocked roads in mountain areas
Higher precipitation intensity in spring and autumn	Thicker snow and ice cover	Greater snow pressure on infrastructure roof
Higher air temperatures	Melting of permafrost	Greater concerns for building construction would require more concerns in permafrost area.
Higher air temperatures in the cool seasons	Reduced heat loss	Cost saving in construction; Shorter heating season
Forests		
Decreased rainfall in warm seasons	More intense dryness	Slower forest growth
Increased precipitation in cool seasons	Increased soil moisture in spring	Decreased forest fire risk in spring.
Higher air temperature	Increased cumulative heat for plant and forest growth	Improved forest growth
Higher air temperatures in warm seasons	Reduced transpiration from forest cover; Increased cumulative heat for forest and plant growth	Improved forest growth; More frequent outbreaks of harmful pests and insects
Increased frequency and intensity of heat waves	Heat stress in forest ecosystems	Slower forest growth

Criteria for prioritization should reflect main environmental, economic and social issues, be easy to use and informative. Environmental criteria have been defined as biodiversity loss and ecosystem services, because climate change is a gradual process which directly impacts on biodiversity deterioration and indirectly influences ecosystem service losses. Mongolian people's livelihoods greatly rely on ecosystem benefits. In terms of economic development, climate change will cause direct negative impacts on infrastructure and assets and indirect effects on business and market activity. Direct impacts of climate change affect health and livelihoods and indirectly affect employment.

The multi criteria decision analysis enables us to rank climate change impacts and related sectors based on quantified losses/risks, even though impacts can be different in natural and socio economic sectors.

In order to review MCDA results, the methodology, process and results were presented and stakeholders have provided their feedbacks during sector prioritization workshop and other meetings.

Key experts also used opportunities to get comments during other workshops related to climate change and adaptation.

Based on the MCDA results, **arable farming and animal husbandry sub sectors** were identified as the sectors most vulnerable to climate change and their social, economic and environmental losses due to impacts are expected to be higher than those of other sectors (Table 10). Major reasons are as following:

Arable farming

o Increased dry spells (frequency and intensity), their impacts include declines in crop yield and economic, social and environmental losses are expected to increase.

Animal husbandry

o Increase of winter snow falls and increased risks of harsh winter (white *zud*), on the other hand, severe drought will reduce pasture biomass, and these impacts together will bring massive livestock death during winter.

The economic, social and environmental losses in these sub sectors are anticipated to be high, therefore, it is necessary to adapt to climate change by identifying the proper technologies for adaptation, and promote technology transfer and diffusion in these (sub) sectors. It is most beneficial to implement adaptation technology for these (sub) sectors and their contribution to development will be higher in terms of reducing climate change impact risks compared with other sectors.

Those selected subsectors were also identified as sectors highly vulnerable to climate change in the Second National Communication (SNC, 2010) of Mongolia.

The water sector has higher rating than human health, forestry and infrastructure. However, water is a cross cutting issue which is related to other sectors and sub sectors including arable farming and animal husbandry. Consequently, water saving technologies such as drip irrigation and rain and snow water harvesting have been included within the arable farming and livestock subsectors.

Table 10: Sector selection using multi criteria decision analysis

(Sub) sectors	Climate change	Impacts	Consequence	Loss /risk						Overall weight score
				Economy		Environment		Society		
				Asset	Business and market activity	Biodiversity	Ecosystem service	Health and livelihood	Unemployment	
Arable farming	**More intense dry spells**	**Severe drought**	**Decline in crop yields**	**48.5**	**12.1**	**0.0**	**0.0**	**12.1**	**12.1**	**85**
	Increase in frequency of heat wave	Slower photosynthesis process in crops	Decline in crop yields due to heat stress	24.2	12.1	12.1	3.0	12.1	6.1	70
	Decrease in summer rain	Lower soil moisture content	Decline in crop yields	24.2	12.1	0.0	3.0	6.1	6.1	52
	Increase in effective heat in the growing season	Outburst of crop disease	Decline in crop yields	24.2	0.0	12.1	0.0	6.1	0.0	42
	Decrease in precipitation and increase temperature	Soil imbalance	Deterioration of soil fertility	24.2	12.1	0.0	0.0	0.0	0.0	36
	Earlier melting of permanent snow cover	Drier soil during planting	Limited opportunity to plant crops early	0.0	0.0	0.0	0.0	6.1	6.1	12
	Increase in surface evaporation	Soil imbalance	Decline in crop yields and need to irrigate	0.0	0.0	0.0	0.0	6.1	6.1	12
Animal husbandry	**Increased winter precipitation**	**Deeper snow cover in pasture**	**Increased risk of harsh winter/ zud**	**48.5**	**3.0**	**0.0**	**6.1**	**12.1**	**12.1**	**82**
	Increased precipitation and temperatures in winter	More humid weather	Increased risk of white and black zud	48.5	3.0	0.0	0.0	12.1	12.1	76
	Increased number of hot days	Severe drought	Pasture degradation	24.2	3.0	12.1	12.1	6.1	6.1	64
	Decrease precipitation and increase temperature in summer	Intensifying dryness	Intensifying desertification	24.2	0.0	12.1	12.1	6.1	6.1	61
	Decreased precipitation and increased temperatures in summer	More intense dryness	Decreased soil organic matters	24.2	0.0	12.1	12.1	6.1	6.1	61
	Increased number of hot days	Stress on pasture due to heat waves	Degradation of pasture and changes in pasture species	24.2	0.0	12.1	12.1	6.1	0.0	55
	Increase effective heat in warm season	High probability of insects outburst of pasture	Decline pasture yield	24.2	0.0	6.1	6.1	12.1	6.1	55
	Increased precipitation and temperatures in winter	Increased density of snow	Grazing challenges	24.2	0.0	0.0	0.0	12.1	6.1	42
	Increased number of hot days	Shorter grazing time	Reducing of livestock weight gain	24.2	0.0	0.0	0.0	6.1	0.0	30
	Increased air temperature in warm seasons	Increased surface water evaporation	Decreased open water	0.0	0.0	0.0	6.1	0.0	0.0	6

Water	Decreased summer precipitation	Decreased soil moisture content	Descending soil ground water	0.0	0.0	51.6	12.9	0.0	12.9	77
	Increased temperatures in warm seasons	Increased evaporation of surface water	Decreased water resource of open basin and lake in the steppe and Gobi region	0.0	0.0	51.6	12.9	0.0	12.9	77
	Increased temperatures in warm seasons	Increased evaporation of surface water	Decreased water resource of open basin and lake	0.0	3.2	51.6	12.9	0.0	0.0	68
	Increased number of days with positive temperatures	Increased melting of glaciers of Altai high mountains	Increased river runoff and water resources in the Altai mountain region	12.9	3.2	25.8	0.0	6.5	0.0	48
	Increased precipitation in winter	Increased snow in runoff forming zone	Increased risk of spring flood	12.9	0.0	25.8	0.0	0.0	0.0	39
	Increased intensity of summer precipitation	Weak rainfall infiltration into soil	Increased risk of river flood	12.9	3.2	0.0	0.0	6.5	12.9	35
	Increased air temperatures	Melting permafrost from top side	Increased river runoff in permafrost area	12.9	0.0	0.0	0.0	0.0	0.0	13
Infra-structure	Increased amount and intensity of rainfall in warm seasons	Increased rainfall water flow as runoff and lower soil infiltration	Increased risk of flood damages in city, settlement and road	16.7	0.0	0.0	8.3	33.3	16.7	75
	Increased intensity precipitation in spring and autumn	Deeper snow and ice	Increased snow and ice pressure on infrastructure and building	16.7	8.3	0.0	0.0	33.3	16.7	75
	Increased snow in cold seasons	Deeper snow cover	Increased risk of snow blocking roads in the mountainous regions	0.0	0.0	0.0	0.0	16.7	0.0	17
Forests	Increased frequency and intensity of heat wave	Stress on forest ecosystem	Slower forest growth	0.0	15.4	15.4	7.7	15.4	15.4	69
	Increased temperatures in warm seasons	Improved heat supply	Increased frequency of outburst of insects and diseases	30.8	0.0	15.4	7.7	15.4	0.0	69
	Increased air temperatures in warm seasons	Increased water loss due to transpiration and evaporation	Slower forest growth	0.0	0.0	0.0	0.0	15.4	15.4	31
	Reduced precipitation in warm seasons	Higher aridity index	Slower forest growth	0.0	0.0	15.4	7.7	0.0	0.0	23
Human health	Increased precipitation in cold seasons	Increased risk of zud	Social service of herders family would be a challenge	42.1	5.3	0.0	0.0	0.0	10.5	58
	Increased atmospheric instability	Increased frequency of extreme events	Increased vulnerability	42.1	5.3	0.0	0.0	10.5	0.0	58
	Increased summer temperatures and humidity	Extended insect areal	Outbreak of new disease	0.0	0.0	10.5	21.1	10.5	0.0	42

Human health	Increased frequency and intensity of heat waves	Increased cardiovascular disease	Increased mortality and morbidity	21.1	5.3	0.0	0.0	10.5	0.0	37
	Increased intensity of summer rainfall	Increased risk of river and flash flood	Increased risk of human mortality	21.1	0.0	0.0	0.0	10.5	0.0	32

4. Technology prioritization for Arable Farming

After sectors were prioritized, key experts on arable farming identified existing and potential technologies for climate change adaptation. The list of technologies was reviewed and compiled by the Working group on Adaptation including all key experts listed in Table 3, and nine adaptation technologies for Mongolia were pre-selected. Related key experts prepared Technology Fact Sheets for each technology (Annex 2.A) which included: brief technology descriptions, the total costs of the technology, the application potential in the country, the adaptation and other social, economic, and environmental benefits. Based on the Technology Fact Sheets, technologies were ranked using MCDA. The MCDA results were reviewed at least three times by different group of stakeholders such as the Ministry of Food, Agriculture and Light Industry; and other projects, programs and research institutions. Interviews with at least two representative farmers were conducted to validate prioritization results. Finally, three technologies for arable farming were selected.

4.1 Climate Change Vulnerability and Existing Technologies and Practices in Arable Farming

In agricultural areas of Mongolia, precipitation variation is high during the growing season, which leads to big fluctuations in crop yields from year to year. In the last 20 years, crop yields have had decreasing trends. There have been many factors that have affected this tendency. Firstly, soil fertility has been depleted after long term crop rotation of black fallow-wheat–black fallow. From the 1990s, a significant amount of agricultural land was abandoned due to a lack of investment and financial resources. The frequency and magnitude of drought and aridity increased in the late 1990s. Measurement of crop fields by the Agricultural Institute of *Darkhan-Uul aimag* showed that the spring wheat yield decreased by 28 kg/ha per year during the period of 1986 to 2007 (MARCC, 2009).

Another factor affecting yield decline is the rising number of hot spells during crop flowering and pollination stages. Climate change impacts study revealed a significant correlation between the number of days with temperatures higher than 26 ^{0}C and the critical period – July for wheat crops. This is also reflected in changes to crop development stages. In theory, when temperatures rise, the crop development stage will be shortened. However, higher temperatures above certain thresholds will possibly delay the crop development. Observation data confirmed that all wheat stages were shortened except the stage from tilling to heading.

In climate change impacts study, the decision support system for agrotechnology transfer (DSSAT) 4.0 model was used to assess future trends of spring wheat yield. Spring wheat yields were estimated for temperature increases of 1°C, 2°C and 3°C and precipitation changes of ±10% and ±20%. In addition, CO_2 concentration was taken in the years of the study of crop yield changes as current in the 2011 to 2030 period, 1.5 times higher in the period of 2056-2065 and double in 2080-2099 years. Due to faster crop growth under higher temperatures, the spring wheat growing period could be shortened by 3-5 days.

Spring wheat yield changes in the future were estimated in an A1B emission scenario projected by the *HadCM3* model. This showed that wheat yield would decline between 1-30 percent (on average 13 percent) in 2011-2030 from the current average yield. However, possible effects of warming, such as pest and disease occurrence, hot spells, changes in the nature of precipitation changes (more frequent heavy rains) etc were not included in the simulation (SNC Mongolia, 2010).

The following adaptation measures have been recommended for agriculture in the Second National Communication, MARCC and National Action Plan for Climate Change:

- ✓ Development and introduction of drought and hot weather resistant local varieties of spring wheat
- ✓ Extending irrigated agriculture based on drought resistant crops, application of water saving and soil protection technologies
- ✓ Establishment of protection tree strips around cropland
- ✓ Application of improved agricultural practices through strengthening of the capacity of research institutions to conduct studies on pests and diseases, tillage and planting technologies, chemical applications and crop varieties, etc.
- ✓ Extension of fertilizer production and processing, and converting dung and manure wastes from swine and cow farms into organic fertilizer
- ✓ Coordination of cultivation of wild land and crop farming in remote areas through economic policies
- ✓ Supporting farmers, companies and farming groups to apply best soil tillage practices and technologies through taxation and economic policies
- ✓ Carrying out research on winter wheat planting
- ✓ Education of farmers and cultivators on climate change response actions
- ✓ Promoting information and experience exchange between local and international agricultural institutions and farmers
- ✓ Improvement of legislation on land utility and land ownership

The main existing technologies in use in the sector are as follows:.

- ✓ Improved crop rotation through use of fallow tillage
- ✓ Application of herbicide and pesticide: 78,800 liters of cereal herbicide and 320,000 liters of fallow herbicide were supplied by the government to wheat growing farms and companies in 2011.
- ✓ Fertilizers: 1500 Metric tons of mineral fertilizers were provided by the government to grain producers using loans with 30% pre-payment in 2011. 76 Metric tons of bio fertilizers and 8,400 liters of nitrogen fertilizers were applied by vegetable growers in each year.
- ✓ Building modern grain storage and vegetable storage facilities
- ✓ Greenhouse: Greenhouses and plastic materials were supplied to vegetable growers and berry tree farmers using soft loans. About 400 greenhouses over 50,000 square meter area were established in the last 3-4 years (www.mofa.gov.mn).
- ✓ Irrigation system: About 11.8 % of the total agriculture land or 37,500 ha is irrigated. The majority of them is

potato and vegetable fields. In 2010, 22 irrigation systems were established and repaired.

- ✓ Research and experiments on planting fruit trees and bushes are being conducted in Darkhan-Uul aimag. Some varieties of fruits are brought from other countries.
- ✓ Sea-buckthorn planting is being extended and equipments to harvest fruits have been tested. Small scale processing factories have been established.
- ✓ Agriculture machines and tractors have been renewed in order to increase agricultural production.

4.2 Adaptation Technology Options for Arable farming and their main adaptation benefits

Agricultural key experts along with stakeholders identified nine adaptation technologies (Table 11) for arable farming.

Table 11: Arable farming technologies and their main adaptation benefits

No	Technology	The main climate change adaptation benefits
1	Crop planting under plastic mulch	✓ Soil moisture retention ✓ Limiting weeds growth ✓ Reducing nitrogen and other nutrients losses through leaching ✓ Reduction in soil compaction
2	Vegetable production system through drip irrigation	✓ Efficient use of water ✓ Reducing demand for water and water evaporation losses ✓ Efficient fertilizer application ✓ Less dependency on wind and rain
3	System of wheat intensification through conservation tillage	✓ Protection of soil fertility ✓ Reducing soil erosion ✓ Soil moisture retention
4	Forest strip protection of crop fields	✓ Reducing soil erosion due to wind ✓ Biodiversity conservation
5	Breeding of new varieties of crop using marker assisted selection (MAS)	✓ New varieties of crop adapted to drought, diseases and local context ✓ Time saving
6	Proper rotation system of cereal planting	✓ Protection of soil fertility ✓ Reducing pest and weed spread ✓ Reducing land degradation
7	Integrated Nutrient Management	✓ Protection of soil fertility ✓ Increase of environment friendly nutrients application
8	Potato seed production system using aeroponics	✓ Less dependency on weather and climate ✓ Sustainable and healthy potato seed supply
9	Using intelligent nutrient management-micronutrient gel for crops and trees	✓ Efficient management of water application ✓ Cost effective nutrient management

Technology fact sheets with detailed information on these technologies are attached in Annex 2.A.

4.3 Criteria and process of technology prioritization for Arable farming

Criteria for technology prioritization were discussed by the Working Group on Adaptation and were selected. The selected technologies should have benefits in economy, environment and social development of the country. Similarly to the sector prioritization, six indicators as shown in Table 11 have been selected for the multi criteria decision analysis. Also financial cost and contribution to reduce vulnerability were assessed.

Key experts on arable farming have identified potential technologies lists and technology fact sheets with detailed information such as brief technology descriptions, the total costs of the technology, the application potential in the country, the adaptation and other social, economic, and environmental benefits. Experts made the first prioritization using MCDA analysis and presented at Workshop 3 of stakeholders in order to receive feedback and opinions. Based on discussion, rating and ranking of technologies of arable farming were reviewed and updated. Individual interviews with representative farmers regarding technologies were conducted. At Workshop 4, technology prioritization was finalized in consensus with all members of the Working Group on Adaptation considering reflections of stakeholders (Table 12). Final MCDA results are displayed in Table 13.

Table 12: Technology prioritization initial scores in arable farming

Technology	Benefits						Investment cost (low-3, meduim-2, high-1	Contribution to reduce vulnerability
	Economy		Environment		Society			
	Asset	Business and market activity	Biodiversity	Ecosystem service	Health and livelihood	Employment		
Crop planting under plastic mulches	4	4	3	3	5	4	2	5
Vegetable production system with drip irrigation	5	4	4	4	5	3	2	5
System of wheat intensification through conservation tillage	5	5	4	4	5	3	2	5
Forest strip protection of agriculture land	3	2	5	3	3	3	1	5
Breeding of new varieties of crop using marker assisted selection (MAS)	4	4	2	4	2	2	2	4
Proper rotation system of cereals planting	3	4	5	4	4	3	2	4
Integrated Nutrient Management	4	4	3	4	3	3	2	4
Potato seed production system using aeroponics	4	4	3	3	3	2	3	4
Using intelligent nutrient management- micronutrient gel for crops and trees	3	3	4	4	3	2	1	5

Table 13: Final technology prioritization using multi criteria decision analysis tool in arable farming

Technology	Benefits						Investment cost (low-3, meduim-2, high-1	Contribution to reduce vulnerability	Overall weight	Ranking
	Economy		Environment		Society					
	Asset	Business and market activity	Biodiversity	Ecosystem service	Health and livelihood	Employment				
Crop planting under plastic mulches	1	4	9	0	9	3	23	6	54.7	**V**
Vegetable production system with drip irrigation	3	4	17	1	9	1	23	6	64.6	**II**
System of wheat intensification through conservation tillage	3	6	17	1	9	1	23	6	66.5	**I**
Forest strip protection of agriculture land	0	0	26	0	3	1	0	6	36.4	**VII**
Breeding of new varieties of crop using marker assisted selection (MAS)	1	4	0	1	0	0	23	0	29.8	**VIII**
Proper rotation system of cereals planting	0	4	26	1	6	1	23	0	62.0	**IV**
Integrated Nutrient Management	1	4	9	1	3	1	23	0	42.9	**VI**
Potato seed production system using aeroponics	1	4	9	0	3	0	47	0	63.4	**III**
Using intelligent nutrient management- micronutrient gel for crops and trees	0	2	17	1	3	0	0	6	29.4	**IX**

High ranking technologies scored relatively higher rates of economic asset, environment biodiversity and livelihood benefits for the country. System of wheat intensification was ranked as the highest in terms of economic asset and business and market and livelihood benefits because the technology would help to secure wheat production in the country in future. Vegetable production system with drip irrigation plays crucial role in dry condition and contributes to soil fertility conservation and got the highest scores in economic asset and livelihood criteria. Potato seed production system has important functions in biodiversity and higher investment benefits according to MCDA results.

4.4 Results of technology prioritization

One of the challenges in MCDA was reaching consensus among stakeholders and even among key experts. So clarification of climate change adaptation benefits was needed frequently. Consequently, review of MCDA has been conducted several times.

Based on MCDA final results, three technologies were prioritized:

- System of wheat intensification (SWI): System of wheat intensification that integrates the conservation tillage practices and holistic plant management is a viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability. SWI consists of conservation tillage and holistic plant management with an emphasis on wheat root treatment to achieve the objective of economically, ecologically and socially sustainable agricultural production. SWI method is about managing the crop, soil, and nutrients to promote a vibrant soil system that, in turn, promotes larger root systems. Conservation tillage practices reduce the amount of soil erosion through ensuring permanent soil cover minimizing soil disturbance and slowing water flow. In the pilot project of conservation tillage in Mongolia, tillage operations were significantly reduced for cropping.

- Vegetable production system (VPS) with drip irrigation: The technology aims to intensify vegetable production through a set of water saving equipments such as drip irrigation, and low cost green house or mulch. Drip irrigation is not only related to irrigation regime and equipment - it also includes fertilizer, pesticide and soil management and their proper application. As a whole system, the technology can increase efficiency and provide many benefits to farmers. Mulch is a product used to suppress weeds and conserve water in crop production and landscaping. Mongolia is experiencing water shortages and an increasingly dry climate due to climate change. Therefore, drip irrigation with plastic mulch can help reduce water consumption, decrease labour intensity, and increase production.

- Potato seed production system (PSPS): comprises the development of varieties, producing mini tubers or elite seeds, multiplying seeds, and storage and delivery systems. Producing potato mini tubers in aeroponics has high reproduction coefficient and requires less labour, time and financial resources than potato seed production in soil. The technology can improve the supply of good and healthy potato seeds, and increase the potato production per area. The technology will be the basis of a sustainable supply of potato seed of adapted potato varieties and free of virus infections.

For the final selection of technologies, we took a system based approach – that is, crops systems as a whole (such as wheat or potato) were considered and were combined with individual technologies into a comprehensive system technologies. A system wide approach was used because a simple, one-piece approach cannot solve complex problems such as climate change and environmental degradation.

5. Technology prioritization for animal husbandry

The technology prioritization of animal husbandry sector followed the same process of arable framing sector. Livestock experts identified potential technologies for climate change adaptation and developed the Technology Fact Sheets for each technology (Annex 2.B). Based on the technology fact sheets, technologies were ranked through MCDA. The MCDA results were reviewed along with stakeholders groups. Final review of MCDA results and ranking was done by the working group on adaptation. Three technologies for animal husbandry were selected through the process.

5.1 Climate Change Vulnerability and Existing Technologies and Practices in animal husbandry

Climate change, through pasture alteration, indirectly influences the productivity and efficiency of animal husbandry. In addition, climate changes such as temperature, precipitation and variations in snow coverage could also have an effect on animal energy cycles and dynamics. An increasing number of very hot summer days due to climate change has the potential to influence the summer conditions for animal grazing.

Many interrelated factors have an influence on livestock and its main parameters, such as animal fat and live-weight changes. These factors impact on growth, reproduction, productivity and vitality. Consequently, the investigation of trends in changes of weight has become a key issue and includes many concerns related to climate and ecological changes. The analysis of monthly sheep weight for 21 years at the zoo meteorological station in *Tsetserlegsoum* of *Khuvsgul* and *Orkhon soum* of *Bulgan aimag* demonstrated that sheep weight has decreased by 4 kg and goat weight - by 2 kg on average in the forest steppe regions. The rate of this decrease has been significant especially since 1990. According to measurements, the weight of a matured cow has dropped by 13.8 kg from 1980 to 2001 (SNC Mongolia, 2010).

These negative changes in animal productivity and meat production will lead to biological and economic losses. The survival rate of animals during lean and severe winter and spring conditions would be reduced because of an insufficient accumulation of energy and weight of livestock in the summer-autumn period. Consequently, this leads to long term weight loss because of diminished ability to gain weight in the summer- autumn seasons. If the decline in animal weights is extrapolated to nationwide livestock production, the loss in meat production could amount to thousands of kilograms of meat. Subsequently, the herders' livelihoods and its flow on economic benefits would decrease. In addition to weight reduction, other animal products have decreased. Multi year measurements in the forest steppe sites also indicate that wool production of sheep has dropped by 90g or 4.3g per year. As a result, the total wool production in the country could reduce by 60 metric tons. Also, goat cashmere and cattle hair production are tending to decrease. In particular, cashmere production per goat has decreased by 4.1g or 0.2g per year over the past 20 years. The total national production of cashmere is estimated at 2 metric tons assuming there are 11 million goats in the country. These results show that recent climate changes primarily have a negative effect on pastoral livestock, which leads to a reduction in livestock productivity and impacts the economic efficiency of animal husbandry. Due to climatic changes over the past 20 year period, sheep, goat and cattle hair cutting times have shifted earlier by about a week (MARCC 2009).

The hot air temperatures during the summer-autumn period significantly impact on sheep grazing, which ultimately affects livestock reproduction, fat and productivity. Animal stimulus lessens and the daily pasturage duration decreases due to the reduction in animals grazing on pastures under very hot temperatures.

In the future, Mongolian sheep live-weight in the summer-autumn period will decrease in most areas because of increased summer warming and dryness, as shown in Table 14.

Table 14: Sheep live-weight changes in summer-autumn period by* HadCM3 *model under* SRES *A2 emission scenario, (%)

Regions	*2011-2039*	*2040-2069*	*2070-2099*
The forest steppe	-10.68	-34.40	-57.75
The steppe	-12.85	-31.67	-39.50
The high mountains	-2.92	-3.05	-9.03
The Gobi desert	2.02	3.87	-0.18

Source: SNC Mongolia, 2010

The rate of decline in sheep weights will be greater moving from the south, to the north west of the country. In other words, declines in sheep weight gain will be greater in the forest steppes than in the steppe and the *Gobi* desert areas.

Animal husbandry adapts to environmental and climatic changes through the biological adaptive ability of livestock itself and is regulated by human activity. Half of the Mongolian population lives in the countryside and their main source of livelihood is animal husbandry. Animal husbandry activities also provide food and fiber to the other half. Animal husbandry and its growth has significant influence on the country's food safety, rural development and well being of herdsmen and livestock, which are all tied and inseparable.

Adaptation measures in animal husbandry are identified in the major documents such as (MARCC 2009, SNC Mongolia 2010 and NAPCC Mongolia 2010):

- ✓ Development of a new model of combined practices of pastoral and modern intensified livestock farming
- ✓ Establishment of integrated livestock model farms in suburban areas or along rail and national road transportation lines.
- ✓ Improving animals tolerance abilities and rearing best local breeds
- ✓ Strengthening risk management of pastoral livestock and insurance systems
- ✓ Diversifying livelihood sources for herders and support farming initiatives
- ✓ Building capacity of livestock managers and herders through various methods
- ✓ Introduction of the best technologies for the processing of livestock raw materials
- ✓ Supporting household and community based enterprise intitiatives
- ✓ Reinforcement of the legal environment on the management of the structure of herds and animal numbers in accordance with pasture resource sustainability
- ✓ Defining regions or areas for pastoral and intesified animal husbandry
- ✓ Regulation of the number of animals through taxation policy and pasture carrying capacity
- ✓ Supporting investment sources for pasture improvement through a tax on pasture usage or charge, etc.
- ✓ Supplying herdsmen with portable and renewable energy sources

The main existing technologies in the animal husbandry sector are described briefly:

- ✓ Pasture management by herders groups through land leasing in peri-urban areas: This is a system of leasing peri-urban pasture lands to herder groups, and providing key infrastructure and training so that they can improve livestock management, productivity and, ultimately, farm income. About 300 herder groups (representing approximately 1,000 households) in areas near 3 major cities have benefited and the project funded by Millennium Challenge Corporation of USA.

- ✓ Index based livestock insurance: This was introduced in 2005 by the Government with support from the World Bank. The insurance program is a combination of self-insurance, market based insurance, and a social safety net. Herders bear the cost of small losses that do not affect the viability of their business, larger losses are transferred to the private insurance industry, and only the final layer of catastrophic losses is borne by the government. This project has been scaled up and will be rolled out to additional *aimags*, with the intention to reach all of Mongolia's 21 *aimags* by 2012.

- ✓ Livestock Early Warning System: This is a forage monitoring system that provides near real time spatial and temporal assessments of current and forecast conditions for Mongolian livestock. The system aims to assist with providing appropriate information and analysis to herders, local/provincial and national government officials to make decisions. The system includes monitoring of vegetation, modeling, mapping and statistical analysis. Dissemination and training in the use of products are being done at regional and local levels.

- ✓ Forage management: The Government supports hay mowing as a preparatory measure for climate risks and winters. Producing forage through natural hay mowing has increased by about 9% compared to 2009 (www.mofa.gov.mn). However, proper sustainable management of forage considering pasture degradation and drought is required.

- ✓ Rodent and insect control in pasture: This activity was done in about 150 *soums* of Mongolia and the Government spent almost 1.3 million US$ in 2008. Operations to protect against insects and grasshoppers use imported chemical pesticide. For rodents, biological and microbiological methods have been used. However, there has been no significant progress.

- ✓ Intensified farming: In order to ensure food security for the urban population, intensified farms have being developed in the last decade. Types of intensified farms are milk production from cows, beef production, wool production, swine and chicken farms. Artificial insemination which uses deep frozen semen has been conducted at 36 breeding centers for cows and 38 breeding centers for sheep and goats.

- ✓ Livestock disease management: The Government is implementing the Animal Health and Livestock Marketing project with support from the EU. One of the objectives is to improve animal health through background research, investment in laboratory equipment and facilities and training of herders and local government officials in 5 *aimags* of Mongolia.

5.2 Adaptation Technology Options for animal husbandry and their main adaptation benefits

Animal husbandry in Mongolia is nomadic in nature so adaptation technologies need to be appropriate for the context. Livestock experts with stakeholders have identified seven adaptation technologies for animal husbandry (Table 15)

Table 15: Livestock technologies and their main adaptation benefits

No	Technology	The main climate change adaptation benefits
1	Seasonal to inter-annual prediction and early warning system	✓ Improving climate change prediction and research capacity ✓ Reducing economic losses caused by climate related disasters ✓ Strengthening capacity to plan and implement climate change adaptation measures ✓ Increased resilience to natural disasters
2	Planting of forage perennials resistant to drought and cold winter for fodder production	✓ Improving vegetation cover and biodiversity ✓ Reducing pasture degradation
3	Selective breeding of livestock	✓ Improving livestock quality and new breeds resilient to climate change and local context ✓ Controlled animal numbers and composition
4	Producing supplement feed for winter and spring	✓ Efficient use of pasture plants ✓ Increased resilience of livestock to *zud* and drought
5	Rain and snow water harvesting for herder groups	✓ Efficient water resource usage ✓ Improving vegetation cover if water is used for forage planting ✓ Better resilience to drought and drier climate
6	Producing supplement forage with bacterial enzymes for livestock	✓ Efficient use of pasture plants ✓ Increased resilience of livestock to *zud* and drought ✓ Decreased methane release from ruminant animals
7	Sustainable Pasture Management	✓ Efficient use of pasture ✓ Decreased pasture degradation ✓ Increased animals resilience
8	Livestock disease management	✓ Better control livestock diseases specially vector- borne. ✓ Increase resilience of livestock to diseases

Detailed information of the above technologies is given in Technology Fact Sheets attached in Annex 2.B.

5.3 Criteria and process of technology prioritization for Animal husbandry

Criteria for technology prioritization were selected through a similar process mentioned in 4.3. The selected technologies are expected to benefit the country's economy, environment and social development. The same indicators of arable farming were used in the multi criteria decision analysis for animal husbandry.

Livestock key experts identified potential technologies and TFSs for each technology. Identified technologies were initially rated based on their economic, environmental and social benefits, costs and contribution to reducing vulnerability using MCDA by the Working Group on Adaptation with all key experts. Stakeholders provided their feedback and opinions at workshops as well as through meetings and discussions. Based on stakeholder comments, rating and ranking of technologies of livestock were reviewed and updated. Initial scores per technology have been shown in Table 16. Final results using a multi criteria decision analysis tool have been presented in Table 17.

Table 16: Initial technology prioritization scores in animal husbandry

Technology	Benefits						Investment cost (low-3, meduim-2, high-1	Contribution to reduce vulnerability
	Economy		Environment		Society			
	Asset	Business and market activity	Biodiversity	Ecosystem service	Health and livelihood	Employment		
Seasonal to inter-annual prediction and livestock early warning system	4	3	4	4	4	3	2	4
Planting of forage perennials resistant to drought and cold winter for fodder production	3	3	4	4	3	2	1	4
Selective breeding of livestock	4	3	4	4	4	1	2	3
Producing supplement feed for winter and spring	3	3	3	3	3	2	2	3
Rain and snow water harvesting for herder groups	3	3	4	3	4	2	1	4
Producing supplement forage with bacterial enzyme for livestock	3	3	2	3	3	2	2	3
Sustainable Pasture Management	2	3	4	4	2	2	2	4
Livestock Disease Management	4	4	3	4	4	3	1	4

Table 17: Technology prioritization results using MCDA tool in animal husbandry

Technology	**Benefits**						**Investment cost (low-3, meduim-2, high-1**	**Contribution to reduce vulnerability**	**Overall weight**	**Prioritization**
	Economy		**Environment**		**Society**					
	Asset	**Business and market activity**	**Biodiversity**	**Ecosystem service**	**Health and livelihood**	**Employment**				
Seasonal to inter-annual prediction and livestock early warning system	23	0	23	3	4	15	23	8	97.5	**I**
Planting of forage perennials resistant to drought and cold winter for fodder production	11	0	23	3	2	8	0	8	53.8	**VI**
Selective breeding of livestock	23	0	23	3	4	0	23	0	74.7	**II**
Producing supplement feed for winter and spring	11	0	11	0	2	8	23	0	55.1	**V**
Rain and snow water harvesting for herder groups	11	0	23	0	4	8	0	8	53.2	**VII**
Producing supplement forage with bacterial enzyme for livestock	11	0	0	0	2	8	23	0	43.7	**VIII**
Sustainable Pasture Management	0	0	23	3	0	8	23	8	63.3	**IV**
Livestock Disease Management	23	3	11	3	4	15	0	8	65.8	**III**

Firstly ranked technologies have relatively higher scores of economic asset, environmental biodiversity and livelihood benefits for the country. Seasonal to inter-annual prediction and early warning of natural disaster was ranked as the highest in terms of economic asset, environmental and livelihood benefits because the technology would help to significantly reduce vulnerability of livestock to *zud*. Second and third technologies which are Selective breeding and Livestock Disease management, play a crucial role in improving livestock quality and reducing the vulnerability of livestock to animal diseases. So, experts and stakeholders decided to merge these two technologies into a comprehensive system technology of High quality livestock. Sustainable Pasture management which ranked as fourth, was selected due to its importance in nomadic livestock and ecosystems.

5.4 Results of technology prioritization of animal husbandry

Because of the unique nature of livestock sub-sector in Mongolia, identifying adaptation technologies has been a complicated task. Nevertheless, technology prioritization for animal husbandry has been agreed upon by stakeholders. Three technologies have been identified as high priority:

- Seasonal to Inter-annual Prediction and Livestock Early Warning system (SPLEWS): The current livestock sector is based on the traditional nomadic pasture system and herder families' livelihood is highly dependent on and influenced by weather and climate. SPLEWS is "the provision of precise and effective information through identified institutions that allows herders and government officials to prepare for effective response to slow on set disasters including drought and *zud* to avoid or reduce risks". SPLEWS integrates main components such as risk knowledge, monitoring and predicting, disseminating information and response. Through effective implementation of SPLEWS, animal loss can be significantly reduced by 80%.

- High quality livestock (HQL) through selective breeding and animal disease management: Improving animal quality rather than quantity is the best method to ensure high production and livestock development in Mongolia. The livelihoods of about 160 thousand herding families depend on livestock. HQL technology aims to improve the quality of all animals based on selective breeding using these core herds as well as improved animal health services. Diffusion of the technology would enable Mongolia to control livestock numbers within its pasture carrying capacity and to reduce overgrazing and desertification.

- Sustainable pasture management: Pastureland is the backbone of Mongolian agriculture. Pasture degradation and desertification are among the most serious environmental problems. Comprehensive sustainable pasture management will conserve natural resources and thereby increase livestock productivity. All of these directly increase the nation's resilience to withstanding the negative impacts of climate change and the benefits of SPM will be widespread with producers as well as consumers.

SUMMARY CONCLUSIONS

The main objective of the Technology Needs Assessment is to identify technology options to reduce the vulnerability of Mongolia to climate change and to ensure sustainable development. The following major steps have been taken in the assessment:

- ✓ Established an organizational structure and facilitated stakeholder engagement
- ✓ Defined implications of climate change for the country's development priorities and strategies
- ✓ Prioritized sectors and subsectors
- ✓ Identified of technologies as high priorities for climate change adaptation

The TNA process was participatory and aimed at involving multi sectoral experts and stakeholders in sector prioritization. Consequently stakeholder engagement was one of the key aspects of achievement. Different entities including ministries, research and educational institutions, international and national NGOs, private enterprises, and representatives of farmers and herders were involved in the process in different ways.

Based on research and multi criteria decision analysis (MCDA), arable farming and animal husbandry sub sectors were identified as the sectors most vulnerable to climate change and their social, economic and environmental loss due to impacts are expected to be higher than those of other sectors. The agriculture sector is a major economic sector for the country and the livelihoods of herders and farmers rely on these sub sectors. Many of the Government's development policies focus on sustainable development of the agriculture sector.

Water is cross cutting issue which is related to other sectors and sub sectors including arable farming and animal husbandry. Whilst the water sector was not prioritized, water saving technology options have been included within arable farming and livestock subsectors.

Climate change impacts on prioritized sub sectors and current status of technology applications have been defined based on research of existing studies and documents. Potential adaptation technologies with detailed information have been identified and discussed through an intensive stakeholder engagement process. Prioritization of adaptation technologies was completed and the following six technologies which contribute to reducing agriculture sector vulnerabilities have been prioritized:

Arable farming:

- System of wheat intensification (SWI): System of wheat intensification that integrates the conservation tillage practices and holistic plant management is a viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability.
- Vegetable production system (VPS) with drip irrigation: The technology aims to intensify vegetable production through a set of water saving equipment such as drip irrigation, and low cost green house or mulch.

- Potato seed production system (PSPS): comprises the development of varieties, producing mini tubers or elite seeds, multiplying seeds, and storage and delivery systems. The technology can improve the supply of good and healthy potato seeds and increase the potato production per area. The technology will be basis of sustainable supply of potato seed of adapted potato varieties and free of virus infections.

Animal husbandry:

- Seasonal to Inter-annual Prediction and Livestock Early Warning system (SPLEWS): The current livestock sector is based on the traditional nomadic pasture system and herder families' livelihood is highly dependent on and influenced by weather and climate. SPLEWS integrates main components such as risk knowledge, monitoring and predicting, disseminating information and response. Precise seasonal prediction and proper preparation for *zud* would result in saving about 80 % of animals' losses every winter.

- High quality livestock (HQL) through selective breeding and animal disease management: Improving animal quality rather than quantity is the best method to ensure high production and livestock development in Mongolia. The livelihoods of about 160 thousand herding families depend on livestock. HQL technology aims to improve the quality of all animals based on selective breeding using these core herds as well as improved animal health services. Diffusion of the technology would enable Mongolia to control livestock numbers within its pasture carrying capacity and to reduce overgrazing and desertification.

- Sustainable Pasture Management (SPM): Pastureland is the backbone of Mongolian agriculture. Pasture degradation and desertification are among the most serious environmental problems. Comprehensive sustainable pasture management will conserve natural resources and thereby increase livestock productivity.

Next steps would be conducting barrier analysis and defining enabling frameworks and developing Technology Action Plan based on the Technology Needs Assessment report.

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ANNEX 1: CLIMATE CHANGE IMPACT ON SECTORS

Changes in climate and environment	*Potential impact*	*Risk (high-3, medium-2, low-1)*	*Indirect consequences*	*Information source reliability (high-3, medium – 2, low – 1)*	*Confidence level (high-3, medium – 2, low – 1)*	*Total score*
Agriculture/Arable Farming						
1.Increase of CO_2 in the atmosphere	Transpiration of most crops will be reduced	2	Crop production will be decreased	2	2	6
2.Increase of CO_2 in the atmosphere	Soil moisture will be increased	1	Increase of greenhouse gases from soil	2	2	5
3.Summer rain would decrease	Soil moisture content will be decreased	3	Decrease of crop harvest	3	3	9
4.Rain intensity variation coefficient will be increased in growing season	Soil water availability will be unstable	3	Crop production will be unstable	3	3	9
5.Rain intensity will be increased	Soil erosion from water will occur	2	Crop production will be reduced	3	2	7
6.Rain intensity will be increased	Threats of hail & thunderstorms will be increased	2	Crop production will be reduced	3	2	7
7.Winter precipitation will increase	Snow coverage will be deeper	1	Opportunities for winter crops will be greater	3	1	5
8.Precipitation of cool seasons will be increased	Soil moisture in spring will be higher	1	Crop germination can occur earlier	2	1	4
9.Dry spells will be longer during growing period	Drought, and hot and dry wind storms will cause more threats	2	Crop yields will decline	2	2	6
10.The average temperature gets higher during warm season	Growing season will be extended	3	Crops adapted to warm climate need to be planted	3	3	9

11.The average temperature higher during warm seasons	Crops can be planted earlier	3	Opportunity to expand crop field	3	3	9
12.Melting of stable snow cover will start earlier	Soil will be drier during planting	2	Early planting will be limited	3	3	9
13.Melting of stable snow cover will start earlier	Opportunity of land improvement with snow will be limited	2	Opportunity to increase crop production would be reduced	1	1	4
14.Evaporation from land will be increased	Soil moisture will be unstable	3	Crop yield will be decreased, irrigation is required	3	3	9
15.Soil will be frozen in shallow layers	Soil tillage can be started earlier	1	Cost of soil tillage especially frozen soil will be reduced	1	1	3
16.Frequency of hot spells will be increased	Photosynthesis rate of crops will slow down	3	Crop will experience heat stress and yield will be reduced	3	3	9
17.Frequency of hot spells will be increased	Drought will be intensified	3	Wheat grain can not be filled and harvests will reduce	3	3	9
18.Diurnal temperature amplitude will be greater during growing season	Cumulated heat for crop growth will be unstable	2	Unstable crop yields	2	2	6
19.Diurnal temperature amplitude will be greater during growing season	Frequent frosts during planting period	2	Loss of crop yields	2	2	6
20.Higher cumulated heat for crop growth during growing period	Crop pests and insects may spread	3	Crop yield will be reduced	3	3	9

21.Humidity and temperature will be increased during growing season	Expansion of crop diseases will occur	3	Crop production will be reduced in quality and quantity	2	2	7
22.Rainfall will be reduced and temperature will increase	Soil moisture will be unstable	3	Soil fertility will be depleted Content of soil organic carbon and nitrogen will be reduced	2	3	9
Animal husbandry / Livestock						
1. CO_2 concentration in the atmosphere will be increased	Pasture C_3plants will grow better	2	Pasture in the Gobi desert regions may benefit	2	2	6
2. CO_2 concentration in the atmosphere will be increased	Crop transpiration will be decreased	2	Pasture will be affected positively	2	1	5
3. CO_2 concentration in the atmosphere will be increased	Soil moisture and water will be increased	2	Emission of CO_2 andCH_4 from soil will increase	2	1	5
4.Rain will decrease in summer	Soil moisture will be reduced	3	Pasture biomass will decrease	3	3	9
5.Rain variation coefficient will rise during growing season	Soil moisture availability will be unstable	3	Pasture biomass will vary greatly	3	3	9
6.Frequency of intense rainfall will increase	Soil erosion by water will occur	2	Pasture production will drop gradually	3	3	8
7.Frequency of intense rainfall will increase	Coverage area of one rain event will be decreased	2	Vegetation-drought cover will have patchy pattern	3	3	8
8.Intense rainfall will have more weight in the total precipitation	Soil moisture will be reduced	3	Pasture biomass will decrease	3	2	8

9.Rainfall continuity will be reduced	Soil moisture availability will decrease	2	Pasture biomass will decrease	2	2	6
10.Dry spells will be longer in summer	Drought and hot and dry windstorms will have more threats	2	Grazing of animals will be shorter due to heat stress	2	2	6
11.Dry spells will be longer and wet spells will be shorter in summer	Drought and hot and dry windstorms will have more threats	2	Risks of drought will increase	2	3	7
12.Winter precipitation will increase	Snow coverage on pasture will be deeper	3	Harsh winter/ zud will have more risks	3	3	9
13.Winter precipitation will increase	Snow coverage on pasture will be deeper	3	Animals cannot graze on pasture	2	2	7
14.Winter precipitation will increase	Ice may cover pasture area	3	Animals cannot graze on pasture	2	2	7
15.Winter precipitation will increase	Spring soil moisture will rise	1	Animals can graze in spring due to earlier plant growth	2	2	5
16.Air temperature will rise	Growing season will be extended	1	Animals will have longer to gain weight	3	2	6
17.Air temperature will rise in warm season	Evaporation from water surface will increase	3	Open water sources will be scarce	3	3	9
18.Air temperature will rise in warm season	Cumulative heat for plant growth will be improved	2	Pasture in the high mountains may be improved	3	3	8
19.Air temperature will rise in warm season	Potential evapotranspiration will increase	3	Dryness will be intensified	3	3	9
20.Air temperature will rise in warm season	Plant transpiration will increase	3	Biomass will be improved	3	3	9

21. Air temperature will rise	Permafrost starts to melt from the top	3	Meadow pasture will improve in the high mountain belts	2	2	7
22. Air temperature will rise	Springs will appear in the high mountain belts	3	Water supply may improve in the high mountains	2	2	7
23.Number of hot days will be increased	Drought will be intensified	3	Pasture will be degraded	3	3	9
24.Number of hot days will be increased	Animals cannot graze due to heat stress	3	Animals' weight gain will be reduced	3	3	9
25. Number of hot days will be increased	Pasture plants will experience heat stress	3	Pasture plant composition will be changed and pasture will be degraded	3	3	9
26.Temperature in winter will rise	Animal heat losses will be reduced	2	Zud risk will be reduced	3	3	8
27.Temperature in winter will rise	Animal pen/ shelter will lose less heat	2	Opportunity for intensive farming may be improved	3	2	7
28.Temperature in winter will rise	Ice thickness of rivers will be reduced	2	Water supply for animals can be improved	3	2	7
29.Temperature variation coefficient will be increased in winter	Weather will become more unstable	3	Zud caused by ice (iron zud) will be more frequent	2	2	7
30.Temperature variation coefficient will be increased in winter	Cold waves might continue longer	3	Zud risks will be increased	2	2	7
31.Temperature variation coefficient will be increased in spring and autumn	Spring windstorms may greatly vary	2	Sustainability of livestock may deteriorate	2	2	6
32.Temperature variation coefficient will be increased in summer	Frequency of warm and cold waves and stability are possibly increased	2	Sustainability of livestock may deteriorate	2	2	6

33.Frequency of extreme cold will be reduced	Zud risks will decrease	2	Animals death will decrease	2	2	6
34.Summer rain will decrease	Ground water levels will deepen in the steppe region	2	Pasture water supply will get worse	2	2	6
35.Summer rain will decrease and air temperature will increase	Dryness process will be intensified	3	Desertification will be intensified. Self accelerating process of desertification will occur in the steppe region	3	3	9
36.Precipitation as well as air temperature will increase during cool season	Weather will become more humid	3	Risk of different types of zud (white and iron zud) will happen	3	3	9
37.Precipitation as well as air temperature will increase during cool season	Density of snow coverage will rise	3	Grazing will be difficult because hooves of sheep and goats will be too injured to dig snow	3	3	9
38.Air temperature and absolute humidity will increase	Weather will become more humid	2	There will be outbreaks of animal infectious diseases	2	2	6
39.Cumulative heat for crop development will increase during warm season	Probability of pasture pests and insect outbreaks will escalate	3	Pasture biomass will decline	3	3	9
40. Cumulative heat will increase during the warm season	Grasshopper (grasshopper of Munhkhairhan) will expand in the Altai mountains	2	Pasture in the high mountains will be degraded	2	2	6
41.Rainfall will decrease while temperature will increase during the warm season	The dryness process will be intensified	3	Soil organic matter will be reduced	3	3	9

Water resource and quality						
1.Summer rain will decrease	Soil moisture content will be reduced	2	Water resources in the arid region will be reduced	2	2	6
2.Summer rain will decrease	Soil moisture content will be reduced	3	Ground water level will deepen	3	3	9
3.Precipitation in the cool season will increase	Snow in water basin will increase	3	Water resources of rivers will increase	3	3	9
4.Precipitation in the cool season will increase	Snow in water basin will increase	3	Spring flood risks will escalate in the mountainous areas	3	3	9
5.Precipitation in the cool season will increase	Snow caps will increase in the high mountains	2	Water resource originated from the Altai mountains will increase	2	2	6
6.Rain intensity will increase in summer	Less water will infiltrate the forest and soil	3	River flood risks will be higher	3	3	9
7.Rain intensity will increase in summer	Infiltration of rain water into soil will be lower	3	Flash flood risks will be higher	3	3	9
8.Rain intensity will increase in summer	River run off will increase	2	Small river beds will be changed	1	1	4
9.Rain intensity will increase in summer	Rain water will not infiltrate into the soil and flow away	2	Water will accumulate in marsh hollows in the steppe and the Gobi desert area	1	2	5
10.Air temperature will increase	Permafrost will start to melt from the top	3	Run off of rivers will rise in permafrost areas	3	3	9
11.Air temperature will increase	Permafrost will start to melt from the top	3	Water level of lakes will rise in permafrost areas	3	3	9
12.Number of days with temperatures above 0°C will increase	Glaciers in the Altai mountains will melting	3	Run off of rivers will rise in the Altai mountains	3	3	9

13.Number of days with temperature above 0^0C will grow	Glaciers in the Altai mountains will melt	3	Water resource of the Great Depression Lakes will increase	3	2	8
14.Air temperatures will increase in the warm season	Evaporation from water surfaces will increase	3	Water in basins and lakes will decrease	3	3	9
15.Air temperature will increase in the warm season	Air temperature will increase in the warm season	3	Water in basins and lakes will decrease in the steppe and the Gobi regions	3	9	9
16.Air temperature will increase in the warm season	Water temperatures will rise	2	Water quality of lakes will deteriorate in the steppe and the Gobi regions and areas without permafrost	2	2	6
17. Air temperatures will rise in the cool season	Ice thickness of rivers and lakes will decrease	3	Transportation on river and lake ice will be more dangerous	3	2	8
18.Air temperatures will rise in the cool season	The period with ice on rivers and lakes will shorten	3	Water usage will improve for livestock	3	2	8
19.Frequency of extreme hot days will increase	Melting of high mountains glaciers will be intensified	3	Run off of rivers originating in glaciers will increase	3	2	8
20.Frequency of extreme cold days will decrease	Ice thickness of rivers and lakes will decrease	3	Transportation on river and lake ice will be more dangerous	3	2	8
21.Air temperature will cross 0^0C earlier	Snow will melt earlier	2	Probability of spring floods will decrease	2	2	6
Human Health						
1.Rain intensity will increase in summer	Risks of river and flash floods will increase	3	Risks of human death and injury will increase	3	3	9
2.Precipitation will increase in the cold season	Zud will happen more	2	Herders will have limited access to health service due to disasters	3	3	9

3.Precipitation will increase in the cold season	Roads in mountains maybe blocked and become slippery	3	Risks to human life will increase	2	2	7
4.Intensity of heavy rain will increase	Frequency of thunderstorms will increase	3	Risks to human life will increase	2	2	7
5.Air temperatures will increase	Soil freezing layers will be shallower which will lead to better conditions for worms and larva of insects in the soil	2	Insect borne infections are likely to spread	1	2	5
6.Air temperatures and absolute humidity will increase in the warm season	Fly, mosquito and insects which carry infections will spread to greater areas	3	New disease or infection outbreaks will be possible	3	3	9
7.Air temperatures will increase in winter	Risk of freezing will be lower	2	Human lives and injuries will be at less risk due to extreme cold	3	3	8
8.Air temperatures will increase in the warm season	Food may be damaged and poisoned easily	2	Digestive disorders may increase	3	3	8
9.Frequency and intensity of heat waves will increase	Cardiovascular diseases will increase	3	Human mortality will increase	3	3	9
10.Unstable condition of the atmosphere will increase	Atmosphere related disasters will occur more frequently	3	Population vulnerability will increase	3	3	9
Biodiversity and ecosystems						
1. CO_2 concentration in the atmosphere will increase	C3 plants will have higher biomass	2	Ecosystem production will increase in the Gobi desert area	2	2	6

2. CO_2 concentration in the atmosphere will increase	Plant transpiration will be reduced	2	The total ecosystem production will benefit	2	2	6
3. CO_2 concentration in the atmosphere will increase	Soil moisture will increase	2	Emission of CO_2, CH_4 from soil into the atmosphere will increase	2	2	6
4.Rainfall amount will decrease in summer	Soil moisture content will be reduced	3	Ecosystem primary production will decrease	3	3	9
5.Rainfall variation coefficient will increase during growing season	Soil moisture balance will be unstable	3	Ecosystem primary production will vary in greater ranges	3	3	9
6.Frequency of heavy rain will increase	Soil erosion by water will occur	3	Soil fertility will be depleted	3	3	9
7.Heavy rain will contribute more to total precipitation	Soil moisture will decrease	3	Ecosystem primary production will decline	3	2	8
8.The total duration of rain will be shortened	Soil moisture uptake by plants will be reduced	2	Ecosystem primary production will decline	2	2	6
9.Dry spells will be longer and wet spells will be shorter	Drought, and hot and dry windstorms will have more threats	3	Drought risks will be increased	3	3	9
10.Precipitation will increase in winter	Snow coverage will be deeper	3	Wild hoofed animals including gazelle will have challenges to survive	3	3	9
11.Air temperatures will increase in the warm season	Evaporation from water surfaces will increase	3	Open water basins and ponds will become scarce	3	3	9
12.Air temperatures will increase in the warm season	Potential evapotranspiration will increase	3	Vegetation will experience water deficits	3	3	9

13.Geographical patterns of climate factors will be changed	Moisture and heat regimes will be changed	3	Shift of natural zones can occur	3	9	9
14.Air temperatures will increase in the warm season	Cumulative heat for plant growth will increase	2	Ecosystem primary production will increase in the high mountain belts	3	3	8
15.Air temperatures will increase in the warm season	Potential evapotranspiration will increase	3	Dryness and desertification process will be intensified	3	3	9
16.Air temperatures will increase in the warm season	Plant transpiration will increase	3	Photosynthesis rate will be intensified	3	3	9
17.Air temperatures will increase	Permafrost will melt from the top	3	Ecosystem production will be improved in the high mountains	2	2	7
18.Air temperatures will increase	Spring will start earlier in the high mountains	3	Moisture availability will be improved in the high mountains	2	2	7
19.Number of hot days will increase	Drought will be intensified Pasture plants will experience heat stress	3	Pasture composition will change and ecosystem production will decline	3	3	9
20.Winter temperatures will get warmer	Heat loss of wild animals will be reduced	2	Risk of zud will decrease	3	3	9
21.Winter temperatures will get warmer	Animals hibernating in winter will survive better	2	Number of animals hibernating in winter might increase	3	2	7
22.Rain will decrease and air temperatures will increase in the warm season	Increased drying process	3	Desertification will be intensified and self accelerating desertification will occur in the steppe	3	3	9

23.Precipitation and air temperatures will increase in the cool season	Density and depth of snow will increase	3	Conditions for wild hoofed animals will deteriorate. On the contrary, animals hibernating in winter can survive better	3	3	9
24.Higher cumulative heat for plant growth in the warm season	Outbreak of insects and pests harmful to forests and pastures will increase	3	Ecosystem production will decline	3	3	9
25.Higher cumulative heat for plant growth in the warm season	Grasshopper of Munhkhairhan will spread in the Altai mountains	2	Pasture in the high mountains will be degraded	2	2	6
26.Heat and moisture balance will change in the warm season	Insects and bacteria which carry infections will spread	2	New diseases of wild animals will spread	2	2	2
27.Rain will decrease and air temperatures will increase in the warm season	Soil surface layers will dry	3	Soil organic carbon and nitrogen will decrease in the high mountains	3	3	9
Infrastructure						
1.Amount and intensity of heavy rain will increase in the warm season	Flooding will occur more easily because water cannot infiltrate into the soil	3	Roads and urban areas may be covered by flooding	3	3	9
2.Precipitation will increase in the cold season	Snow cover will be deeper	3	Road in mountains may be blocked	3	3	9
3.Precipitation will increase in the cold season	Electricity power lines will be shed by heavy ice	2	Electricity supply losses may occur more	2	2	6
4.Precipitation intensity will be higher in spring and autumn	Snow and ice cover will be thicker	3	Snow pressure on infrastructure rooves will increase	3	3	9

5.Summer rain will decrease	Dryness will be more intense	2	Sand will shift and cover roads and railways in the steppe and the Gobi regions	2	2	6
6.Summer rain will be more intense	Frequency of heavy rain, hail and thunderstorm may increase	2	Thunderstorm may cause more damages	2	2	6
7.Air temperatures will increase	Permafrost will melt from the top	3	Building construction will require more attention in permafrost areas	3	3	9
8. Air temperatures will increase in the warm season	Melting of glaciers will be more intense in the high mountains	2	Snow and ice avalanches may happen more frequently	2	2	6
9.Air temperature will increase in cool season	Heat loss may be reduced	3	Cost savings may be possible for construction	3	3	9
10.Air temperatures will increase in the cool season	Heat loss may be reduced	3	Heating season will be reduced	3	3	9
11.Frequency and intensity of heat waves will increase	Cooling of building may be necessary	2	Application of air conditioning will increase	2	2	6
Forest						
1. CO_2 concentration in the atmosphere will increase	Photosynthesis rate will be intensified	2	Forest growth will be improved	2	2	6
2. CO_2 concentration in the atmosphere will increase	Transpiration will decrease and eventually soil moisture may increase	2	CO_2 and CH_4 emissions from soil into the atmosphere will increase	2	1	5
3.Rainfall will decrease in the warm season	Dryness will be intensified	3	Forest growth would be slower	3	3	9
4.Precipitation will increase in the cool season	Soil moisture in spring will increase	3	Forest growth will improve where cumulative temperature is sufficient	2	2	2

5.Precipitation will increase in the cool season	Soil moisture in spring will increase	3	Forest fire risks will be decreased in spring	3	3	9
6.Rain intensity will rise in summer	Thunderstorm occurrences will increase	2	Forest fire risks will increase	2	3	7
7.Air temperatures will increase	Cumulative temperature will increase	3	Forest growth will be improved	3	3	9
8.Air temperatures will increase in the warm season	Transpiration from forest cover will be reduced	3	Forest growth will be improved	3	3	9
9.Duration of warm periods above 0ºC will be extended	Forest fire risky period will be extended	3	Forest fire risks will increase	3	2	8
10.Air temperature will increase in warm season	Permafrost will melt from the top	3	Ecological balance may change	3	2	8
11.Air temperatures will increase and snow cover will be deeper	Hibernating animals will face more favorable conditions and other animals environments may deteriorate	3	Forest ecosystems may change	2	2	7
12.Frequency and intensity of heat waves will increase	Forest ecosystems will experience heat stress	3	Forest growth will be slower	3	3	9
13.Air temperatures will increase in the warm season	Cumulative heat will increase	3	Harmful pests and insects will outbreak more often	3	3	9
14.Air temperatures will increase in the warm season	Forest diseases may outbreak where moisture and heat conditions are favorable	2	New diseases of forest may outbreak	2	2	6

ANNEX 2: TECHNOLOGY FACTSHEETS FOR SELECTED TECHNOLOGIES

Technologies in the arable farming

A.1. Crop growing under plastic mulches	
1. Introduction	Plastic mulch is a product used to suppress weeds and conserve water in crop production and landscaping. Mongolia is experiencing water shortages and an increasingly dry climate due to climate change. Therefore, it needs technologies to reduce water consumption, decrease labor intensity and increase production. Potato, water melon, cucumber, tomato, peppers and other crops can be planted in plastic mulch.
2. Technology characteristics	Crops grow through slits or holes in thin plastic sheeting. Plastic mulch is often used in conjunction with drip irrigation. Some research has been done using different colors of mulch to monitor its effects on crop growth. This method is predominant in large-scale vegetable growing, with millions of acres cultivated under plastic mulch worldwide each year. Disposal of plastic mulch is cited as an environmental problem; however, technologies exist to provide for the recycling of used/disposed plastic mulch into viable plastic resins for re-use in the plastics manufacturing industry.
3. Country specific applicability and potential	Evaporation from potato and vegetable fields can be prevented, the vegetables and fruit plants can be kept warm; irrigation water and labor expenses can be reduced; and weeds can be controlled. As a result harvest can be increased by 35-40% with this technology. After potato and other vegetable seedlings are transplanted, they will be covered with plastic film. When the plant comes out from the ground, holes will be cut in the plastic cover so that only plants will be seen on the ground. Drip irrigation will be done under the coverage through pipes. Today Mongolia has 6500 ha of vegetable and 3000 ha of irrigated potato fields. If the technology is applied in all fields, 5 to 7 years are required for the technology full implementation depending on availability of plastic materials. Plastic materials should be able to endure at least 2-3 years and farmers need to store plastic materials properly during winter.170,000 farmers who grow potato and vegetables can benefit from the technology nationwide. A re-processing factory can be run by 2-3 people if workers have been trained.
4. Status of technology in country	Today the technology is used by a small number of Mongolian farmers to grow crops such as peppers, water melon cucumber and tomato. So awareness raising and extensive training needs to be done among farmers. Some farmers are using the technology the Government has supported farmers to purchase 23,000 m2 plastic materials using soft loans. However, using plastic mulch is limited in the country because supply system of equipment and materials and manufacturing are not established, costs are high and knowledge and skills of farmers remains relatively low. There are excellent companies who produce this type of technology products. **Jain Irrigation Systems** (often known as **Jain Irrigation**, **JISL**, or simply **Jains**) is a multinational organization with global presence in 120 countries based in Jalgaon, Maharashtra, India. JISL employs over 7,500 workers, having 24 manufacturing plants, manufactures a number of products, including drip and sprinklerirrigation systems and components, integrated irrigation automation systems, Also, there are companies selling custom made drip irrigation system and agricultural products in Israel.

5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	This technology is not aimed at creating jobs. However, if factories manufacturing plastic materials and equipments are set up in the country, jobs can be created. In 2011, vegetables were planted on 7,200 ha of land and the average yield was 12,500 kg/ha. If yields increase by 35% or 4500 kg/ha, the total harvest of vegetables will go up by 28.6 metric tons from 6500 ha planting area. Today 1 kg of vegetables costs 650 *tugrugs* on average, the above additional vegetable harvest will bring 18.2 billion *tugrugs* of additional income to farmers. Every year the water use for irrigation is 3200 m^3 per ha. The total volume of water used for irrigation is estimated at 20.8 million m^3. With the technology applied to agricultural land, irrigation water use will be halved and become 10.4 million m^3. The water saving nature of the technology can help increase farmers' income and improve their livelihoods and eventually health conditions. Introduction of the technology can encourage the rural population to save water and raise awareness about the importance of the technology. Establishment of small scale processing factories requires professional workers. Early harvest of vegetables for consumption will increase and it can help to reduce malnutrition and micro nutrient deficiencies among children. There are two ways to reduce negative impact on the environment. - Biodegradable plastic mulches can be used. - In order to dispose of the plastic properly, small scale recycling factories can be established in *aimags* and big *soums* of agricultural areas.
6. Climate change adaptation benefits	The use of plastic mulches along with the use of drip irrigation has several benefits: - Extend planting dates - Soil moisture retention: Due to warming water demand by crops will be increased. Plastic mulches reduce the amount of water lost from the soil due to evaporation and less water will be needed for irrigation. Plastic mulches also help evenly distribute moisture to the soil which reduces crop stress. - Plastic mulches limit weed growth. - The use of drip irrigation in conjunction with plastic mulch reduces leaching of nitrogen and other nutrients compared to using furrow irrigation. Drip irrigation applies less water with fertilizers injected and thus fertilizers are applied to the root zone as needed. This also reduces the amount of fertilizer needed for adequate growth when compared to broadcast fertilization. - Improved crop quality: fruit are prevented from contacting the soil which leads to reduced fruit rot and keeps the fruit and vegetables clean. - Reduction in soil compaction: The plastic mulch covering the soil decreases the crusting effect of rain and sunlight.
7. Financial Requirements and Costs	Plastic cover for 1 ha can cost about 200 USD when using imported materials. 8000 ha of vegetables such as carrots and onion planted in rows do not need to use plastic coverage. Therefore plastic coverage to cover the remaining 6500 ha area will cost about 1.3 million USD for at least 3 years. If biodegradable plastic is procured, the price might be higher. Each processing factory costs about 18,000-25,000 USD. Establishment of factories in all aimags, cities and agricultural soums will require about 1.4-2.0 million USD from enterprises. Importers and factory owners also need financial support in the form of long-term low-interest loans. **The total required funding:** Total expense1.3 million +2.0 million =3.3 million USD International assistance – 0.5 million USD for small low-income farmers Agriculture Fund of the Government- 0.5 million USD as loan Enterprises and individuals -2.0 million +0.3 million USD as a loans , total 2.3 million USD

A.2. Vegetable production system using drip irrigation and water saving methods	
1. Introduction	Drip irrigation is based on the constant application of a specific and focused quantity of water to soil crops. The system uses pipes, valves and small drippers or emitters transporting water from the source (i.e. wells, tanks and or reservoirs) to the root area and applying it under particular quantity and pressure specifications. The system should maintain adequate levels of soil moisture in the rooting areas, fostering the best use of available nutrients and a suitable environment for healthy plant roots systems. Managing the exact (or almost) moisture requirement for each plant, the system significantly reduces water wastage and promotes efficient use.
2. Technology characteristics	A drip irrigation system typically consists of: • Pumps or pressurized water system • Filtration systems • Nutrient application systems • Backwash Controller • Pressure Control Valve (Pressure Regulator) • Pipes (including main pipe line and tubes) • Control Valves and Safety Valves • Poly fittings and Accessories (to make connections) • Emitters A wide range of components and system design options is available. Drip tape varies greatly in its specifications, depending on the manufacturer and its use. Drip tape is a type of thin walled dripperline used in drip irrigation[1]. The wetting pattern of water in the soil from the drip irrigation tape must reach plant roots. Emitter spacing depends on the crop root system and soil properties. Drip irrigation zones can be identified based on factors such as topography, field length, soil texture, optimal tape run length, and filter capacity. Many irrigation system suppliers use computer programs to analyze these factors and design drip systems. Once the zones are defined and the drip system is designed, it is possible to schedule irrigations to meet the unique needs of the crop in each zone. Recent automatic system technology has been particularly useful to help control flows and pressure, and to identify potential leaks thereby reducing labor requirements. System design must take into account the effect of the land topography on water pressure and flow requirements. A plan for water distribution uniformity should be made by carefully considering the tape, irrigation lengths, topography, and the need for periodic flushing of the tape. The design should also include vacuum relief valves into the system.
3. Country specific applicability and potential	Mongolia has been piloting drip irrigation systems since 1997 and the applicability of this technology has been confirmed. This technology is very suitable for growing vegetables, berries and bushes in Mongolia. Drip irrigation systems help farmers reduce water consumption of vegetables and berries. Initial cost of equipments will be high, however operating cost of irrigation can be saved due to this water saving technology. Small farms and families can use several small scale drip irrigation systems for 0.5 ha and need a storage room for keeping equipments in winter. The storage space requirement is small and it can be solved by farmers and households.
4. Status of technology in country	Currently, about 100 ha of agriculture land has installed drip irrigation systems with support from international projects.

1. http://en.wikipedia.org/wiki/Drip_tape

5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	The introduction of drip irrigation systems can save water and labor and does not create new jobs. When vegetable harvests increase and stabilizes at the national level, food security of population can be improved. Drip irrigation systems can save water and increase crop and vegetable production. The labor use for irrigation can be reduced by 25 person day or 200 USD per ha and in total 1.6 million USD for all 8000 ha each year. Assuming that crop production would increase 15% from the level in 2011, total yield can increase by 15,000 metric tons. If 1 kg of vegetable costs 0.5 cents, total revenue of increased harvest will be about 7.5 million USD per year. Compared to surface irrigation, which can provide 60 per cent water-use efficiency and sprinklers systems which can provide 75 per cent efficiency, drip irrigation can provide as much as 90 per cent water-use efficiency. Using drip irrigation systems requires clean water free of mud and filters require frequent cleaning. There is no other specific skill or expertise requirement for maintenance.
6. Climate change adaptation benefits	Drip irrigation technology can support farmers to adapt to climate change by providing efficient use of water supply. Particularly in areas subject to climate change impacts such as seasonal droughts, drip irrigation reduces demand for water and reduces water evaporation losses (as evaporation increases at higher temperatures). Scheduled water application will provide the necessary water resources direct to the plant when required. Furthermore, fertilizer application is more efficient since it can be applied directly through the pipes. As is the case with a sprinkler system, drip irrigation is more appropriate where there is (or is expected to be) limited or irregular water supply for agricultural use. However, the drip technology uses even less water than sprinkler irrigation, since water can be applied directly to the crops according to plant requirements. Furthermore, the drip system is not affected by wind or rain (as is the sprinkler technology).
7. Financial Requirements and Costs	**The total required funding:** Drip irrigation systems cost 800 - 2500 USD per ha depending on the specific type of technology, automatic devices, and materials used as well as the amount of labor required. If 6000 ha land of vegetables and 2000 ha of berry planting use the technology, the total cost will be 100 million USD. One system can be used for 10-15 years. Currently, about 100 ha of agricultural land has installed drip irrigation systems with support from international projects. In the future, the 'Agriculture Support Fund of Mongolia' can provide subsides or loans to promote drip irrigation systems. A revolving fund of 4 million USD per year can be supported by the Government's 'Agriculture Support Fund of Mongolia' and international donors in order to provide the necessary equipments and system. It can take 5-8 years for the technology to be applied in wide range of farms in Mongolia.
8. Institutional and organizational requirements	A whole range of institutional conditions must be understood before drip irrigation technology selection can be made. These include land tenure issues, water rights, and financial incentives by government and taxation. Large-scale irrigation schemes usually form part of national policy and could be harnessed to support national employment initiatives. Where the drip irrigation type is not available nationally, foreign imports or government-supported stimulation of national manufacture will be required alongside investment in training for design, installation and maintenance. Coordination with public or private authorities in charge of water management will be crucial and could be facilitated through the establishment of a committee of irrigation users. At the local level, social organization for the participatory monitoring of water resources and quality could provide a key monitoring tool. Whichever method is selected, developing regulations for the distribution and allocation of water would provide an important mechanism for conflict resolution.

A.3. System of wheat intensification using conservation tillage	
1. Introduction	Conservation Agriculture (CA) is based on the integrated management of soil, water and agricultural resources to achieve the objective of economically, ecologically and socially sustainable agricultural production. There are three main principles: • permanent soil cover; • minimal soil disturbance; and • crop rotation.
2. Technology characteristics	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. 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. Tillage operations are reduced for cropping and chemical fallow is applied.
3. Country specific applicability and potential	In 2010, Soil- Agrochemical laboratory of Agriculture Research Institute of Mongolia carried out research on 579,300 ha of agricultural land and the results showed that 60.6 % of the agricultural land suffered medium level soil erosion and 4.5 % was of slight soil erosion. Mongolia has piloted zero tillage several times. One of them was through the FAO project in 2000-2002, which demonstrated that conservation agriculture is a technically viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability. ***Weed control*** is still a challenge for conservation agriculture. 2.4-D herbicide is applied at the tillering stage. On fallow, Roundup is sprayed twice. However long term impacts should be considered and studied. Proper application rate should be defined. ***Yield data*** show that conservation agriculture provides more reliable yields during periods of drought. Conservation agriculture facilitates the capture of snow and retention of soil moisture; thus providing better conditions for plant development. In addition, biological activity in the soil and phosphorus availability is enhanced. Grain quality on conservation agriculture plots is comparable with that of traditionally planted cereals[2].
4. Status of technology in country	This technology has been piloted since 1990. At less than 30% of the total agriculture land, the technology is being applied at certain extent.
5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	Conservation agriculture can save labour and fuel; although investment will need to be made into machinery and chemical weed control. As local and imported seed drills can be modified, this technology can be introduced without heavy investment into new machinery. As local modifications worked as well as the imported Brazilian parts, these could be mass-produced, which would increase savings and availability of parts to farmers. It should be noted that care needs to be exercised in the correct assembly and adjustment of the furrow-opener parts. Wheat yield on chemical fallow is higher and profit would be increased by about 70 USD per ha and cost of 1 Metric tons of wheat is reduced by 25 USD. The research showed that average wheat yields have been 17300 kg/ha in the last 10 years due to application of reduced tillage which led to yield increase of 200 kg/ha. If this technology is applied to all 300,000 ha of agricultural land, the total increase would be about 80,000 metric tons of wheat. Farmers income would be increased. Wheat production increases would lead to better food security in the country and wheat exports. Soil humus would be increased by 0.16 % in soil layer of 10 cm, wind erosion will decrease by 75-80 % and vegetation cover would be maintained. Agricultural land would be conserved and return to natural status with vegetation cover.

2. Silke Hickmann, Conservation agriculture in northern Kazakhstan and Mongolia, FAO Agricultural and food engineering working document, 2006, www.fao.org/ag/ca/doc/J8349e.pdf

6. Climate change adaptation benefits	The technology will help to maintain soil fertility and reduce soil erosion. Fallow can also help retention of soil moisture too.
7. Financial Requirements and Costs	**The total required funding:** Current price of Roundup for weed control is about 10 USD per liter. Mongolia needs about 2.1 million USD for 400,000 ha of cereals and forages and 300,000 ha of fallow. Importation of sprayer techniques and its parts would cost about 2.5 million USD, seeding machines is about 3 million USD. The total cost would be 7.6 million USD. The technology requires at least 5 – 7 years to be applied nationwide.
8. Institutional and organizational requirements	***Training*** –Awareness creation, training and research need to be continued to ensure the successful extensive introduction of these technologies. ***Government support*** – Farmers should receive support from the government in Mongolia. This would include credit for renovation and updating of machinery and equipment and support for the purchase of herbicides and fertilizers. It is foreseen that the advantages of this technology will increase after an initial transition period, ensuring more profitable farming. Seeding equipment, herbicide sprayer- machines, new types of herbicides, and professional expertise are required.

A.4. Forest strip protection of agriculture land	
1. Introduction	A forest strip or windbreak is a plantation usually made up of one or more rows of trees or shrubs planted in such a manner as to provide shelter from the wind and to protect soil from erosion. They are commonly planted around the edges of agriculture land. Windbreaks are also planted to help keep snow from drifting onto roadways and even yards. Other benefits include providing habitat for wildlife and in some regions the trees are harvested for wood products.
2. Technology characteristics	Mongolia is located in the northeast of Central Asia with a dry and windy climate. Rain fed agriculture is subject to higher risks of soil erosion due to stronger wind especially in spring and autumn. In order to reduce negative effects of wind and maintain soil moisture, planting tree and bush strips as protection from wind is recommended. This method is used by Russia, Kazakhstan, and Canada where climate conditions are similar. Due to intensification of dryness and warming, the number of days with strong wind and dust storms has been increasing. Most farms apply bare soil fallow on almost 50% of cereals plantations, which leads to wind erosion and loss of soil fertility. Protection from those losses and climate change impacts is crucial today. Approximately 50 aspen and willow trees should be planted per ha (4 rows with 4 m distance and strip length is 50 m). Forest strips can increase cereals production by 20-30 % and vegetables by 50-70 %.
3. Country specific applicability and potential	It was implemented in 1980s in Mongolia but stopped during 1990s due to social and economic hardships in the transition period. Previous forest strips were cut down and destroyed.
4. Status of technology in country	The technology was successfully implemented in agricultural land in Mongolia during 1975 to 1990 and 1.5% of the total agricultural land or 20,000 ha had forest protection strips. Methods and guides are available. However, today few cereal fields have forest strip protection.

5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	Farmers can benefit from stable and higher crop production. The country can benefit from reduced desertification, land degradation and sand movements. Cultivation of 1000 tree seedlings of trees requires 1 person/year and seedling transplantation requires 2 persons/0.5 year for 100 ha. In total, 1200 persons are required to work at tree nurseries and 260 persons for planting and caring for growth of trees. Applying this technology also needs equipment and land for nurseries, irrigation systems, plastic tunnels, tree bed diggers and tractors. - All costs will be paid by enterprises and farmers. The Government needs to provide support in the form of tax exemptions and loans with low interest and a supportive legal environment. Social benefits are difficult to estimate because the technology does not directly aim at increasing crop production. Instead it intends to protect soil fertility from soil erosion due to wind and rain. There may be indirect benefits of forest strips for human health by improving micro climate condition in terms of air and soil. Forest protection strips can also contribute to the reduction of ecosystem degradation, air pollution and greenhouse gasses.
6. Climate change adaptation benefits	The technology can help reduce soil erosion due to wind and alleviate droughts. It can increase crop production today as well as under future climate change.
7. Financial Requirements and Costs	**The total required funding:** 1.2 million tree seedlings for 26,000 ha cost 2.4 million USD, seedling planting, nursery, and irrigation cost is estimated to be about 3.9 million USD per year. Farmers can pay the cost in cash and credits. At least 68% out of total 650,000 ha agricultural land needs to be protected with forest strips, and 32.5 million tree seedlings will be needed, at a total cost of 70 million USD.
8. Institutional requirements	The main challenge of the technology is that large amount of seedlings need to be nursed. Also caring and irrigation costs are high in the first 1-2 years. International and government assistance is essential. However, some expenses can be paid by farmers. Today a law on “Soil Protection and Fighting against Desertification” has been submitted to the Parliament for approval. In the draft law, plantations bigger than 100 ha are requird to have forest strip protection. Support to tree nursery farms is necessary and agricultural land with forest strips can be exempted from tax.

A.5. Breeding new variety of crops using marker assisted selection (MAS)	
1. Introduction	In order to yield high production, good varieties of crops which are adapted to local soil, weather and climate are necessary. New crop variety research and application is considered as of high results and low expense among many factors of crop production in the world. One of many methods of creation of new varieties is physical mutagens and this allows creating base materials with wide range of evolutions within short time period. Also, new variety creation can be shortened through effective selection of types in early stages of F_2-F_3, M_2 using marker techniques of protein and DNA. Selection techniques are widely used under the motto “using nuclear energy for peaceful purpose” by many countries.
2. Technology characteristics	New varieties with high yields that suit the local climate, hydrology, and soil conditions, tolerant to biotic and abiotic stresses are required to be generated through a combination of traditional adaptation selection methods with modern diagnoses, biotechnology, mutation and gene engineering methods. It generally takes 12-15 years to develop a new variety, which is too slow and expensive. To solve these problems, methods with DNA markers are required in selection programs. Despite high initial investment, protein and DNA marker technology can help to significantly reduce the selection work expense. Features that are envisioned by experts are evaluated at genetic level. Consequently research errors are minimized and the development of high productivity varieties can be done quickly. Variety generation process can be done with nuclear reactor and radiation to plant cells which lead to quick changes in plant genes. Selection of materials can be done based on estimated advantages and productivity. Consequently, new variety can be created based on biological and morphological features. New variety production can be done in a relatively short time and the expenses can be reduced.
3. Country specific applicability and potential	Some experiment fields, techniques and laboratory are available. However, the work will need a good laboratory, which is expensive to build and operate. Lack of resources limits the utilization of the technology.
4. Status of technology in country	About 30 % of wheat breeds planted in Mongolia are local varieties. The country started some research for new varieties using chemical mutation in order to get materials for selection. But application of physical mutagens and molecule markers is not done due to lack of equipment and laboratories.
5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	Newer climate proofed varieties could be developed in a shorter span of time than conventional breeding programs. Saving time, money, resources and also timeliness in availability of required variety could be direct benefits. Job creation can be expected in breeding laboratories. New varieties of high yield wheat can increase yields and increase profits by 300-2000 USD per ha (2011 estimates). Food security would be improved through supplying wheat products of good quality. Farmers’ income would be increased from the increased wheat production. This is an environmental friendly technology and improved vegetation will reduce risks of desertification.
6. Climate change adaptation benefits	New varieties with high yields and suitable for local conditions, tolerant to biotic and abiotic stresses are required to be developed a through combination of traditional adaptation selection methods with modern diagnoses, biotechnology, mutation and gene engineering methods under climate change and technology changes.
7. Financial Requirements and Costs	Calculation of expense is difficult. Firstly, investment is needed to build well equipped laboratories of molecule biology and reliable mutagens resources. Maintenance of laboratories and permanent operations require stable and permanent funding.
8. Institutional requirements	Intellectual investment, mutagen resources, and laboratory of molecule biology are required. Intellectual property rights system should be in place while new varieties are developed and introduced to agriculture.

A.6.Crop rotation of cereals in Mongolia	
1. Introduction	Crop rotation is the practice of growing a series of dissimilar types of crops in the same area in sequential seasons. Crop rotation confers various benefits to the soil. A traditional element of crop rotation is the replenishment of nitrogen through the use of green manure in sequence with cereals and other crops. Crop rotation also mitigates the build-up of pathogens and pests that often occurs when one species is continuously cropped, and it can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants.
2. Technology characteristics	Growing the same crop in the same place for many years in a row disproportionately depletes the soil of certain nutrients. With rotation, a crop that leaches the soil of one kind of nutrient is followed during the next growing season by a dissimilar crop that returns that nutrient to the soil or draws a different ratio of nutrients. During the period of transition towards a market economy since 1990, previous irrigation systems collapsed and spring wheat was planted without proper rotation, which caused soil erosion, land degradation, and weeds. As a result, wheat yields have decreased and irrigated land has reduced to only 5,000 ha. Therefore, under the national agriculture campaign '*ATAR*-3' initiated in 2010-2011, irrigated land is increasing due to the Government support of investments and policy.
3. Country specific applicability and potential	Research on rotation systems in irrigated planting has only started recently in Mongolia. The choice and sequence of rotation crops depends on the nature of the soil, the climate, and precipitation which together determine the type of plants that may be cultivated. Other important aspects of farming such as crop marketing & economic variables must also be considered when deciding crop rotations. In the 1980s, several rotations were experimented within Mongolia. For example: 2-year rotations of bare fallow and wheat or barley, 3-year rotations of bare or occupied fallow or green manure/wheat/oats for grain or green fodder/barley or wheat, 4-year rotations of bare fallow/potatoes or wheat/wheat/oats for grain or green fodder or barley and a 5-year rotation of bare fallow/wheat/barley/peas + oats/wheat. But it did not continue nor was practiced during the transition period. Today, research and experiments of crop rotations is required. Incorporation of livestock is possible when forage plants are planted. Interaction between animals and land can be beneficial.
4. Status of technology in country	Crop rotation is a common practice internationally. But, in Mongolia crop farms do not have the appropriate technology for crop rotation, varieties of cereals which can grow well and produce high yield under the Mongolian soil and climate conditions.
5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	A general effect of crop rotation is that there is a geographic mixing of crops, which can slow the spread of pests and diseases during the growing season. The different crops can also reduce the effects of adverse weather for the individual farmer and, by requiring planting and harvest at different times, allowing more land to be farmed with the same amount of machinery and labour. - Nutrients: Rotating crops adds nutrients to the soil. In order to improve soil fertility, different crops such as cereals and legumes would be planted. Technical investment will be required and jobs will be created. - Pest and weed control: Crop rotation is also used to control pests & diseases that can become established in the soil over time. The changing of crops in a sequence tends to decrease the population level of pests. A different crop allows the weeds to be eliminated, breaking the ergot cycle. - Soil erosion: Crop rotation can greatly affect the amount of soil lost from erosion by water. Combining the country's traditional methods with world advanced technology can help develop proper agro-technology to increase production. Income of farmers will increase and national food security will be improved. Also, forage for livestock will be produced. Crop producers and their workers can benefit from the technology.
6. Climate change adaptation benefits	Crop rotation can reduce negative impacts such as decreases in soil organic matters, spread of pests and weeds and soil erosion under dry and warming climate condition.

7. Financial Requirements and Costs	**The total required funding:** About 400,000 USD might be required every year. Research and experiments would require 3-5 years and the technology implementation requires 5 years.
8. Institutional requirements	Some irrigation systems are being constructed through government support and enterprises investments. The main challenge is a lack of financial resources.

A.7. Integrated Nutrient Management[3] in Mongolia	
1. Introduction	Soil is a fundamental requirement for crop production as it provides plants with anchorage, water and nutrients. A certain supply of mineral and organic nutrient sources is present in soils, but these often have to be supplemented with external applications, or fertilizers, for better plant growth. Fertilizers enhance soil fertility and are applied to promote plant growth, improve crop yields and support agricultural intensification. Fertilizers are typically classified as organic or mineral. Organic fertilizers are derived from substances of plant or animal origin, such as manure, compost, seaweed and cereal straw. Organic fertilizers generally contain lower levels of plant nutrients as they are combined with organic matter that improves the soils physical and biological characteristics. The most widely-used mineral fertilizers are based on nitrogen, potassium and phosphate. Environmental concerns and economic constraints mean that crop nutrient requirements should not be met solely through mineral fertilizers. Efficient use of all nutrient sources, including organic sources, recyclable wastes, mineral fertilizers and bio-fertilizers should therefore be promoted through Integrated Nutrient Management[4].
2. Technology characteristics	The aim of Integrated Nutrient Management (INM) is to integrate the use of natural and man-made soil nutrients to increase crop productivity. INM aims at optimal use of nutrient sources on a cropping-system or crop-rotation basis. This encourages farmers to focus on long-term planning and make greater consideration for environmental impacts. INM relies on a number of factors, including appropriate nutrient application and conservation and the transfer of knowledge about INM practices to farmers and researchers. In addition to the standard selection and application of fertilizers, INM practices include new techniques such as deep placement of fertilizers and the use of inhibitors or urea coatings (use of area coating agent helps to retard the activity and growth of the bacteria responsible for denitrification) that have been developed to improve nutrient uptake. Key components of the INM approach include: 1) Testing procedures to determine nutrient availability and deficiencies in plants and soils. Systematic appraisal of constraints and opportunities in the current soil fertility management practices and how these relate to the nutrient diagnosis, for example insufficient or excessive use of fertilizers. 2) Assessment of productivity and sustainability of farming systems. Different climates, soil types, crops, farming practices, and technologies dictate the correct balance of nutrients necessary. Once these factors are understood, appropriate INM technologies can be selected 3) Participatory farmer-led INM technology experimentation and development. The need for locally appropriate technologies means that farmer involvement in the testing and analysis is required. Harsh climatic conditions are a major cause of soil erosion and depletion of nutrient stocks. By increasing soil fertility and improving plant health, INM can have positive effects on crops in the following ways: 1. A good supply of phosphorous, nitrogen and potassium has been shown to exert a considerable influence on the susceptibility or resistance of plants towards many types of pests and diseases 2. A crop receiving balanced nutrition is able to explore a larger volume of soil in order to access water and nutrients. In addition, improved root development enables the plant to access water from deeper soil layers. With a well-developed root system, crops are less susceptible to drought 3. With appropriate potassium fertilisation, the freezing point of the cell sap is lowered, thus improving crop tolerance to frost.

3. Source: http://climatetechwiki.org/content/integrated-nutrient-management
4. Roy, R. N., A. Finck, G. J. Blair and H. L. S. Tandon , 2006, Plant nutrition for food security, FAO Rome, 2006.

3. Country specific applicability and potential	Agriculture has developed intensively in Mongolia in the last 50 years, but proper nutrient management technologies, to maintain and improve soil fertility, which have been absorbed by crops during their growth are missing. Especially in the last 20 years, organic fertilizer application has been ignored, which causes ecological degradation and negative effects on crop production. According to a soil fertility survey done in 2008-2010, 70.7% of crop land has soil with humus less than 2.5%. Mongolia has about 370,000 ha of arable land (wheat is grown on 310,000 ha; potato- on 15,000 ha; other vegetables on 10,000 ha; animal forage on 25,000 ha and oil plants on 10,000 ha). It is estimated that in total 40,900 metric tons of mineral fertilizers (NPK)and 2,300metric tons of rhizobacterial fertilizers are needed to keep yield stable and high.The technology can be applied in 15 out of Mongolia's 21 *aimags*. About 5-8 years would be required for the technology introduction and application.
4. Status of technology in country	Application of fertilizers has been little practiced in Mongolia in the last 20 years. Recently, the agricultural campaign "*ATAR*-3" supported by the Government has helped some farmers to use fertilizers in small scales in order to improve soil fertility and increase crop production. But currently, mineral fertilizers are being used more in cereal growing. Integrated Nutrient Management is required for cereal farms in order to ensure sustainable and organic agriculture production.
5. Benefits and impact on the country development ✓ Economic (-Job creation; -Investment) ✓ Social (-Income generation; - Education; - Health) ✓ Environmental	INM appropriate to local conditions of climate, soil and crop varieties will be developed and tested. Increased crop production will be more sustainable and can support food security at the local as well as national level. Locally available natural and biological materials can be used as organic fertilizers through composting. Production of organic fertilizers can create an income source for farms and workers. INM empowers farmers by increasing their technical expertise and decision-making capacity. It also promotes changes in land use, crop rotations, and interactions between forestry, livestock and cropping systems as part of agricultural intensification and diversification. A largely untapped source of potential fertilizer is urban waste however it requires more detailed research to be a viable option.
6. Climate change adaptation benefits	INM enables the adaptation of plant nutrition and soil fertility management in farming systems to site characteristics, taking advantage of the combined and harmonious use of organic and inorganic nutrient resources to serve the concurrent needs of food production and economic, environmental and social viability.
7. Financial Requirements and Costs	Estimated costs for key components of the INM are listed below 1) Testing of current soil conditions and appraisal of current management- about 60,000 USD. 2) Identify appropriate INM technologies for specific contexts (at least 10 contexts in 3 agriculture regions) – 250,000 USD 3) INM technology experimentation and development – 500,000 USD. 4) Nationwide application of INM - 8.6 million USD. **The total required funding is estimated at about 30.1 million USD**
8. Institutional requirements	Agrochemical tests of soils should be done once every 5 years according to the Agriculture Law (16.6). Testing and systematic appraisal of soil fertility during INM should be applied. Research institutions and laboratories will be involved in technology development. Stable supply of mineral and organic fertilizers will be required. The Government needs to support fertilizer producers. Farmers' participation and their knowledge are essential for success.

A.8. Potato seed production system using aeroponics	
1. Introduction	Potatoes are the second most important crop after wheat in Mongolia. Limited accessibility to high quality potato seeds is a perennial problem amongst many growers and is partly attributable to inefficiencies in various links of the seed production system.
2. Technology characteristics	Aeroponics would appear to have a number of potential attributes to make seed potato production more efficient. The technology has potential to eliminate all but one generation of seed potato multiplication in the field, thus lowering costs and raising the plant health quality of the first field production generation. This technology has 3 steps in order to supply reliable potato seeds. 1. Produce mini tubers using aeroponics (Crop environment such as nutrients, temperature and moisture can be artificially created.) 2. Produce potato seeds using mini tubers at agriculture extension fields of *aimags* or seed producers fields 3. Supply healthy potato seeds to farmers. According to experiments in Mongolia, micro plants grown in laboratories can withstand stress in 7-14 days. After transplanted in aeroponic greenhouse, new tubers come up after 5-6 days and can be harvested after 45-48 days. During a harvesting season, they can be partially harvested 7 to 9 times. This technology has high reproduction coefficient and requires less labor, time and financial resources than potato seed production in soil. Cost per tuber is reduced and would be approximately 98.7 *tugrugs* (0.08 US cents).
3. Country specific applicability and potential	According to the technology, about 20 micro tubers each of 5 grams can be grown from one potato of new variety. When about 5000 new grown tubers are transplanted into greenhouses, 95% can grow successfully, which can provide a good source of high quality potato seeds. Mini-tubers can be initial elite seed materials which can develop to produce potato seeds in order to supply to farms. Activity can be sustainable as long as products can be sold and grown again. This technology can improve the supply of good and healthy potato seeds and increase the potato production per area. This technology should be further piloted and widely applied in all the potato farms in the country. The introduction and application of this technology requires about 5-6 years.
4. Status of technology in country	In order to intensify the production of potato tubers, research on growing potato tubers in airoponic systems with optimal conditions in air has being carried out by the Mongolian National Agriculture Research Institute under the "Mongolian Potato Program" since 2007. Mongolia has become the 5th country in Asia to pilot this technology in potato seeds production. In 2008 and 2009, mini tubers were planted in greenhouses and fields with drip irrigation systems. The success rate of growth was 100 % and 5-8 healthy potato tubers grew from one bush. This confirms the good quality of the seeds. This method can be applied by potato seed farms and greenhouse farms. The technology allows for healthy potato of high quality probably twice a year if all conditions are created properly.
5. Benefits and impact on the country development ✓ Economic (Job creation; Investment) ✓ Social (Income generation; Education; Health) ✓ Environmental	It will be basis of sustainable supply of potato seed of adapted potato varieties and free of virus infections. Establishment of local production systems instead of transporting to farms would save energy, time, and cost. New income will be generated through selling mini- tubers as elite potato seeds. It can be harvested twice a year and in total 200,000 tubers can be produced per year. They can be planted as elite potato seeds in the country in order to supply reliable potato seeds to farms. Capacity of national staff will be improved to use the technology. The technology is environmentally friendly. The potato tubers will absorb 99.8% of their nutrients in the air and 0.02 % in fog types, so photosynthesis is intensified.

6. Climate change adaptation benefits	Since the micro crop is grown in laboratories and mini tubers are grown in greenhouses, so it is less dependent on weather and climate variability and changes. Establishment of local production systems would reduce GHG emissions.
7. Financial Requirements and Costs	Some research expenses can be provided by National Scientific Foundation of Mongolia. Other equipment, materials and substances can be supplied with the support of the Agency of Science and Development and 'Mongolian Potato Program'. Capacity building, training and experience sharing trips need to supported by international organizations. Cost allocation: International – 20,000 USD The state budget: - 40,000 USD Enterprises and individuals – 22,000 USD **The total required funding: 82,000 USD.**
8. Institutional requirements	Possible areas of research to improve productivity include optimizing nutrient solutions, plant density, number of harvests and harvesting intervals. Resources such as greenhouses and capacity building are required.

A.9. Using Intelligent Nutrient Management– Micronutrient gel[5] for crop and tree	
1. Introduction	This is a new technology for water and fertilizer storage with micronutrients for all types of plants. The technology is efficient in terms of water consumption and labour saving and has the potential to be used in agriculture, forestry and vegetables.
2. Technology characteristics	This technology uses a granulate or powder, which has the ability to absorb and store up to 150 times its own weight in water and then pass this on to plants as required. Once in contact with water, the granulate swells up to form a gel, in order to absorb and store water, which would normally be lost in the soil through evaporation or leaching. The gel is enriched with valuable plant fertilizers, which makes it nutritious and allows the continuous supply of the plant roots with both water and fertilizer. Once the water reserve has been gradually consumed, the gel reassumes its solid form and the process can start again from the beginning. Moreover, it can be repeated over several (6) years. The main characteristics of the gel have defined through experimentation: - 1 kg of gel is capable of storing up to 150 liters of distilled water - Plant can absorb stored water and nutrients through its roots - Micro nutrients absorbed in the gel have a positive effect on soil quality. - It will enable application of mineral fertilizers into soil and ground water to be reduced. - It will reduce irrigation frequency. If the gel is applied in 1 kg per cubic meter of area, sandy soil can store 11-15 % more water; loamy sand – 9-18%; and sandy loam – 11-17%. Evaporation rate will be 3 mm per day (3 l/m^2) and stored water can be used for 3-6 days. - It will shorten germination and growth periods, so it can improve plant growth in dry and desert areas - Crop production is expected to increase significantly
3. Country specific applicability and potential	This technology is tested and its standards and quality have been confirmed in the EU. This technology has the potential to be used in the following sectors: • Agriculture • Forestry, tree and shrub planting in cities and towns • Land reclamation and environment restoration • Vegetation restoration against desertification and degradation • Plant transportation and storage
4. Status of technology in country	Preparation for testing in Mongolia is being done.

5. http://www.aquita.eu/en/aquita/nutrient_management/

5. Benefits and impact on the country development ✓ Economic (Job creation; Investment) ✓ Social (Income generation; Education; Health) ✓ Environmental	This technology assists to increase high production in agriculture, forestry and vegetable gardening sectors. Using the technology in forestry, forest strip protection and agriculture can create jobs. The following benefits characterize the technology: - Improve efficiency of water usage by plants - Increase plant growth, making plants larger, stronger and more resistant and enhance survival capacity - Reduce cost of irrigation and fertilization - Improve yields which lead to increased food security Environmental benefits are: - Reduced fertilizer application - Less fertilizer runoff - Environmentally compatible - Improved soil quality - Counteracts desertification and wind erosion
6. Climate change adaptation benefits	This technology can help to reduce negative impacts of climate change such as desertification and water deficits and increase green house gas absorption.
7. Financial Requirements and Costs	It is difficult to estimate t**he total required funding**. Research and testing expense of the technology; and Gel expense is 0.6-1 USD per tree. The diffusion and implementation of the technology would require 3-5 years.
8. Institutional requirements	Introduction of the technology would not require specific skills and resources. Local farmers and enterprises can apply this technology under supervision and guidance from experienced international experts.

Technologies in the animal husbandry

B.1. Seasonal to Inter-annual Prediction[6] and Livestock Early Warning System	
1. Introduction	This technology allows for a forecast of weather conditions for a period of three to six months ahead. Seasonal forecasts are based on existing climate data; in particular, on sea surface temperatures, which are then used in ocean-atmosphere dynamic models, coupled with the synthesis of physically plausible national and international models.
2. Technology characteristics	According to the World Meteorological Organisation (WMO) definitions, Seasonal to Interannual Prediction (SIP) ranges from 30 days up to two years. Modern and science-based systems facilitate seasonal forecasting. Predicting climate seasonal anomalies requires the use of complex coupled atmosphere-ocean models. It is believed that ocean variability is an important factor influencing climate variations and changes due to the ocean's larger capacity to absorb from and release heat back into the atmosphere. A considerable effort has been made to improve the understanding of the phenomena responsible for seasonal variability and most of the major meteorological institutions around the world have developed Ensemble Prediction Systems (EPS) for operational seasonal forecasting based on coupled atmosphere-ocean general circulation models. Climate change is challenging traditional knowledge about seasonal forecasting and farmers can no longer predict climate using natural indicators. Although knowledge and understanding of the socio-economic circumstances is important and must be taken into account, knowledge of climatic variability can lead to better decisions in agriculture, regardless of geographical location and socio-economic conditions. Within agricultural systems, this technology can increase preparedness and lead to better social, economic and environmental outcomes. It helps decision-making, from tactical crop management options, and commodity marketing to policy decisions about future land use. This technology has the following key components: - Seasonal to interannual prediction using dynamic models - Monitoring of pasture including vegetation and snow coverage using ground observation data validated remote sensing methods - Modelling of pasture using real time monitoring data and weather prediction - Harsh winter/Zud and drought mapping with pasture carrying capacity which will be input for livestock planning in winter - Validating through real data and improvement to the system
3. Country specific applicability and potential	Today, long term weather predictions (from 1 month to 6 months) are being produced using statistical methods in Mongolia. Economic losses and damage caused by atmospheric disasters has increased in the last few decades in Mongolia. Frequency of these types of disasters increased due to climate change and vulnerability has worsened due to increased disaster magnitude and excessive human pressures. Due to climate change, even though air temperatures have increased, occurrences of harsh winters/zud's are expected to increase as a result of frequent drought, and increased extreme phenomena such as snow and storms. For example: during the zud of 2008-2009, about 10 million livestock died and it led to massive social impacts on herders' livelihoods and the country's economy. Almost one third of herders lost all their animals. SIP is linked to a great variety of practical applications, from security related issues, such as water resource management, food security, and disaster forecasts and prevention; to health planning, agriculture management, energy supply and tourism. It is an important element in some policy/decision-making systems and is the key to achieving the longer-term goals of climate change adaptation strategy. SIP is taken into consideration for the strengthening of drought and Zud/ harsh winter preparedness and management, including zud contingency plans of animal locations in winter and spring, at the local (soum), provincial (aimag) and national levels. The technology would need about 3-4 years to implement.

6. http://climatetechwiki.org/content/seasonal-interannual-prediction

4. Status of technology in country	Currently, the Government and other organizations make winter plans of animals' location and their movements. The plan is based on pasture capacity defined by maximum biomass stock cut seasonal prediction is not taken into account due to insufficient seasonal prediction capacity.
5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	SIP will contribute to more precise livestock winter movements and forage preparation. Also, within agricultural systems, this technology can increase preparedness and lead to better social, economic and environmental outcomes. It helps decision-making, from tactical crop management options and commodity marketing to policy decisions about future land use. Based on the technology, animal loss in winter can be reduced by 20-50 % especially during zud. Herders' vulnerability to natural disasters and climate change would be reduced.
6. Climate change adaptation benefits	It will strengthen climate change adaptation capacity.
7. Financial Requirements and Costs	**The total required funding is estimated at 800,000 USD** - Seasonal to interannual prediction using dynamic models cost - Monitoring and modelling of pasture would require some equipment and research - Mapping software and models - Trip to testing sites, research and capacity building of users including decision makers at national and local levels, herders and other officials such as NEMA.
8. Institutional requirements	SIP requires cross-disciplinary research approach that brings together institutions (partnerships), disciplines (such as climate science, agricultural systems science, rural sociology, and many other disciplines) and people (scientists, policy makers and direct beneficiaries) as equal partners. The Ministry of Nature, Environment and Tourism and the Ministry of Food, Agriculture and Light Industry will play major roles to introduce SIP enable it to reduce negative impacts of natural disasters and to make precise decisions on agricultural practices. Participation of research institutions such as the Institute of Meteorology, Agriculture and Livestock Institutes, NGOs including Green Gold, Pasture Management Association of Mongolia and government agencies such as the National Emergency Agency (NEMA), herders and farmers are essential in this process. The interpretation of seasonal predictions of climate are not easy for most agricultural technicians and farmers as they are given as probabilities of positive or negative variations in temperature or precipitation. Although it must be recognised that all such predictions have an uncertainty associated with them, agricultural stakeholders need a lot of assistance as to how to identify the likely seasonal trends. Equally, meteorological services need staff with skills to present the information in a way that the public can understand and make use of it.

B.2. Planting of forage perennials resistant to drought and cold winter for fodder production	
1. Introduction	During 1986-1990, Mongolia produced about 1 million tons of forage a year. Since 1990, forage production has decreased by about 65% due to privatization of livestock[7]. 13 big cooperatives and 27 small factories which produced animal fodder at the local level were closed down. Also, types of forage have changed considerably. At the same time, livestock numbers have increased significantly and reached about 36 million in 2011. However, natural resources are limited, because about 70% of pasture has been classified as degraded to a certain extent, production of hay mowing decreased and the diversity of plants declined. Consequently, production of seeds of local varieties that are drought and frost resistant and forage production is required.
2. Technology characteristics	In the past, several plant species (*Agropyron L, Elymus L, legumes* etc) have been tested. This technology consists of several components: 1. Research and identification of the best plant species for the region such as mountains, the forest steppe, and the steppe. 2. Planting of forage plants: Perennials can be used as seeds or forage for subsequent 5 to 7 years in the same planted field. Protection from animal grazing is essential while plants are growing. Investments such as planting techniques, water efficient irrigation systems, environmentally sound pest and disease control are needed. 3. Establishing a seed bank of forage plants at provincial level. Storage and transportation are required to supply a province.
3. Country specific applicability and potential	Experimental seeds were sent to Russia and Inner Mongolia of China for seed exchanges and research. The preliminary research confirmed the seeds that can be planted. "Sumber -1" of *Agropyron* and "Mandal" of *Carex L* are drought and frost resistant perennial varieties. They have 75-80% survival rate in winter, 80-85% of emergence rate, grass biomass of 2650-3050 kg/ha and seed production of 280 -300 kg/ha. It can be mowed 2-3 times each year. 75-80% of the above varieties can survive harsh winters when air temperature is -30 to -35 ^{0}C and soil temperatures are -40 to -45 ^{0}C. In summer it would produce seeds and grass harvests. Also in summer, plants absorb carbon dioxide and greenhouse gasses. 3-5 years would be required to introduce the technology.
4. Status of technology in country	Technologies to plant the above perennials in the forest steppe and high mountain regions are being studied and piloted.
5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	After the introduction of the technology, herders would have hay fields with high production for 5-7 years and eventually livestock production would be increased. About 1500 jobs such as tractor drivers, agriculture machine drivers, trucks drivers, workers in forage factories, finance and storage staff, and agriculture specialists etc would be created in forage producing farms. Herders and forage producers in the forest steppe and the steppe zones will get benefits and their income could be increased by 25-30%. Forage plants would be fully beneficial to the environment.
6. Climate change adaptation benefits	Planting of forage perennials and local varieties would lead to increased biomass, decreased pasture degradation and mitigation of greenhouse gases.
7. Financial Requirements and Costs	**The total required funding: 1.3 million USD** International agencies– 1.2 million USD The state budget- 800,000 USD Enterprises and individuals– 200,000 USD
8. Institutional requirements	Experts need to train herders about planting and growing of forage perennials, and using seeds and forage production. The technology introduction requires techniques and machineries, capacity building of experts and financial support.

7. Additional forage for livestock, 2009, http://www.mongolfarmer.mn/index.php?option=com_content&task=view&id=420&Itemid=32

B.3. Selective Breeding of Livestock (High Quality Livestock)	
1. Introduction	Genetic make-up influences fitness and adaptation, and determines an animal's tolerance to shocks such as temperature extremes, drought, flooding, pests and diseases. Adaptation to harsh environments includes heat tolerance and an animal's ability to survive, grow and reproduce in the presence of poor seasonal nutrition as well as parasites and diseases. Selective breeding is a technology that aims to improve the value of animal genetic diversity. As developments have been made over time in improving measurement techniques and methods for estimating an animal's genetic potential, the power and effectiveness of selective breeding as a tool has also increased. Over the last half century it has helped achieve dramatic improvements in the productivity of livestock species as well as improvements in the health and welfare of livestock and other animals.
2. Technology characteristics	Selective livestock breeding is the systematic breeding of animals in order to improve productivity and other key characteristics. Various methods for selective breeding exist: advanced methods such as artificial insemination, transplanting fetuses and transferring egg-cell etc will be used in Mongolia. Key breeding traits associated with climate change resilience and adaptation includes thermal tolerance, low quality feed, high kid survival rates, disease resistance, good body condition and animal morphology. Livestock producers must be able to incorporate long-term planning into production management strategies. Such measures could include: (i) identifying and strengthening local breeds that have adapted to local climatic stress and feed sources and (ii) improving local genetics through cross-breeding with heat and disease tolerant breeds. In 2011, Mongolia had about 36 million livestock. Professional institutions have estimated that about 3 million animals have optimal characteristics of locally adapted, with maximum survival and high production breeds which are called core herds. The technology aims to improve quality of all animals in aimags and soums based on selective breeding using core herds.
3. Country specific applicability and potential	Major legislation such as the National Livestock Program, 'The State Pro-herders Policy', and 'The State Policy on Food and Agriculture' approved by the Parliament of Mongolia aims to improve income and livelihoods of herders through increased livestock production and quality. Animal weight would decrease and production drop in Mongolia due to negative impacts of climate change. The research showed that the weight of matured cow has dropped by 14-16 kg, sheep and goat weight has decreased by 5-6 kg and wool yield of sheep has decreased by 90 g in the last 40 years. About 6-8 years will be required to implement the technology.
4. Status of technology in country	Mongolia focuses on rearing livestock which is resilient to natural disasters such as hot and cold weather, drought and harsh winter and adapted to climate change. Researchers of the Institute of Livestock of Mongolia have successfully implemented 3 innovation projects in this field.
5. Benefits and impact on the country development ✓ Economic (-Job creation; -Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	According to statistics of 2011, there are 328,000 people in 155,000 herding families. They would benefit from the technology implementation. - Jobs such as livestock experts and herders would be created. - Profit from increased livestock can benefit herders. Training can be done in classes as well as distance learning. - State policy of safe and clean food supply to population will be implemented. - Herders would have fewer animals and higher production. Pasture management would be improved.
6. Climate change adaptation benefits	Herders would own the breeds which are resilient to climate change, adapted to local context and possess the highest production. Animal numbers and composition (ratio between sheep and goats play critical role in pasture degradation) can be controlled. Greenhouse gas emissions would be decreased and herders would have access to carbon market.
7. Financial Requirements and Costs	**The total required funding: 2 million USD** From International donors – 1.4 million USD The State budget - 0.4 million USD Private enterprises – 0.2 million USD

8. Institutional requirements	The legal environment is considered suitable to implement the technology. Because it is within the framework of the National Livestock Program approved by the Parliament. Veterinary/ breeding centers have been established in all 329 soums. The centers are responsible for implementing the state policy towards improving livestock quality. Also trainers have been prepared in each soum in order to build herders' capacity and facilitate trainings. A professional livestock department is operating in each aimag with the aim of managing livestock quality and improving operations. Sustainability is ensured based on the above mentioned structure and network of the government in order to increase livestock production and improving herders' income and livelihoods through better livestock quality.

B.4. Producing supplement feed for winter and spring	
9. Introduction	Mongolia is experiencing more intense warming than the global average because air temperature has increased by 2.14 ^{0}C in the past 60 years. Due to warming, the cool season has shortened and the warm season became longer. But winter precipitation has a tendency to increase and summer drought becomes more frequent which both have negative effects on animal husbandry. To ensure sustainable livestock production, supplement feeding with high protein and nutrients is required for livestock for 200-240 days of winter and spring season.
1. Technology characteristics	Many countries produce high protein feed for livestock. The Research Institute of Animal Husbandry piloted and introduced technologies to produce supplement feed using renewable natural plant resources. Researchers estimated that only 40-50% of required daily intake is taken from pasture in winter and spring seasons. Also only 20-25% of the required protein is obtained from pasture. Consequently, animals lose 25-35% of gained weight and become weak during these seasons and deaths occur. So, supplement feed with protein and nutrients is needed for livestock during harsh weather and under climate change as the frequency of harsh winters is expected to increase. The technology can contribute to better feed of animals in winter and spring lean periods. Specific plants which have low preference by animals could be raw materials for supplement feed. It can be mowing and with additianal substances as supplement feed. There are low palatable plants such as *Urtica L, Chenopodium L, Artemisia L, Corispermum L and Iris* L etc, grown in summer and autumn in all regions of the country. These plants can be used as raw materials for producing supplement feed with 9-10 MJ exchange energy and 200-250 mg carotene per kg.
2. Country specific applicability and potential	There are many locally known methods for producing supplement feed for animals. These methods should be studied and the localized technology for producing supplement feed should be defined and tested. This technology requires 6-8 years to be introduced in all *soums* and *aimags*.
3. Status of technology in country	Researchers of the Livestock Institute of Mongolia have done some research on producing supplement feed using renewable vegetation resources and experimented in local contexts.
4. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	According to the census in 2011, there are 155,000 herding families and 328,000 people who would benefit from the technology implementation. Also, an increase of livestock production would lead to improved food security for the population and supply of raw materials to light industries. Positions such as forage experts and workers of fodder producing factories would be created. Herders and forage factory workers would benefit directly because of increased profit. Training can be facilitated in classes as well as through distance learning. The Government policy on 'supplying population with ecological food' would be supported by the technology implementation.

5. Climate change adaptation benefits	Due to climate change, pasture biomass has been degraded, the number and quality of palatable plants declined in almost all aimags and soums. A climate change adaptation study revealed that animals' weight is decreasing and production is dropping because of a lack of forage. Greenhouse gas emissions will be reduced while livestock will be fed with high quality supplement feed in winter and spring.
6. Financial Requirements and Costs	**The total required funding 2.9 million USD for investment of feed producing factories and facilities.** From International agencies – 1.7 million USD State budget - 0.7 million USD Private source - 0.5 million USD
7. Institutional requirements	There are opportunities to produce such fodder in all aimags and soums and by any herders.

B.5. Rain and snow water harvesting for herder groups	
1. Introduction	Because of global warming and climate change, rainfall in summer is expected to decrease and winter precipitation increase. The decrease in summer rain will lead to drying of rivers and streams, lack of pasture water, and reduction of pasture biomass supply for animal forage. Rain and snow water harvesting is a particularly suitable technology for areas where there is limited surface water, or where groundwater is deep or inaccessible due to hard ground conditions. Therefore, snow and spring snow melt water can be used in animal husbandry.
2. Technology characteristics	Rain and snow water harvesting is defined as a method for inducing, collecting, storing and conserving local surface runoff (rain or surface water flow that occurs when soil is infiltrated to full capacity) for agriculture in arid and semi-arid regions[8]. For the Mongolian context, snow and rain water can be harvested in small scale reservoir near summer or spring camping sites and used for animal drinking. The catchment area is the area with deep snow accumulation or flash flood flow near herders' spring or summer sites. Water reservoirs can be established using rock surfaces or building dams. In order to prevent water leakage, plastic materials can be used and reservoir surfaces should be built properly using rocks and soils. Water storing devices can be improved through the use of tanks or locally available materials. Conveyance can be completed appropriately using traditional methods and materials from water reservoirs to animal drinking tanks. This will be used for animals drinking for spring and early summer when water resources are scarce. Maintenance is required for cleaning of dams and reservoir annually in autumn. It can be used for planting of forage for livestock too.
3. Country specific applicability and potential	In areas of high snow, water harvesting basins or reservoirs can be established in order to collect water of melting snow and use for animal drinking and growing forage plants. This technology can be introduced in the high mountains and the forest steppe zone. This technology is piloted, however there might be some challenges. For example, hot and dry weather and low precipitation can shorten water usage period due to high evaporation of collected water. Suitable locations should be identified based on surface relief, precipitation and other factors by researchers. This technology would require 3-5 years to be implemented.
4. Status of technology in country	This technology is widely used and accepted in other countries. Also the technology has been piloted in *Khuvsgul, Arkhangai, Bulgan and Khentii aimags* with the support of the International Fund for Agriculture Development.

8. http://climatetechwiki.org/content/rainwater-harvesting

5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	Herders in vast areas can benefit from the technology. One reservoir can be used by 2-3 herding families or a herders group for animal drinking water and watering small scale fields of animal forage and hay. Building and maintenance of water harvesting system would create new jobs at local level. Techniques and equipments are not required to be procured from abroad. Resources within the country can be used. This technology will support herders to increase their income and improve their livelihoods. Herders will gain experience and skills to establish water reservoirs in dry areas. Pasture management can be improved and ecosystem degradation would be reduced.
6. Climate change adaptation benefits	This is an appropriate adaptation technology when water resources are diminishing due to climate change. In the context of high variability of seasonal precipitation, it can enhance crop yields, livestock production and other forms of agriculture.
7. Financial Requirements and Costs	One reservoir requires about 20,000-40,000 USD depending on accessibility and remoteness of sites. 80% of cost could be paid by international agencies or state funding and 20% by herder groups. If 100 reservoirs are established in a year, about 2.3 million USD would be required.
8. Institutional requirements	Initially, professional support is needed to identify appropriate locations and construction work. Capacity building is necessary at local levels. Once local people gain experience and skills, they will be able to run it themselves.

B.6. Producing supplement forage with bacterial enzymes for livestock	
1. Introduction	There are about 2600 plants growing in pastures of Mongolia and 600 of them are eaten by livestock. Pasture biomass varies greately due to natural zones and seasons. Especially in winter, pasture biomass decreases significantly, its nutrient content is reduced by about 50-70%, protein by 60-70% compared to summer. Therefore, animals can not graze sufficient forgae, and lose 25-30 % of live weight, sometimes die. For example, about 10.2 million animals died in the winter of 2010. Cellulose in supplemental forage for ruminant animals break down in intestines and methane and carbon dioxide are released. Cellullose in pasture plants increase by 30-40% in winter and spring. Also straw which is used for animal forage has high amount of cellulose. So, supplemental forage should be enriched with enzymes in order to increase digestibility and reduce methane release.
2. Technology characteristics	Bacterial substances and enzymes would be produced by raising local varieties of bacteria which disintegrate cellulose. It would be used to produce forage with low cellulose and high protein through processing of agriculture secondary products by environment friendly technology. The technology can be introduced in any area of the country. Initially, bacterial enzymes would be produced by professional organizations and experts. Dosages for animals should be determined. Then local residents would be trained on application. Finally they would be able to enrich animal forages with the enzymes. After the technology diffusion, forage production using straw and other available materials would be increased. Livestock production would be increased and animal deaths would decrease.
3. Country specific applicability and potential	Environmentally friendly forage availability for animals would be increased due to processing of agricultural residue products or low palatable plants. Herders' income would be increased since animal production is increased. Eventually, food security would be improved. The factory would produce bacterial enzymes and supply them to herders. Application instructions should be developed and provided to customers. When results are demonstrated and confirmed, other factories can be established in local areas. The technology diffusion requires 3-4 years to implement in all soums and aimags.

4. Status of technology in country	The technology is being piloted in a project of International Agency of Nuclear Energy in Mongolia.
5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	This technology would allow the creation of jobs. However, fermenting and other techniques are needed to be procured from other countries. The technology solutions and methodologies are developed in detail due to science and technology projects, so internal resources would be deployed. The technology would allow improvement in animal production and quality. Consequently, herders' income would be increased and livelihoods would be improved. Researchers' experiences and capacity will be expanded. Human health would have positive impact due to usage of high protein food. Plants with low importance which are a result of pasture degradation would be used for forage. Also greenhouse gas (methane) emissions would be reduced due to changes in the oxidation process in intestines of ruminant animals processing of straw and other residue materials.
6. Climate change adaptation benefits	As a country with a harsh and continental climate, long cold winter and spring and nomadic livestock, supplemental forage is essential and green house gas (methane) from ruminant animals can be reduced due to the technology.
7. Financial Requirements and Costs	Factory of bacteria production would require about 800,000 USD. 50% the total cost can be from international funding 40% from the state budget 10% from enterprises and individuals.
8. Institutional requirements	Residents and herders need extensive awareness about the benefits, and skills for producing forage need to be transferred. There might be some challenges in some areas because the technology is just being piloted. For example, in good winters, herders do not feed their animals. However, they need to be trained to do so.

B.7. Sustainable Pasture Management	
1. Introduction	Sustainable Pasture Management (SPM) is a climate change adaptation technology in the animal husbandry sector. SPM helps sustain healthy soils and restore degraded pastures which bring many benefits including ensuring sustainable animal husbandry, alleviating rural poverty and building resilience to major environmental challenges. Pasture degradation has already taken place to various degrees and the objective of SPM should be restore degraded land while preventing further degradation and ensuring continued ecosystem health and function.
2. Technology characteristics	Mongolia has about more than 40 million livestock in an area of 1.1 million km^2 of rangeland. Pastureland is the backbone of Mongolian agriculture. Pasture degradation and desertification are among the most serious environmental problems. In the countryside, pasture degradation is widespread and occurs in all ecosystems at different intensities. Pasture is the main source of livestock food and herders livelihood in Mongolia. Well managed pasture helps to protect the environment and natural resources and also continue to sustain ecological functions and services. Pasture degradation in the country has manifested in several ways: decreased biomass production, soil fertility decline, and desertification, fewer and more unpalatable plant species. In addition, physical damage by human activities has increased extensively. At present, about 70% of pastureland is degraded in some form. Overgrazing, off-road driving, mining, global warming, low precipitation and lack of land management skills are causing more and more problems for the rangelands in Mongolia. Thus it is becoming increasingly difficult to provide the necessary amount of fodder for the livestock that are the main source of income for more than one third of the population.
3. Country specific applicability and potential	There can be different categories of pastures depending on usage[9]: • *Otor* pasture – *Otor* is reserved pasture where herders move to when faced with a critical situation such as changing pasture, or weather conditions. They differ from seasonal moves in that they are not regular and repeated and usually do not include the entire herd and household. This type of pasture also can be classified into smaller types. • Transit pasture which is used temporarily while animals are moving to other locations • Peri-urban pasture • Pasture for intensified livestock which is settled in a fixed location • Pasture for nomadic livestock.
4. Status of technology in country	Several projects have been implemented in the country. Pasture Law is under discussion for many years and yet to endorse.
5. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	Comprehensive sustainable pasture management (SPM) will conserve natural resources and thereby increase livestock productivity. All of these directly increase the nation's resilience to withstanding the negative impacts of climate change and the benefits of SPM will be widespread with producers as well as consumers. **Socio economic benefits** • Increased income of herders • Increased food security • Alleviate rural poverty • Improved livelihoods • Sustaining traditional lifestyles • Improved social sustainability and cooperation of different stakeholders **Environmental benefits** • Increased biomass and vegetation • Restored biological diversity including plant species • Sustained water sources (open and ground) • Increased soil fertility • Reduced greenhouse gas emissions • Reduced risks of natural disasters • Ensured ecological sustainability and ecosystem functions and services

9. Mongolian Society for Range Management web page: http://www.msrm.mn/index.php?option= com_content&view=article&id=303%3A-2011-&catid=85%3A2011-03-25-05-27-00&Itemid=453&lang=mn

6. Climate change adaptation benefits	The technology would help to increase resilience of livestock which is vulnerable to climate change.
7. Financial Requirements and Costs	In total 15,8 million US$ would be required from the government and international donors and private enterprises. Pasture Law - about 10 million US$ per year Subsidy program for pasture usage - about 5 million US$ Capacity building of herders and related organizations – 350,000 US$ R&D of SPM – 450,000 USD
8. Institutional requirements	Pasture Law would be supportive legal framework for the technology. Central and local governments, herders NGOs and herders group lay important roles in the implementation of the technology.

B.8. Livestock Disease Management (High Quality Livestock)	
9. Introduction	Livestock diseases contribute to an important set of problems within livestock production systems. These include animal welfare damages, productivity losses, uncertain food security, loss of income and negative impacts on human health. Livestock disease management can reduce disease through improved animal husbandry practices. These include: controlled breeding, controlling entry to farm lots, and quarantining sick animals. This is done through developing and improving antibiotics, vaccines and diagnostic tools, evaluation of *ethnotherapeutic* options, and vector control techniques.
10. Technology characteristics	Livestock disease management is made up of two key components: • Prevention (biosecurity) measures in susceptible herds • Control measures taken once infection occurs. The probability of infection from a given disease depends on existing farm practices (prevention) as well as the prevalence rate in host populations in the relevant area. As the prevalence in the area increases, the probability of infection increases.
11. Country specific applicability and potential	According to the national statistics for 2011, the number of animals infected by disease in 2011 has almost doubled compared to in 2008. About 500 incidences of animals infectious diseases were recorded in 2011 in majority of *soums*. A sharp rise in both animal and human brucellosis incidence has become a serious problem. Rabies and anthrax remain endemic with occasional human cases. Other prevailing infectious diseases are contagious *pustular* dermatitis, contagious *agalactia*, *enterotoxemia* and *pasteurellosis*. National level surveillance of infectious diseases in animals and management of appropriate preventive measures are urgently required in Mongolia. This technology would allow: • the establishment of national level surveillance system of infectious diseases including vector borne diseases among animals and mapping of potential outbreak areas • an action plan for common infectious diseases • a piloting of the surveillance and response system • setting up of local veterinary centers and strengthened treatment system • capacity building of herders, local veterinarians and other related workers
12. Status of technology in country	Currently, there are two major projects on animal health: - Animal health and livestock marketing with support of the EU: Improvement in diagnosis and tests would be improved through laboratory and facilities in 5 aimgs - Brucellosis eradication program by the Government and Swiss Development Agency.

13. Benefits and impact on the country development ✓ Economic (- Job creation; - Investment) ✓ Social (- Income generation; - Education; - Health) ✓ Environmental	Benefits of livestock disease prevention and control include: higher production (as morbidity is lowered and mortality or early culling is reduced), and avoided future control costs. When herders mitigate disease through prevention or control, they benefit not just themselves but any others at risk of adverse outcomes from the presence of disease on that operation. At-risk populations include herders, local residents, and consumers. The beneficiaries might also include at-risk wildlife populations surrounding the area that may have direct or indirect contact with livestock or livestock-related material.
14. Climate change adaptation benefits	The major impacts of climate change on livestock diseases have been on diseases that are vector-borne. Increasing temperatures have supported the expansion of vector populations into cooler areas. Changes in rainfall patterns can also influence an expansion of vectors during wetter years and can lead to large outbreaks. Climate changes could also influence disease distribution indirectly through changes in the distribution of livestock. Improving livestock disease control is therefore an effective technology for climate change adaptation.
15. Financial Requirements and Costs	Livestock disease management costs include: testing and screening, veterinary services, vaccines, training of livestock keepers and veterinary staff, and perhaps changes to practices and facilities to reflect movement restrictions and quarantines when animals are added to the herd. Prevention and control costs are generally evaluated against expected financial losses resulting from a disease outbreak in a cost-benefit analysis. The assumption is that increased prevention and control costs lower the expected losses by diminishing the expected scale of an infection. In 2011, the Government spent 4,700 million *tugrugs* (about 4 million USD) for prevention measures, about 700 million *tugrugs* (0.5 million USD) for laboratory tests and diagnosis and 1,800 million *tugrugs* (about 1.6 million USD) for vaccination anti infectious diseases of livestock.
16. Institutional requirements	Public policies range from bounties/indemnities for infected livestock to required herd depopulation and farm decontamination, to decentralization programme for provision of veterinary services and drug supplies. Livestock and animal health policy should be oriented to both the commercial and pastoral sectors and include pro-poor interventions to support the most vulnerable populations. Government investments in infrastructure (including early warning systems, roads, abattoirs, holding pens, processing plants, air freight/ports and so on), systematic vaccination, and in research and development can all contribute to providing an enabling environment for effective livestock disease management. Removing or introducing subsidies for improved management, insurance systems and supporting income diversification practices could benefit adaptation efforts.

ANNEX 3: LIST OF KEY EXPERTS AND STAKEHOLDERS INVOLVED AND THEIR CONTACTS

Sector/ Technology	Expert/ Stakeholder Name	Organization	Approach of consultation	Time	Topic
Key experts:					
Leader	Dr. P.Gomboluudev	Institute of Meteorology and Hydrology; p_gombo@hotmail.com	Leading and supervising all activities	daily	Climate change in Mongolia;
Agriculture/ Arable Farming	B.Bolortsetseg	Climate Change, Nature and Society NGO; ccnsMongolia@gmail.com	Leading Agriculture Working Group	daily	Impact of climate change on arable farming
Arable Farming	Dr. G.Davaadorj	Project of Desertification and Mitigation, Swiss Development Agency; GDavaadorj2001@yahoo.com	Key consultant	Every week	Sector prioritization; Current technologies in arable farming; preparation of 4 TFS; Facilitation of agriculture stakeholders
Arable Farming	Dr. G.Bayarsukh	Research Institute of Planting and Arable Farming, National University of Agriculture; bayar67@yahoo.com	Key consultant	Every week	Sector prioritization; Current technologies in arable farming; TFS; Facilitation of agriculture stakeholders
Animal husbandry	Dr. B.Binye	Head of Livestock Policy Sector, Ministry of Food, Agriculture and Light Industry, bynie99@yahoo.com	Key consultant	Every week	Sector prioritization; Current technologies in arable farming; TFS; Facilitation of agriculture stakeholders
Animal husbandry	Dr. D.Nergui	Director of Research Institute of Animal Husbandry	Key consultant		Actively engaged in sector prioritization, current technologies in livestock; preparation of 3 TFSs
Water	Dr. G.Davaa	Water sector, Institute of Meteorology and Hydrology, watersect@yahoo.com	Key consultant	Every week	Sector prioritization; Current technologies in water sector; 3 TFS in water application; Facilitation of water stakeholders
Pasture	B.Erdenetsetseg	Agriculture sector, IMH, erdtsetseg@yahoo.com	Key consultant	Every week	Sector prioritization; Current technologies in pasture management; Facilitation of agriculture and livestock stakeholders
Natural disaster	Dr. L.Natsagdorj	Consultant, IMH, natsag03@yahoo.com	Key consultant	Every week	Sector prioritization; Facilitation of agriculture and livestock stakeholders
Stakeholders:					

Water	Dr. T.Oyunbaatar	Water sector, IMH,	Meeting	Once a month	Technology prioritization; Review of water related TFS; translation of TFS and reports
Technology and Innovation	Dr. Borchuluun	National development institute, borchuluun@technotransmongolia.com	Meeting	Once a month	Sector prioritization; TFS – Intelligent Nutrient Management; Technology Prioritization
Environment	A.Enkhtsetseg	NEMO2 Environment Reform project, World Bank and MNET joint project,	Workshop discussion	One time	Sector prioritization; Methodology review
Pasture management	N.Tsolmon	Peri-urban land project, MCA Mongolia,	Workshop discussion	One time	Current technologies in pasture management; Sector prioritization
Water	D.Dorjsuren	National Water Committee	Workshop discussion	One time	Current technologies in the water sector; Sector prioritization
Forestry	Dr.Dorjsuren	Forestry Division, Institute of Botany, National Science Academy	Workshop and meeting	3 times	Current technologies in forestry; Sector prioritization
Human health	Delgermaa	National Emergency Management Agency,	Workshop discussion	One time	Current technologies in human health; Sector prioritization
Human health	Dr. Burmaajav	Public Health Institute, Ministry of Health	meeting	2 times	Current technologies in human health; Sector prioritization
Pasture	Dr.Enkh-Amgalan	Green Gold project, Swiss Development Agency; Enkhamgalan.@greengold.mn	meeting	3 times	TFS review for pasture and livestock
Agriculture/ Arable farming	Dr. P.Gankhuyag	MoFALI, Director of the Livestock Policy Department	meeting	Every month	TFS review; Technology prioritization
Agriculture/ Arable farming	Dr. A.Bakey	Vice Director of Mongolian State University of Agriculture	Workshop discussion	One time	TFS review; Technology prioritization
Environment	Dr. H.Hanimkhan	Deputy Head of State Extension Center	Workshop discussion	One time	TFS review; Technology prioritization
Environment	Dr.Ts. Banzragch	MNET, Director of the Strategic Planning and Policy department	Workshop discussion	3 times	TFS review; Technology prioritization
Desertification	B.Bayarbat	Coordinator, National Committee for Combating Desertification	Workshop and meeting	Every month	Livestock TFS review; Technology prioritization
Pasture management	D.Bulgamaa	Researcher, Green Gold project; bulgamaa@greengold.mn	Workshop and meeting	Every month	Livestock TFS review; Technology prioritization
Land	J.Davaabaatar	ALACGAC, Head of the Land issues department; jdavaabaatar@yahoo.com	Workshop discussion	1 time	Agriculture TFS review; Technology prioritization
Pasture management	B.Enhmaa	ALACGAC, specialist; Enkh1106@yahoo.com	Workshop and meeting	Every month	Livestock TFS review; Technology prioritization

Pasture management	S.Enhbold	Project of Desertification and Mitigation, Swiss Development Agency	Workshop and meeting	Every month	Livestock TFS review; Technology prioritization
Agriculture/ Livestock	Ts.Batzaya	Rural development specialist, Project of Desertification and Mitigation, Swiss Development Agency	Workshop and meeting	3 times	Livestock TFS review; Technology prioritization
Desertification	N.Mandah	Desertification Study Center, IGE, reseacher	Workshop and meeting	3 times	Livestock TFS review; Technology prioritization
Pasture	Dr. S.Tserendash	Researcher, Institute of Livestock, Mongolian State University of Agriculture	Workshop discussion	3 times	Livestock TFS review; Technology prioritization
Pasture	Dr. D.Ariungerel	LEWS project, MercyCorps; ariunregel@yahoo.com	Workshop and meeting	4 times	Livestock TFS review; Technology prioritization
Agriculture/ Livestock	Dr. A.Enkh-Amgalan	Director, Policy Research Center	Workshop discussion	2 times	Livestock TFS review; Technology prioritization
Agriculture/ Livestock	B.Erdenebaatar	Expert, Policy Research Center	Workshop and meeting	4 times	Livestock TFS review; Technology prioritization
Pasture/ remote sensing	Dr. M.Erdenetuya	Specialist, Environment Information Center ; m_erdenetuya@ yahoo.com	Workshop and meeting	Every month	TFS review; Technology prioritization
Arable farming	T. Tuvshinzaya	*Bayantsogt* Company; wheat and vegetable farming, *Tuv aimag*	Interview and discussion	2 times	Arable farming TFS review; Technology prioritization
Agriculture	S.Tsogoo	Greenhouse company, agriculture supplier	Interview	1 time	Arable farming TFS review; Technology prioritization
Arable farming	R.Nyamsuren	Small scale farmer (vegetable and berry) in *Khan-Uul* district, UB	Interview and discussion	2 times	Arable farming TFS review; Technology prioritization
Livestock	Z.Dorj	Herder, *Bayantsogt soum, Tuv aimag*	Interview	1 time	Livestock technology prioritization
Disaster management	D.Turbat	National Emergency Management Agency	Workshop and meeting	2 times	Sector prioritization; Early warning and livestock disease management TFS review; Technology prioritization
Arable farming	Zandankhuu	Household gardening project manager, NGO	Interview and discussion	2 times	TFS review; Technology prioritization
Arable farming	Lopilmaa	Household gardening project coordinator, NGO	Interview	1 time	TFS review; Technology prioritization

SECTION II

Barrier Analysis and Enabling Framework

EXECUTIVE SUMMARY

The Technology Needs Assessment (TNAs) for climate change adaptation in Mongolia was a set of activities to identify and determine the adaptation technology priorities of the country. TNAs are central to the work of the Parties to the Convention (art. 4.5 UNFCCC).

The Technology Needs Assessment for Climate Change in Mongolia was carried out from July 2011 to December 2012. Through the process of the TNA, arable farming and animal husbandry sectors were identified as priority sectors for climate change adaptation. Then, following an extensive consultative process, a list of potential technologies for each sector were identified, and prioritized by using a Multi Criteria Decision Analysis (MCDA) process. Six adaptation technologies were selected in total for the sectors based on the stakeholder consultation and the multi criteria analysis. In the barrier analysis and enabling framework, barriers, possible measures and enabling environments were defined for each of selected technologies. Although potential technologies were identified as priority needs, there are still barriers to overcome in technology transfer and diffusion. Therefore, the barrier analysis was carried out and an enabling framework was identified for each technology through stakeholder consultations from June to October 2012.

A summary of identified barriers and measures to overcome those barriers are given below.

1. Arable farming sector:

The prioritized technologies for climate change adaptation in the arable farming sector based on the stakeholder consultations were: (1) System of wheat intensification (SWI), (2) Vegetable production system (VPS) with drip irrigation and mulches and (3) Potato seed production system (PSPS). These three technologies were selected as the most promising adaptation options in the arable farming sector for Mongolia. All three technologies were categorized as consumer goods. The identification of barriers and measures were based on the brainstorming session with the stakeholder working group, review of literature and surveys and other investigations by the consultant.

The potential of the first technology System of wheat intensification (SWI) lies in increasing wheat production through adapting conservation tillage practices and holistic plant management with an emphasis on wheat root management. SWI is believed to be a technically viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability.

Fifteen key barriers for the development of SWI were identified. The two most critical barriers identified for the expansion of SWI arise from financial and economic constraints for undertaking increased investments, namely the high cost of equipment and supplies and limited financial capacity of grain producers.

Thirteen non-financial SWI barriers were identified, with three of the barriers - (i) Insufficient human resource and professionals; (ii) Poor coordination between key actors of SWI; and (iii) Lack of research capacity -recognized as among the most critical barriers. The other ten non-financial barriers are: Lack of incentive policy; Limited knowledge and skills; Low quality of agriculture equipment and supplies; Limited access to international markets; Inadequate infrastructure; Lack of legume seed banks; Conflict between animal husbandry and arable farming; Low demand of legumes; Inadequate information about legume consumption; and Lack of standards for imported equipment and supplies.

Stakeholder consultations and study of analytical reports produced by key experts suggested numerous economic/financial and non-financial measures that can be undertaken to overcome the barriers identified for SWI. Many of the measures suggest financial support to grain producers, importers of equipment and supplies and local manufacturers, capacity building for agriculture professionals and farmers, and facilitating better coordination between key actors in the wheat production system.

The second prioritized technology for the arable farming sector is the Vegetable Production System (VPS). The technology aims to intensify vegetable production through a set of water saving equipment such as drip irrigation, and low cost greenhouse or mulches. Drip irrigation is not only related to irrigation regime and equipment, it also includes fertilizer, pesticide and soil management and their proper application. As a whole system, the technology can provide efficiency and benefits to farmers. Vegetable production system with drip irrigation and mulches can support farmers to adapt to climate change by providing efficient use of water supply. Particularly in areas subject to climate change impacts such as seasonal droughts, drip irrigation and mulches reduces demand for water and reduces water evaporation losses (as evaporation increases at higher temperatures).

During the barrier analysis process with stakeholders, ten key barriers were identified and they were classified into two categories - economic and financial barriers; and non-financial barriers. These ten barriers included two economic and financial barriers (high capital cost; limited access to long term soft loans) and nine non-financial barriers. Amongst the eight non-financial barriers there are two technical barriers (insufficient quality assurance of drip irrigation and other equipment; inadequate investments into infrastructure facilities). There is also one barrier for policy, legal and regulation (lack of subsidy policy which encourages farmers to adapt the technology); human skills (limited knowledge and skills to use drip irrigation and mulches); institutional and organizational capacity (lack of training and demonstration); market failure (underdeveloped local market and supply chain system); social, cultural and behavioural (lack of attitude towards water saving behaviour); and network failure (poor coordination between key actors). According to the view of the stakeholder group, out of all the barriers identified under the VPS, the most important barrier was the high capital cost.

The identified measures to overcome the barriers for diffusion of the VPS included two economic and financial measures and eleven non-financial measures. The economic and financial measures comprised (a) tax exemption policy for importers of drip irrigation and mulching equipment and supplies; (b) long term soft loans for importers, local manufacturers, repair service providers. The non-financial measures comprised: Set up incentive policy to encourage farmers deploy the technology; Systematic agriculture professionals' development; Capacity building of vegetable farmers; support research on vegetable production with drip irrigation and mulches; Establish maintenance and repair service of agriculture and irrigation equipment at provincial level; Develop rural infrastructure; facilitate coordination between actors in supply chain at local level; Support farmers and groups to explore funding opportunities; Organize integrated supply of drip irrigation equipment and supplies and Strengthen guidelines and standards on imported agriculture machineries goods and supplies.

In the context of climate change adaptation, Potato Seed Production System (PSPS) helps to build sustainable, reliable and high quality potato seed production in the country. PSPS components include: development of varieties, producing mini tubers or elite seeds, multiplying seeds, and better storage and delivery systems. Producing potato mini tubers in aeroponics has a high reproduction coefficient and requires less labor, time and financial resources than potato seed production in soil. The technology can improve the supply of good and healthy potato seeds and increase the potato production per area.

Barrier analysis for PSPS identified seven key barriers with two from the economic and financial category and others from policy, legal and regulatory, human skills, institutional and organizational capacity, market failures and network failure categories. Overall, inadequate financial resources and high cost of equipment and capital seems to be at the root of many problems in this sector. Besides economic and financial barriers, there are many barriers to PSPS resulting from poor institutional and coordination arrangements.

Stakeholders suggested several economic, financial and non-financial measures that can be undertaken to overcome the barriers identified for PSPS. Many of the measures suggested in order to overcome economic and financial barriers include assuring adequate funding from the government , international and private resources, provision of long term soft loan to potato seed producers, and tax exemption of imported aeroponics systems and other facilities. The measures recommended to overcome non-financial barriers comprised: setting up a subsidy policy on the application of PSPS; training of agriculture professionals on aeroponic and potato seed production; expanding research capacity on potato varieties and advanced equipment; training of potato seed farmers; investing into local infrastructure; and intensifying potato supply chain processes.

Barriers to technology transfer and diffusion for climate change adaptation are likely to be interlinked because they are parts of a bigger system or sector. Analysing individual barriers is risky because it overlooks more holistic and potentially more efficient opportunities to address their combined effects. The linkages of different barriers faced by the three prioritized technologies in the arable farming sector are analysed, so as to maximize synergies and optimize the effects of recommended measures. This process identified four key barriers that are common to the three specific technologies: inadequate finances; insufficient policy framework; inadequate human skills; and poor research and development. For each of these four common barriers alternative sets of measures required to overcome them were identified.

The prioritized technologies for climate change adaptation in the animal husbandry sector based on stakeholder consultations were; (1) Seasonal prediction and early warning systems (2) High quality livestock through selective breeding and animal disease management and (3) Sustainable pasture management. The first and third technologies were categorized as other non-market goods and the second technology categorized as consumer goods. The process of barriers analysis, identifying and prioritizing the barriers, and identifying measures to overcome the barriers (leading to development of an enabling framework) were carried out with the participation of sectoral technical stakeholders, review of literature, interviews with subject matter experts and other investigations done by key experts.

Climate change will undoubtedly influence animal husbandry. In addition, climate changes such as temperature, precipitation and variations in snow coverage could also have an effect on animal energy cycles and dynamics. Much research suggests that climate change is expected to negatively affect animal husbandry through pasture degradation and desertification, decreasing animal productivity and increased natural disasters especially droughts and heavy snow in winter.

The first technology option for the animal husbandry sector, Seasonal prediction and livestock early warning system (SPLEWS) is recognized as a very important technology because it helps to reduce economic losses and mitigate the number of animal deaths from drought and zud by providing information that allows herders and government officials to plan and implement measures ahead of time. For the Mongolian context SPLEWS is "the provision of precise and effective information through identified institutions that allows herders and government officials to prepare for effective response to slow onset disasters including drought and *zud* avoid or reduce risks". Due to economic loss and magnitude, the primary focus of SPLEWS is in mitigating disaster risk from drought and *zud* (slow onset disasters).

The current livestock sector is based on a traditional nomadic pasture system and thus herder families' livelihood is highly dependent on, and influenced by, weather and climate. The tendency for increased frequency of climate extremes is expected to continue in the future. As a result, drought and *zud* are highly likely to occur more frequently, increasing risks for agriculture and nomadic livestock.

Ideally, when integrated with risk assessment studies and communication and action plans, early warning systems can lead to substantive benefits. Effective early warning systems embrace all aspects of emergency management, such as: risk assessment analysis; monitoring and predicting the location and intensity of the natural disaster; communicating alerts to authorities; and responding to the disaster. The issue in Mongolia is not to establish a new early warning system, but converting the existing early warning system into an effective one. For this purpose the agencies responsible shall fulfill the four components according to their functions and responsibilities to strengthen the early warning system into a reliable, timely, cost-effective, sustainable, and user friendly tool.

Following the stakeholder brainstorming session, four key barriers for technology transfer and diffusion of SPLEWS were identified. Of the key barriers, one belonged to the category of economic and financial barriers and the other three to non-financial barriers. The stakeholders identified the economic and financial barrier (inadequate financial resources) as a crucial barrier for technology transfer and diffusion of SPLEWS. Three non-financial barriers were in the category of institutional and organizational capacity (insufficient research and development), information and awareness (inadequate awareness and understanding), and network failures (poor coordination between organizations).

The measures to overcome the barriers under SPLEWS, were identified and weighed up through group discussions with technical stakeholders, interviewing key personnel, and via email. To overcome the economic and financial barrier the suggested measures were: allocation of required amount of funds by the government; exploration of alternative funding sources; and setting up a low tariff communication system for disaster information. The measures recommended for non-financial barriers included: (a) facilitating consultative periodical meetings among organizations; (b) establishing a post disaster feedback mechanism; (c) supporting research and development on SPLEWS; (d) providing systematic training for different stakeholders; (e) strengthening formal and informal network of disaster effective communication; and (f) developing message packages and educating the public through the media.

The second prioritized technology for the animal husbandry sector was High quality livestock through selective breeding and animal disease management. High quality livestock technology aims to improve quality of all animals in *aimags* and *soums* based on selective breeding using core herds and improved animal health services. Diffusion of the technology would enable Mongolia to control livestock number within its pasture carrying capacity and reduce overgrazing and desertification. The technology includes two large components- selective breeding and animal disease management.

Using advanced breeding equipment such as artificial insemination combined with traditional methods would allow for breeding of high quality animals which are resistant to drought, thermal stress, harsh winter and parasites and diseases. Livestock disease management consists of prevention and control which help to achieve higher production, lower morbidity and mortality, and less loss of animal production. The major impacts of climate change are on vector-borne animal diseases. Climate changes could also influence disease distribution indirectly through changes in the distribution of livestock. A comprehensive disease management system has been identified as essential for Mongolian livestock for climate change adaptation. Outcomes of the technology are improved livestock health and resilience to climate change, increased food security and safety, and better access to urban and international markets.

The barriers identified for this technology consist of three economic and financial which were: inadequate financial resources for local veterinary and breeding units from the government; Lack of financial support for the research and development of livestock breeds and diseases; and the high cost of imported breeding equipment, and veterinary supplies and medicines. Non-financial barriers identified comprised of four policy, legal, regulatory barriers (insufficient focus on livestock adaptation to climate change in legal frameworks, inadequate incentive policies and regulations, inefficient enforcement of the Mongolian Law of Livestock Gene Pool and Animal Health, and unclear roles of state and private veterinary/breeding workers and units at local level); two market failure barriers (low access to tested and proved local breeds and qualified veterinary medicines and services, and underdeveloped market and trade mechanisms) and social, cultural and behavioural barriers (reluctance of herders to breed high quality animals and lack of understanding of importance of the technology); one human skills barrier (insufficient number of animal breeding technicians and veterinarians at local level); information and awareness barrier (lack of information and awareness); and network failure barrier (poor coordination between key actors).

The measures identified to overcome barriers for the diffusion of the technology –high quality livestock technology includes five economic and financial measure and nine non-financial measures. The economic and financial measures are: allocation of financial resources for the law implementation; acquiring funding for the research and development of animal health and breeds; investment into local market and trade network and infrastructure; exemption of importation taxes of veterinary products and breeding facilities and provision of soft loans to local manufacturers of veterinary and breeding products. Non-financial measures comprised: (a) establish appropriate subsidy policy for herders to adapt the technology-efficient enforcement of the law; (b) develop capacity building programs for animal breeding specialists and veterinarians; (c) strengthen state and private veterinary/breeding units- set up animal disease surveillance and prevention system;(d) educate herders about high quality animals; (e) improve partnership between key actors; and (f) ensure quality assurance of imported and produced veterinary and breeding products.

The third technology option for climate change adaptation, the Sustainable pasture management (SPM) is a solution to pasture overgrazing and degradation. At present, about 70% of pastureland is degraded in some form. Overgrazing, off-road driving, mining, global warming, low precipitation and lack of land management skills are causing more and more problems for the pasture in Mongolia. Thus, it is becoming increasingly difficult for Mongolia to provide the necessary amount of fodder for the existing number of livestock that is the main source of income for more than one third of Mongolia's population.

Following stakeholder analysis, the team identified ten key barriers to technology transfer and diffusion of SPM in the context of climate change. Two economic and financial barriers (lack of financial resource for SPM; and lack of a taxation mechanism for pasture usage and management) were the most critical for SPM. Among the other seven key barriers, three barriers in category of social, cultural and behavioural (complexity of pasture system in Mongolia; mobile herding system; and uncontrolled animal numbers); and one barrier each from categories of policy/legal/regulatory (lack of land tenure rights); institutional and organizational capacity (lack of regulation authority and mechanism for pasture usage), information/awareness (lack of awareness), network failures (poor collaboration) and other (frequent drought and zud) were considered as significant barriers.

An extensive set of measures identified to overcome barriers for adoption of SPM technologies were suggested by the stakeholders and various analyses performed. Economic and financial measures such as allocating sufficient funding for law enforcement, financial resources for research and development, and developing subsidy program, were critical to enhance implementation of SPM. Beside other non-financial measures, the most important measure was identified policy/legal/regulation measure which was the establishment of an appropriate legal framework for Mongolia.

Barrier analysis and enabling framework lead to the development of a national Technology Action Plan (TAP) that prioritizes technologies, recommends an enabling framework for the diffusion of these technologies, and facilitates identification of good technology transfer projects and their links to relevant financing sources.

Arable farming sector

Arable farming is one of the most vulnerable sectors to the impacts of climate change in Mongolia. Arable farming mainly consists of cereals, potatoes, vegetables fodder crops, berry fruits and oil-yielding crops. Changing climate and water scarcity suggest potentially negative impacts on agriculture, food security, food production and natural resources in Mongolia. Climate changes include: high temperatures, uncertain and highly variable rainfall patterns and intense natural disasters. These changes combined with deterioration and dwindling natural resources, emphasize the necessity of sustainable adaptation technologies to increase the productivity, stability and resilience of the arable farming sector.

The analysis of technology options was carried out through a participatory process, by compiling a list of all potential technologies available in the arable farming sector to cope with climate change. A prioritization process utilizing the Multi-Criteria Decision Analysis (MCDA) approach was used to rank the various technologies. The MCDA process ranked nine adaptation technologies considering six different benefit criteria from economic, environment and social spheres as well as implementation costs. The most promising technologies are: system of wheat intensification, vegetable production system with drip irrigation and mulches for vegetable and potato seed production system.

Table 18: Prioritized technologies and categories in arable farming sector

No	List of prioritised technologies	Category of the technology[10]
1	System of wheat intensification	Consumer Goods
2	Vegetable production system with drip irrigation and mulches	Consumer Goods
3	Potato seed production system	Consumer Goods

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1.1 Preliminary targets for technology transfer and diffusion

Through barrier analysis and enabling environment process, we expect the following targets for the technologies.

- System of wheat intensification (SWI): There are about 1000 grain producers with approximately 500,000 ha of crop land[11]. Spring wheat is grown in agriculture regions which are mainly the northern and central parts of the country. System of wheat intensification will target at least 80 % grain producers assuming they are permanent farmers dealing with grain production. The technology diffusion will require at least 7-8 years, meaningful implementation in 2019-2020. The full deployment of this technology will have national grain security and environment benefits.

- Vegetable production system with drip irrigation and mulches: Today farmers grow vegetables other than potato on about 8,000 ha of land. This technology will target at least 50% of farm land depending on availability of water resources and electricity for drip irrigation. The full deployment of the technology will require 6-8 years and is expected to be completed by 2020.

- Potato seed production system: In 2011, potato was planted in 14,600 ha of land and harvest was about 200,000 metric tons. From 2010, potato growers have supplied 100% of local demand of potato. However, adapted varieties and seed production is not sufficient. Mongolia has being piloting raising potato tubers in aeroponic system since 2008. Potato seed production system will help to meet at least 80 % of national demand with high quality potato seeds by 2016-2018. Potato production is expected to be increased at least 60% over current level of production.

1.2 Barrier analysis and possible enabling measures for System of wheat intensification (SWI)

Barriers and possible measures to overcome barriers were identified and discussed with stakeholders from Arable farming sector at a workshop on 6th September 2012 and also a key experts' discussion after the workshop.

1.2.1 General description of SWI

Wheat flour is one of major staple foods for Mongolians. During the transition period of 1990-2000, the wheat system faced challenges due to a lack of financial and management issues. In recent years, the Government of Mongolia has endorsed several programs such as 'Agriculture Campaigns' and the National Food Security Program, and has also provided financial and technical support. Crop land has increased 2.5 times since 2007, and total wheat production has met local demand in 2010 and 2011, and the excess (up to 100 000 metric tons) could be exported. However, there is high need for adaptation technologies in wheat production to minimize potential losses, because future climate change impacts and environment degradation can hinder development of sustainable and resilient wheat production system.

System of wheat intensification consists of conservation tillage and holistic plant management with an emphasis on wheat root treatment to achieve the objective of economically, ecologically and socially sustainable agricultural production. SWI method is about managing the crop, soil, and nutrients to promote a vibrant soil system that, in turn, promotes larger root systems. With adequate spacing and loose soil, the roots of the crop can grow deeper than from conventional cropping methods. Conservation tillage practices reduce the amount of soil erosion through

11. Overview of arable farming sector, Ministry of Food, Agriculture and Industry, web page- http://www.mofa.gov.mn/

ensuring permanent soil cover minimizing soil disturbance and slowing water flow. In the pilot project of conservation tillage in Mongolia, tillage operations were significantly reduced for cropping[12].

Holistic plant management is an important component in the wheat system which consists of nutrient and water management, root treatments and crop rotation. Crop rotation is the practice of growing a series of dissimilar types of crops in the same area in sequential seasons. Crop rotation confers various benefits to the soil and mitigates the build-up of pathogens and pests that often occurs when one species is continuously planted on the same piece of land, and it can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants.

In the 1980s, several experiments on crop rotations were conducted in Mongolia. For example: 2-year rotations of bare fallow and wheat or barley; 3-year rotations of bare or occupied fallow or green manure/wheat/oats for grain or green fodder/barley or wheat; 4-year rotations of bare fallow/potatoes or wheat/wheat/oats for grain or green fodder or barley; and a 5-year rotation of bare fallow/wheat/barley/peas + oats/wheat. This trail did not continue (nor was crop rotation practiced) during the transition period from 1990-2010. Today, research and experiments in crop rotations are needed. Incorporation of livestock in crop rotation cycles is possible when forage crops are planted. However in Mongolia crop farms do not have the appropriate technology for crop rotation, including seeds of legume varieties which can grow well and produce high yield under the Mongolian soil and climate conditions. Some research on rotation systems in irrigated planting has only started recently in Mongolia.

A system of wheat intensification that integrates the conservation tillage practices and holistic plant management is a viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability.

1.2.2 Identification of barriers to SWI

In order to identify the barriers to SWI several types of investigations were carried out. These included desk studies through literature survey and rapid appraisal methods (such as face to face and mail interviews) with a range of stakeholders prior to the stakeholder consultation workshop. Through an extensive consultative process, a list of 18 potential barriers for technology transfer and diffusion of SWI technology was compiled. Through further consultation and analysis a list of 15 prioritized key barriers were identified.

1.2.2.1 Economic and financial barriers

Barrier analysis identified two economic and financial barriers;

- High cost of conservation tillage equipment and supplies: The wheat system requires herbicide, fertilizers, seeds of legumes, and harvesting equipment. There are few importers (and no manufacturers) of equipment and supplies in Mongolia. Importing companies' capacity is limited and cannot meet the demands of grain producers. If legumes are used as rotated crop, additional equipment will be required. Each set of the harvesting equipment costs 200 thousand *tugrugs* ($150 USD) per machine. Total cost of additional harvesting equipment for legumes will cost about 111 million *tugrugs* ($90,000 USD).

- Limited financial capacity of grain producers to provide up-front payment to importers: Grain producers struggle to pay loans within a short period because national flour mills have been saturated with grains and the

12 Silke Hickmann, Conservation agriculture in northern Kazakhstan and Mongolia, FAO Agricultural and food engineering working document, 2006, www.fao.org/ag/ca/doc/J8349e.pdf

government procurement and subsidy provision is delayed due to political and macro-economic reasons.

1.2.2.2 Non-financial barriers

Thirteen non-financial barriers were identified.

Policy, legal and regulatory barriers:

- No incentive policy for grain producers to apply climate adaptation technologies: There is a subsidy (per metric ton of wheat) from the government. Now that national demand has been met in the past 2-3 years, the government needs to focus on more environmentally sound climate technologies such as conservation tillage, drip irrigation, rotation etc.

Human skills barriers:

- Insufficient human resources and professionals: Many private companies engaged in cereal growing do not have soil, environment and agriculture science professionals.

- Limited knowledge and skills to use equipment, crop rotation, fertilizers and herbicide. Long term impacts of chemical usage are not known by farmers.

Institutional and organizational capacity barriers:

- Lack of adaptive research and foundation research capacity: Demonstration and experiment of environmental and climate change adaptation technologies are not well considered and are underdeveloped. Fallow processing options and long-term consequences of using fertilizers and herbicide are not available within the country context. Environmental impacts are ignored and not studied yet because arable farming is a relatively new sector with only 60-70 years history.

Market failure barriers:

- Low quality of agriculture equipment and herbicide etc.: Farmers do not have sufficient confidence in the application of new equipment and technologies.

- Limited access to international markets: During the last two years, Mongolia produced more grain than the national demand. However, the government and private enterprises struggled to sell the surplus due to lack of skills and experience in accessing international markets. Mongolian grain products remain relatively unknown by international consumers.

- Inadequate infrastructure: At the provincial level there is no supplier of agriculture equipment, herbicide and others supplies, and there are no maintenance services for equipment. This leads to high cost and great risks to grain producers if they buy advanced equipment and materials.

- Lack of seed bank of legumes: (Legumes seed availability is limited) because legumes are not planted as a rotation crop on a large scale. Therefore the legumes production market is not developed in Mongolia. In order to establish a seed bank, 200 metric tons of legume seed required to be imported in the first year which would cost about $120 000 USD.

Social, cultural and behavioural barriers:

- Conflict between animal husbandry and arable farming: Animals graze on cropland during non-growing season. Conservation tillage requires vegetation coverage throughout the year and not all crop land can be protected with fences.

- Low demand for legumes: Demand for legumes at local markets is low because Mongolians are not used to consume legumes as food or as animal forage. Access to international markets is limited for legumes.

Information and awareness barriers:

- Inadequate information about legumes: The general population (including herders) lack information and knowledge about the benefits of legumes.

Network failures:

- Poor coordination between key actors, such as: grain producers, Arable Farming Support Fund[13], importers, State inspection agency, Ministry of Nature, Environment and Green Development, research organizations and provincial agriculture extension centres.

Technical barriers:

- Lack of standards for imported equipment, supplies and chemicals as well as for export market. Grain producers (who will bear the risks) are not satisfied with the quality of imported equipment and herbicides. Standards for accessing international and other countries markets are not known.

1.2.3 Identified measures for SWI

Measures have been identified by stakeholder consultations held on 6th September 2012, to overcome the barriers discussed earlier for technology transfer and diffusion to adopt SWI. Finally, those measures were validated using results of analysis reported from national and international experiences.

1.2.3.1 Economic and financial measures

- Tax exemption for the imports of wheat intensification technology equipment and supplies: A 15% drop in equipment costs is expected as a result of this measure. However it will lead to decrease in government revenue by 35 billion *tugrugs*.

- Soft loans to importers through the Arable Farming Support Fund: The Fund will need \$7.6 million USD of revolving cash fund - (herbicide cost -\$2.1 million USD, sprayer cost is \$2.5 million USD, seedling machine -\$3 million USD). However farmers are expected to make a down payment of 30% which is about \$2.28 million USD.

- Allocate government financial resources to buy legumes for the State Emergency Pre-positioning Fund and the State Animal Forage Fund. The goods and forage are used in emergency responses and are sold at the harvesting price in winter and spring in areas experiencing a harsh winter. It will require 20 billion *tugrugs* to buy 40,000 metric tons of soya for food and 25 billion *tugrugs* to buy 80,000 metric tons of legumes for forage. However, this money can act as revolving fund.

13. State fund belongs to Ministry of Food, Agriculture and Industry and aims to coordinate Arable farming affairs and implement related policies and program

1.2.3.2 Non-financial measures

Policy, legal, and regulatory measures:

- Incentives for the application of environmental and climate technologies: In 2012, the government is expected to spend about 45 billion *tugrugs* ($37 million USD) in wheat subsidies. It has been an important policy to ensure national food security through supporting grain production. In the future, the resource can be spent on more environmental and climate technologies in order to ensure sustainable development of the agriculture sector.

Human skills measures:

- Capacity building for grain producers: Sufficient knowledge about proper application of chemicals, herbicide and fertilizers will be given to grain producing farmers.

- Systematic Human Resource development plan: Training of agriculture specialists through systematic tertiary education is essential in the future to apply scientific knowledge and practices in arable farming. Climate change adaptation and related technologies need to be explicitly and intentionally included in the curriculums of agricultural colleges and universities.

Institutional and organizational capacity measures:

- Establish professional consulting service at local levels: This will help farmers properly apply the correct herbicide and process fallow. Nationwide, about 2 billion *tugrugs* will be required for additional specialists to teach farmers how to apply chemicals and herbicide. At least 250-300 professionals are required in order to provide professional supervision to at least 600 grain producers out of 1000 farms. Professional consulting service will be based on provincial and *soum* level (where possible) depending on geographical locations and density of farmers and cropland.

- Support research and development of crop rotation options, crops, varieties and fertilizer, irrigation and herbicide optimum applications. There are research organizations such as State University of Agriculture and Farming Research Institute of Darkhan and a few other private colleges which are mainly located in the capital and Darkhan city. However, current research studies are limited due to financial and other challenges. Crop rotation should vary depending on regional context, soil type and geographical characteristics. There is a strong need to expand research of wheat production systems based on different characteristics of climate and soil. Field research in different crop regions will be supported.

Market failure measures

- Improve business regulation and legal framework: Procurement of agriculture equipment and materials can be coordinated at the national level based on actual needs. Contracts between importers, grain producers and the Arable Farming Support Fund should be done with clear legal obligations and terms. Grain producers should pay 30% in down payment and the remaining 70 % should be paid by importers. Arable Farming Support Fund will coordinate and bridge these stakeholders.

- Establish maintenance service of agriculture machinery and equipment at provincial level: This measure would help to reduce cost of machinery and equipment and requires involvement from private enterprises and dealers of agriculture machineries and equipment. Currently few importers of agriculture machineries have repair and maintenance service in Ulaanbaatar none have service at the provincial level. Farmers have to transport their broken machines and equipment to the city or try to find somebody in their area who are not specialised. It increases risk and costs of machinery and shorten equipment lifespan.

Information and awareness measures:

- Increase demand of legumes through awareness-raising about legumes benefits for human and animals. The range of possible uses for legumes will be disseminated through media and press organizations in print, audio and video formats. High rate of literacy and TV use by Mongolians would allow the measure to be carried out efficiently and extensively.

Technical measures:

- Enforce quality assurance and standards legal framework: Quality assurance and standards should be established and enforced for imported equipment and herbicides. International and other standards need to be studied in order to facilitate access to international markets.

- Proper storage facilities should be built to store herbicide and fertilizers in winter time at provincial level. Cost of building a storage facility of 200m^3 volume is 350 million *tugrugs* (about $300,000 USD) ($150-200 thousand USD) per *aimag*. Storages in 8 *aimags* would cost about 2.4 billion *tugrugs* ($2 million USD).

1.3 Barrier analysis and possible enabling measures for Vegetable production system with drip irrigation and mulches VPS

1.3.1 General description of VPS

The technology aims to intensify vegetable production through a set of water saving equipment such as drip irrigation, and low cost green house or mulch. Drip irrigation is not only related to irrigation regime and equipment - it includes also fertilizer, pesticide and soil management and their proper application. As a whole system, the technology can increase efficiency and provide many benefits to farmers. Mulch is a product used to suppress weeds and conserve water in crop production and landscaping.

Mongolia is experiencing water shortages and has an increasingly dry climate due to climate change. Therefore, drip irrigation with plastic mulch can help reduce water consumption, decrease labour intensity, and increase production. Vegetable and other crops, such as water melon, cucumber, tomato, and peppers, can be planted with plastic mulch. Drip irrigation is based on the constant application of a specific and focused quantity of water to soil crops. There is wide range of types of drip irrigation system. However, locally suitable system for specific crop needs to be developed.

Vegetable production system with drip irrigation and mulches can support farmers to adapt to climate change by providing efficient use of water supply. Particularly in areas subject to climate change impacts such as seasonal droughts, drip irrigation and mulches reduces demand for water and reduces water evaporation losses (as evaporation increases at higher temperatures). Furthermore, fertilizer application is more efficient since it can be applied directly through the drip pipes.

Mongolia has been piloting drip irrigation systems since 1997 and the applicability of this technology has been confirmed. The pilots demonstrated suitability and applicability for growing vegetables, berries and bushes in Mongolia. Currently, plastic mulches are used by a small number of Mongolian farmers to grow crops such as peppers, water melon cucumber and tomato. Drip irrigation systems help farmers reduce water consumption for the production of vegetables and berries. Initial cost of equipment will be high, however operating cost of irrigation can be lowered due to water saving. Small farms and families can use several small scale drip irrigation systems which each of them can be set up for 0.5 ha. Because of Mongolia's cold winter, irrigation equipment and mulches need storing facilities. The storage space requirement is not large, so it can be solved by farmers and households.

1.3.2 Identification of barriers to VPS

At the session with stakeholders, VPS with drip irrigation and mulches was identified as a market good. Fifteen barriers were identified and based on their importance they were ranked. Out of the 15 barriers identified, ten top key technologies were selected - these technologies include two economic and financial and eight non-financial barriers.

1.3.2.1 Economic and financial barriers

Two economic and financial barriers were identified:

- High cost of drip irrigation equipment, plastic mulch materials, and facilities. There is no manufacturing of drip irrigation and plastic sheets in the country and equipment and supplies are imported from other countries. For big farms the cost per hectare of drip irrigation is estimated to be quite high at 17 million *tugrugs* ($12,000 USD).

- Limited access to long term soft loans to importers of drip irrigation equipment, facilities and greenhouse and mulch materials as well as vegetable growers.

1.3.2.2 Non-financial barriers

Non-financial barriers identified for VPS drip irrigation and mulches, included policy, legal and regulatory, human skills, institutional and organizational capacity, market failure, cultural and behavioural, network failure and technical barriers. Non- financial barriers are listed below.

Policy, legal, and regulatory barriers:

- Lack of subsidy policy for encouraging farmers to use sound environmental and climate technologies due to the high cost of water saving equipment and materials, vegetable growers face challenges purchasing them.

Human skills barriers:

- Limited knowledge and skills: Vegetable growers do not have sufficient knowledge and skills to use water saving equipment such as drip irrigation, greenhouse or mulches.

Institutional and organizational capacity barriers:

- Lack of training, demonstrations, pilots and experiments for drip irrigation and mulches. There are few research and practical experiments on vegetable varieties, irrigation norms, standards, soil characteristics, application of fertilizers or economic analysis have been done. Application of research and science in practice is very weak.

Market failure barriers:

- Underdeveloped local market and value chain system: many rural farmers are isolated from urban markets, and there are insufficient processing factories and storage to support the conversion of excess product into income growth. The current VPS has a seasonal pattern. Also there is insufficient financial support to strengthen value chains at local level including vegetable processing factories, storage and others.

Social, cultural and behavioural barriers:

- Poor knowledge and attitude towards water saving behaviour: Traditionally, Mongolians use water free of charge which today has led to inefficient consumption and undervaluation of water. Farmers in local areas use open water resources such as rivers, springs or free wells.

Network failures:

- Poor coordination between key actors including government, international and national projects and programs, research and farms and provincial agriculture extension centres. Sustainability of project outcomes and scaling up of promising practices are not ensured with the financial and human resources by international and national agencies. Research work has not been tested in different regional areas through agriculture extension centres which are located in provincial levels.

Technical barriers:

- Insufficient quality assurance of drip irrigation equipment, mulches and supplies: farmers bear these risks and the high costs of equipment.

- Inadequate investments into infrastructure facilities which can help expand market access, water resource and electricity etc. Current development of infrastructure is very centralized in the capital and few cities.

1.3.3 Identified measures for VPS

Potential measures were identified to overcome barriers.

1.3.3.1 Economic and financial measures

Economic and financial measures are very important because the underlying causes of many barriers are related to financial resources. Measures to overcome these barriers include:

- Tax exemption policy for importers of drip irrigation equipment, mulching supplies and facilities. This measure will help to increase availability of equipment and supplies and competitiveness between importers. As a result, the cost of drip irrigation equipment and other supplies is expected to decrease.

- Long term and soft loans for importers, local manufacturers, repair service providers of drip irrigation equipment and supplies and recycling factories of plastic waste from mulches.

1.3.3.2 Non financial measures

Non-financial measures are also important to create enabling environment for the technology diffusion. The following measures were identified to overcome the above mentioned barriers:

Policy, legal and regulatory measures:

- Set up an incentives policy to encourage farmers to deploy sound climate and environmental technologies.

Human skills measures:

- Systematic agriculture professionals' development: Preparing farmers and agriculture specialists through systematic tertiary education is essential in the future to apply scientific knowledge and practices in arable farming. Climate change adaptation and technologies need to be explicitly and intentionally included in curriculum of colleges and the University of Agriculture.

- Capacity building for vegetable farmers: Sufficient knowledge about proper application of mulches, herbicides and fertilizers along with drip irrigation should be given through frequent training by agriculture extension centres and local training centres to farmers. Training can be in different ways as indoors and field practices, audio and visual programs and exposure trips. Frequent training and awareness-raising is critical to successful deployment of technology and to achieve targets.

Institutional and organizational capacity measures:

- Support research on crop production with drip irrigation and fertilizer application: Drip irrigation equipment, norms, regimes, and standards, fertilizer application and other soil tillage equipment should be defined for vegetable crops based on scientific knowledge, experiences from other countries and experiment and tests in the Mongolia. Research outcomes and results need to be scaled up through provincial agriculture extension centres and local training centres.

- Establish maintenance service of agriculture and drip irrigation equipment at provincial level: Importers and dealers of agriculture equipment and facilities should establish their units which provide repair and maintenance service to buyers. Guarantee and quality standards should be thoroughly followed by trade companies.

Market failure measures:

- Develop rural infrastructure such as road, power supply system and water resources, to improve access to water and electricity resources, which are required for drip irrigation.

- Set up an agriculture product market at provincial level and invest into the necessary infrastructure such as buildings, storage and other facilities.

Network failure measures:

- Facilitate coordination between business and community groups who grow, transport, process, and store vegetables and retailers to support value chains at local level. Poor farmers should be involved intentionally in the supply chain process by government as well as other international and national agencies. Coordination between government, international and national projects and program, vegetable farmers and other market actors in value chain should be facilitated focusing on enabling market conditions for farmers.

- Support and train farmer groups and cooperatives to access financial resources from national and international donors for local processing factories, storage and market infrastructure.

- Organize integrated supply of drip irrigation equipment and supplies: Arable Farming Support Fund can facilitate obtaining drip irrigation equipment and supplies and can act as a bridge between farmers and importers. However, transparency and efficiency of the Fund's operation should be ensured and periodical monitoring and evaluation could be done by NGO of farmers, individual farmers and other government audit organizations.

Technical measures:

- Strengthen guidelines regarding quality assurance of imported and produced agriculture equipment and supplies: Quality standards and strict monitoring mechanism should be set up for equipment and materials of drip irrigation and plastic mulch materials.

1.4 Barrier analysis and possible enabling measures for Potato seed production system (PSPS)

Potatoes are Mongolia's "second bread" in terms of scale of production and food value. In the last two years Mongolia met 100 % of the national demand for potatoes. Limited accessibility to high quality potato seed is a perennial problem amongst many growers and is partly attributable to inefficiencies in various links of the seed production system. The potato seed production system technology aims to enable sustainability and reliability of high quality of potato varieties in the country.

Same participatory process was applied to identify barriers, possible measures and enabling environment as the case with the technologies mentioned above.

1.4.1 General description of PSPS

Potato seed production system comprises the development of varieties, producing mini tubers or elite seeds, multiplying seeds, and storage and delivery systems. Today, most of the mini tubers or elite seeds are imported from other countries.

Some initial research and development of local varieties of potato which are better adapted to climate change has being done in research institutions of Mongolia. Within the technology transfer and diffusion ideas, the research will be expanded to improve current potato varieties.

Producing of potato mini tubers or elite seed can be done using aeroponics which is a more efficient technique for seed potato production. The technique has potential to lower costs and raise the plant with qualified health.

Potato seed production system has three main steps:

- Produce mini tubers using aeroponics (crop environment such as nutrients, temperature and moisture can be artificially created.)
- Produce potato seeds using mini tubers at agriculture extension fields of aimags or seed producers fields
- Deliver healthy potato seeds to local markets and farmers.

Producing potato mini tubers in aeroponics has high reproduction coefficient and requires less labour, time and financial resources than potato seed production in soil. The technology can improve the supply of good and healthy potato seeds and increase the potato production per area.

Initial research on growing potato tubers in aeroponic systems with optimal conditions in air has being carried out by the Mongolian National Agriculture Research Institute under the "Mongolian Potato Program" since 2007. Mongolia has become the 5th country in Asia to pilot this technology in potato seeds production. Results were promising and are proven in local contexts. The technology will be basis of sustainable supply of potato seed of adapted potato varieties and free of virus infections. Establishment of local production systems instead of transporting to farms would save labour, time and cost.

Possible areas of research to improve productivity include optimizing nutrient solutions, plant density, number of harvests and harvesting intervals. Resources such as greenhouses and capacity building are required.

1.4.2 Identification of barriers to PSPS

Identification of barriers was done through a stakeholder participatory process (consultation was held on 6th September 2012), plus a review of the literature and interviews with key experts. Several meetings were held with key experts who had conducted research on the subject and were involved in the piloting of related equipment. A range of tools for barrier analysis recommended in a guide book[14] were employed to refine barriers. These prioritized barriers are described below.

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1.4.2.1 Economic and financial measures

The two most critical barriers identified for the diffusion of PSPS arise from financial and economic constraints for undertaking increased investments, namely the inadequate availability of financial resources for such investments and the high risk of investments. These are ranked among the most important barriers.

- Inadequate availability of financial resources: Presently, much of these finances especially for obtaining potato mini tubers and elite seeds are met from a variety of sources such as donor-funded projects. Ideally, after initial years of assistance from various state and non-state sources, the potato seed producers should have been built their financial capacity and operate according to market principles. But, it is often seen that the potato seed producers continue to depend on external sources to secure investments.

- High cost of equipment and materials: Currently, potato seed production depends on largely imports of seeds or mini tubers, aeroponic system, greenhouse and other supplies. Cost of imported equipment and supplies are increasing due to factors such transportation, importation procedures and limited number of licensed importers.

1.4.2.2 Non financial measures

A set of five non-financial barriers that affect PSPS were identified as a critical barriers.

Policy, legal, and regulatory barriers:

- Lack of subsidy policy for potato seed producers: Financial capacity of potato seed producers are limited and cannot afford high cost equipment and supplies.

Human skills barriers:

- Lack of skills and knowledge about aeroponic system: Aeroponic systems are quite new in Mongolia and have only been tested very recently. Potato seed growers and farmers have very limited knowledge and skills about climate technologies, potato varieties and advanced equipment such as aeroponics.

Institutional and Organizational capacity barriers:

- Limited producer and capacity of potato mini tubers: Aeroponic growing of potatoes has been tested and demonstrated in a laboratory in the Agriculture Research Institute in Darkhan. So only few researchers have gained knowledge and skills about the technology. Research on potato seed growing using advanced equipment and aeroponic is limited.

Market failure barriers:

- Underdeveloped local supply chain of potato seed production: There is limited number of initial seed producer and formal and informal potato seed multipliers are not well coordinated at provincial and local levels. Storage capacities at provinces are limited and transportation process is not strongly established.

Network failures:

- Poor coordination between research organizations, provincial agriculture extension centres, potato seed producers and farmers: Research results and outcomes are not disseminated to farmers or scaled up. Provincial agriculture extension centres do not sufficiently carry out demonstrations of promising equipment to local farmers due to limited financial resources.

1.4.3 Identified measures for PSPS

Measures have been identified by stakeholder consultations (held on 6th September 2012) to overcome the barriers technology transfer and diffusion to adopt PSPS. Finally, those measures were validated using results of analysis reported from national and international experiences.

1.4.3.1 Economic and financial measures

- Assuring adequate availability of financial resources: Funding from different sources such as public and private sources is required. Research on potato varieties and agro-technical practices can be funded from the government and other donor agencies. At least three sites with complex aeroponic systems should be established in the western, the central and the eastern agricultural zones – the initial capital investment costs is estimated about $120 000 USD ($40 000 USD each).

- Provision of long term and soft loans to potato seed producers: Arable Farming Fund can provide loans with low interest for 3-5 years which can support farmers to be strong market actors. Micro-finance organizations can reach out to poor farmers to be potato seed growers to strengthen the supply chain of potato production. Farmer groups and companies can build storing facilities of medium and large scales using these loans.

- Tax exemption of imported aeroponic system and other facilities: Considering the importance of PSPS, government should give import tax exemptions/ relief and subsidiary on interest rates for loans for importers/local producers of aeroponic system, equipment, and other supplies. Technical support and quality assurance should be given by researchers and engineers to local producers. Requirements and license obtaining information of potato seed producing and importing should be available and transparent. Marketing support should be given to retailers and whole sellers of equipment and potato seed products.

1.4.3.2 Non-financial measures

Policy, legal, and regulatory measures:

- Set up subsidy policy on application of environmentally sound and climate technologies: Presently, the government implements a subsidy policy on wheat production and spends about 40-45 billion *tugrugs* ($35 000 USD) every year. This policy has helped to produce sustainable wheat production in the last 3-4 years. Now, the subsidy policy needs to consider green development, environmentally sound and climate change adaptation equipment and technologies. Potato seed production using aeroponic, water saving and green technologies should be considered in the policy.

Human skills measures:

- Training of agriculture professionals on aeroponics and potato seed production: Theoretical and practical knowledge and skills should be given to students studying in the State University of Agriculture and other colleges. Working professionals of companies and state agriculture organizations should be re-trained through short term programs and exposure trips to other countries.

Institutional and organizational capacity measures:

- Expanding research capacity on potato varieties and advanced equipment including aeroponics: Research by specialists and post graduate students can be extended focusing on the technology. This kind of research can be funded by National Science Fund, other national programs and international projects.

- Training of potential potato seed producers: Knowledge and skills on mini tuber production, seed multiplying, application of fertilizers and pesticide and other technical aspects can be provided by provincial agriculture extension centres and local training NGOs. Practical experience and field visits in the country can be good to learn about successful practices.

Market failure measures:

- Invest infrastructure: Local infrastructure including road, proper storages, reliable and constant electricity and water supply system should be an essential focus of the Government to support local production system.

Network failure measures:

- Intensify supply chain of potato producers: Awareness raising and coordination of different actors of the potato seed production system can start the process of intensifying the supply chain. Farmer groups including poor farmers can be strengthened through training and micro financial services. Local government can support and bridge farmer groups and private companies to improve the supply chain of PSPS. Procurement, delivery, transportation and storage processes are necessary part of the supply chain system. Systematic and continuous supply of potato products to the bigger market in cities should be coordinated.

1.5 Linkages of the barriers identified

Barriers to technology transfer and diffusion on climate change adaptation are likely interlinked being parts of large system and sector. Analysing barriers to technology transfer and diffusion, one-by-one is risky because it overlooks more holistic (and potentially more efficient) opportunities to address their combined effects. The linkages of different barriers faced by the three prioritized technologies in the arable farming sector are analysed, so as to maximize synergies and optimize the effects of recommended measures. The table below groups' key barriers identified for the three technologies by economic and financial barriers and non-financial barriers.

Table 19: Key barriers identified for the three prioritized technologies in arable farming sector

No	Key barriers identified		
	System of wheat intensification	Vegetable production system with drip irrigation and mulches	Potato seed production system
	Economic and financial barriers		
1	High cost of equipment and supplies,	High cost of equipment and facilities	High cost of equipment and materials
2	Limited financial capacity of grain producers	Limited access to long term soft loans	Inadequate availability of financial resources
	Non – financial barriers		
	Policy, Legal and Regulatory Barriers		
3	No incentive policy for grain producers to apply climate adaptation technologies	Lack of subsidy policy	Lack of subsidy policy for potato seed producers
	Human Skills Barriers		
4	Insufficient human resource and professionals	Limited knowledge and skills	Lack of skills and knowledge esp. about aeroponic system
5	Limited knowledge and skills to use equipment, crop rotation, supplies		
	Institutional and organizational capacity barriers		
6	Lack of adaptive research and foundation research capacity	Lack of training and demonstration	Few producer of potato mini tubers
	Market Failure/Imperfection Barriers		
7	Low quality of agriculture equipment and supplies	Underdeveloped local market and value chain system	Underdeveloped local supply chain of potato seed production
8	Limited access to international market		
9	Inadequate infrastructure		
10	No seed bank of legumes		
	Social, Cultural, Behavioral Barriers		
11	Conflict between animal husbandry and arable farming	Lack of knowledge and attitude towards water saving behaviour	
12	Low demand of legumes		
	Information and awareness Barriers		
13	Inadequate information about legumes		
	Network Failure Barriers		
14	Poor coordination between key actors	Poor coordination between key actors	Poor coordination between major actors
	Technical Barriers		
15	Lack of standards for imported equipment and chemicals as well as for export market	Insufficient quality assurance of drip irrigation equipment, mulches and supplies	
16		Inadequate investments into infrastructure	

In the analysis of barriers (and measures to overcome barriers), many are technology specific and fall within broad categorization of barriers. However, there are some common strands. Although not identified among the key barriers, some of the similar measures were identified in the preliminary list of barriers in a number of occasions. This suggests the ability to follow a common approach to address these barriers.

- **Inadequate finances**: In the category of Economic and Financial barriers, the most commonly cited barrier was the high cost of equipment, supplies and implementation for all three technologies. Mongolia has limited financial and human capacity to locally produce agriculture machineries, equipment and supplies – most are mainly imported from other countries. Limited access to long and soft terms loans were identified as barriers in system of wheat intensification (SWI) and vegetable production system with drip irrigation and mulches (VPS). Inadequate funding was directly identified in the case of potato seed production system (PSPS). The arable farming sector has seasonal patterns in Mongolia so access to loan services from banks and micro-finance organizations are limited especially for small new enterprises and poor farmers due to high interest rates, required collateral and re-payment in short term.

- **Insufficient policy framework**: Policies affect implementation of measures in all three categories of technologies. A subsidy policy by the government is needed to support climate and environmentally sound technologies. Tax exemptions or deduction policy is required in order to ensure affordability of equipment, systems and supplies. Efficient enforcement of the law of procurement of legumes in the State Emergency Fund is needed to support proper rotation system for cereals in technology SWI. Overall policy is identified an area that presents a barrier to promoting selected technologies.

- **Inadequate human skills**: College and university curriculums do not sufficiently focus on climate change and adaptation technologies. Systematic development of professionals through the education system is of critical importance to R&D of selected technologies.

- **Poor research and development**: Research on climate change adaptation technologies and their practical applications is not sufficient which leads to poor understanding and knowledge about technologies and proper application of herbicide and fertilizers by farmers and agriculture professionals.

1.6 Enabling framework for overcoming the barriers in Arable farming sector

Four key barriers that are common to specific technologies were identified in the previous section. This section attempts to identify alternative sets of measures required to overcome these common barriers. Measures to overcome barriers under each of the technologies were discussed in the previous sections. For the four common barriers, technology-specific enabling measures are identified and summarized in Table 20.

Table 20: Key measures identified for the three prioritized technologies in arable farming sector

No	Key measures identified		
	System of wheat intensification	**Vegetable production system with drip irrigation and mulches**	**Potato seed production system**
Economic and financial measures			
1	Tax exemption for the imports	Tax exemption	Assuring adequate availability of financial resources
2	Soft loans to importers through Arable Farming Support Fund	Long term soft loans to importers, producers and service providers	Provision of long term and soft loans
3			Tax exemption of importers and local producers
Non - financial measures			
	Policy, Legal and Regulatory Measures		
4	Endorse incentive policy for grain producers to apply climate adaptation technologies	Set up incentive policy for farmers	Set up incentive policy for farmers
	Human Skills Measures		
5	Capacity building for grain producers	Capacity building of vegetable farmers	Training of agriculture professionals on the technology and equipment
6	Systematic HR development plan	Systematic human resource development	
	Institutional and organizational capacity Measures		
7	Establish professional consulting service at local level	Establish agriculture equipment maintenance service at provincial level	Expanding research capacity on potato varieties and advanced equipment
8	Support research and development of components of SWI	Support research on Vegetable production system with water saving practices and equipment	Training of potential potato seed producers
	Market Failure/Imperfection Measures		
9	Improve business regulation and legal framework	Develop rural infrastructure of road, power and water supply	Invest infrastructure
10	Establish maintenance service of agriculture machineries and equipment at provincial level	Set up agriculture product markets at provincial level	
	Information and awareness Measures		
11	Increase awareness about legume consumption		
	Network Failure Measures		
12		Facilitate coordination between community groups to support value chain of vegetable products	Intensify supply chain of potato producers
13		Support and train farmer groups to gain access to financial resources	
14		Organized procurement of drip irrigation and supplies	
	Technical Measures		
15	Enforce quality assurance and standards legal framework	Strengthen policy on quality standards on imported and produced equipment	

Therefore, based on the measures identified for each of the technologies, technology nonspecific measures to overcome barriers are listed below in Table 21.

Table 21: Key measures identified for the common barriers to prioritized technologies in the arable farming sector

Common barriers	Technologies affected	Measures to overcome key barriers
Inadequate finance	SWI, VPS, and PSPS	• Set up financing mechanisms for specific technology packages • Import tax exemption of technology related equipment and supplies and income tax deduction of local manufacturing of equipment and supplies and service providers • Introduce incentive packages for climate technologies
Insufficient Policy framework	SWI, VPS, and PSPS	• Establish consultative mechanisms with the representation of all stakeholders • Review and improve current incentive policy according to emerging needs of climate change adaptation • Review and improve current tax policy regarding importation and local manufacturing of agriculture equipment and facilities regarding to adaptation needs • Strengthen State Arable Farming Fund and improve its policies and business regulations • Set up legal and financial environment frameworks for professional consulting services at provincial and local levels • Develop an insurance scheme
Inadequate human skills and knowledge	SWI, VPS, and PSPS	• Review current curriculum for agriculture specialist and strengthen them with climate change theories and practices • Develop training packages on climate change and adaptation technologies for different audiences including farmers, agriculture specialists of private enterprises and governments • Develop awareness raising packages for different audiences and conduct systematic awareness raising regarding climate change impacts and promising adaptation technologies for public through media and press
Poor research and development	SWI, VPS, and PSPS	• Increase support to public and private R&D institutions • Strengthen provincial agriculture extension centers to test and demonstrate climate technologies in local context and transfer knowledge and skills to local farmers • Support researchers and specialists to study and in overseas institutions and conduct research on climate technologies

2. Animal husbandry sector

The animal husbandry sector is still the main livelihood and source of wealth for many Mongolians. Animal husbandry plays a vital role in the country's economy. In 2011, the agriculture sector comprised about 13% of GDP. Animal husbandry makes up 73%[5] of the agriculture sector. The livestock herd is estimated to be 40 million in 2011 - including horses camels, cattle, sheep and goats. Animal husbandry in Mongolia is again recovering after the severe winter disaster in 2009-2010 when 8 million livestock were lost. This demonstrates that animal husbandry is heavily affected by weather and natural disasters. Pasture degradation has also become a serious issue due to increased livestock and desertification.

Climate change will undoubtedly influence animal husbandry. In addition, climate changes such as temperature, precipitation and variations in snow coverage could have an effect on animal energy cycles and dynamics. According to research[15], climate change is expected to negatively affect animal husbandry through pasture degradation and desertification, decreasing animal productivity and increased natural disasters (especially droughts and heavy snow in winter).

The analysis of technology options for climate change adaptation in the animal husbandry sector in Mongolia was carried out through an extensive consultative process. A list of eight potent technologies was selected by the stakeholders at the workshop held in July 2011. A prioritization process utilizing the Multi-Criteria Decision Analysis (MCDA) approach was carried out in consultation with stakeholders at a workshop held in September 2011. The criterion decided for prioritizing the technologies included the cost of technologies, and economic, social, and environmental benefits. The most suitable adaptation technologies for the animal husbandry sector were prioritized by the stakeholders by using MCDA.

Table 22: Prioritized technologies and categories in the animal husbandry sector

No	List of prioritised technologies	Category of the technology
1	Seasonal Prediction and Livestock Early Warning System	Other Non-market Goods
2	High quality livestock through selective breeding and animal health system	Consumer Goods
3	Sustainable pasture management	Other Non-market Goods

15. Climate Change Studies in Mongolia, 2003; Climate Change Vulnerability and Adaptation in the Livestock Sector of Mongolia, 2006

2.1 Preliminary targets for technology transfer and diffusion

Preliminary targets for the three technologies in the animal husbandry sector were estimated during TNA and barrier analysis processes.

- Seasonal prediction and livestock early warning system: Precise seasonal predictions and proper preparation for *zud*/harsh winters would result in saving about 80% of the animals which die every winter. This technology belongs to non-market goods and its targeted beneficiary groups are the whole society, including herding and farming communities and other citizens. In terms of geographical targets, people and communities of all areas will benefit from the technology diffusion expected to be completed by 2016.

- High quality livestock through selective breeding and animal health system: The technology is proposed to target all herders in the country through implementing selective breeding equipment and improving the veterinary system. It is estimated that diffusion of this technology can cover at least 60% of the total 154 000 herding families. Anticipated time frame for diffusion of the technology is about 6-8 years which is 2018-2020.

- Sustainable pasture management: The technology is expected to target all 320 *soums* of Mongolia and at least 90% of herding families can benefit from it. The diffusion of the technology would enable herders to manage pasture in better ways and reduce pasture degradation and desertification. The technology transfer and diffusion is intended to be done within 4-6 years and completed by 2018.

Urbanization and changing demand patterns are driving changes in the livestock sector, including linkages between producers and markets[16]. So, anticipated barriers and potential measures of these three technologies are described in the following sub sections.

2.2 Barrier analysis and possible enabling measures for Seasonal Prediction and Livestock Early Warning System (SPLEWS)

2.2.1 General description of SPLEWS

For the Mongolian context, SPLEWS is "the provision of precise and effective information through identified institutions that allows herders and government officials to prepare for effective response to slow on set disasters including drought and *zud*[17] to avoid or reduce risks". Due to the large economic loss and the magnitude, of these disasters the primary focus of SPLEWS is mitigating disaster risk from drought and *zud* which are slow onset disasters. However, rapid onset disasters such as flood, storms and others are also considered in the technology.

The current livestock sector is based on the traditional nomadic pasture system and herder families' livelihood is highly dependent on and influenced by weather and climate. Herder families need to make preparations for winter and spring, and reduce their livestock loss during these seasons. In preparing for winter, the conditions of the previous summer in terms of vegetation growth and the coming winter weather and climate outlook are essential information. This information for planning the migration of herders families, preparation hay and fodder as well as other measures from decision makers at *soum*, *aimag* (province) and country level. Annual economic losses caused by weather related natural disasters have increased in Mongolia. The tendency for increased frequency of climate extremes is expected to continue in the future. As a result, drought and zud is highly likely to occur more frequently, bringing risks for agriculture, and nomadic livestock. Also, there is clear evidence of drought intensification in Mongolia under global climate change[18].

SPLEWS integrates four main components:

- **Risk knowledge**: Risk assessment provides essential information to set priorities for mitigation and prevention strategies and designing early warning systems. Research on future climate change, its potential impacts associated risks is important because weather and climate patterns are changing.

- **Monitoring and predicting**: Systems with monitoring and predicting capabilities provide timely estimates of the potential risk faced by herding communities, the economy and the environment. This component allows for a forecast of weather conditions for a period of three to six months ahead and provides important information for planning and preparations. Seasonal forecasts are based on existing climate data, in particular, on sea surface temperatures, which are then used in ocean-atmosphere dynamic models, coupled with the synthesis of physically plausible national and international models.

- **Disseminating information**: Communication systems are needed for delivering warning messages to the potentially affected locations to alert local and regional governmental agencies. The messages need to be reliable, synthetic and simple so they can be understood by authorities and the public.

16. Mongolia Livestock Sector Study, Volume 1- Synthesis report, World Bank
17. A **zud** or **dzud** (Mongolian: зуд) is a Mongolian term for an extremely snowy winter in which livestock are unable to find fodder through the snow cover, and large numbers of animals die due to starvation and the cold. The term is also used for other meteorological conditions, especially in winter, that make livestock grazing impossible.
18. MARCC, 2009

- **Response**: Coordination, good governance and appropriate action plans are a key point in effective early warning. Likewise, public awareness and education are critical aspects of disaster mitigation.

The main idea behind SPLEWS is that the earlier and more accurately we are able to predict short and long-term potential risks associated with natural and human-induced hazards, the more likely we will be able to manage and mitigate disasters' impact on society, economies, and environment.

The situation in Mongolia: The National Agency of Meteorology, Hydrology and Environment Monitoring (NAMHEM) produce weather forecasts and seasonal predictions and conduct research on weather related disasters. The mandate for development of all hazards Early Warning System is the responsibility of the National Emergency Management Agency (NEMA).

Seasonal outlook for winter and winter pasture capacity is estimated and mapped by the Institute of Meteorology and Hydrology (IMH) based on weather and pasture monitoring at the end of summer. The Ministry of Food, Agriculture and Industry finalize livestock migration schemes six months ahead. Local governments and local emergency departments are responsible for coordinating and implementing the livestock migration scheme along with herders. It is also important to note that agencies in Mongolia are organized according to the specialized tasks for different hazards (NAMHEM, NEMA, IMH, Ministry of Industry and Agriculture), without much information sharing or partnership with other agencies. It is these gaps that have to be addressed by bringing together all concerned agencies.

Another key issue is accuracy of predicting pasture conditions and planning the migration schemes at the smallest level of the *soum*. The issue in Mongolia is not establishing a new early warning system, but converting the existing early warning systems to an effective one. For this purpose the agencies responsible shall fulfill the four components according to their functions and responsibilities to make the strengthen early warning system in the country a reliable, timely, cost-effective, sustainable, and user friendly tool.

2.2.2 Identification of barriers to SPLEWS

The first step was gathering a list of all barriers to the diffusion of the SPLEWS, so a questionnaire was distributed to stakeholders. Then based on the feedback received, stakeholder meetings were organized to analyze the questionnaires in order to identify the barriers. The barriers were then categorized, ranked, and to identify root causes and enabling environment.

Overall six categories of barriers have been identified. Among these, three main types of barriers were economic and financial, institutional and organizational capacities, and information awareness barriers were prioritized and their root causes defined by problem tree analysis.

2.2.2.1 Economic and financial barriers

Lack of financing instruments and training for human resource is one of main barriers to the diffusion of the SPLEWS technology.

- Inadequate financial resources to intensify the technology: The prime objective of SPLEWS is to provide timely, accurate, unambiguous and credible information to a population and decision makers who are at risk of impending disasters. Quality and reliability of information (specifically prediction) is an issue for droughts and *zuds*. Mongolia's territory is relatively large in view of its population. The current networks of observation and monitoring stations are not enough to cover the whole country. There are nearly 130 meteorological stations and the distance between them is 150-300 km. Such low resolution affects the accuracy of monthly and seasonal climate forecast. There is a lack of financial resource to increase the resolution and number of meteorological stations and to purchase monitoring equipment and to build communication infrastructure.

2.2.2.2 Non-financial barriers

Among non-financial barriers, institutional and organization capacity, information and awareness, and network failure barriers are listed below during barrier decomposition and according to their priority ranking.

Institutional and organizational capacity barriers:

- Insufficient research and development of a comprehensive scientific approach to produce timely and user oriented information: Existing institutions, especially the research community, need to carry out more research to develop and introduce new seasonal prediction satellite processing and pasture yield modeling equipment. There is a lack of experts and skilled personnel operating the systems, lack of computing resource to run models and to process satellite images, and lack of a high density observation and monitoring network. Monthly and seasonal prediction accuracy is currently less than 60% the skill level is very diverse and especially weak in seasonal forecasting.

Information and awareness barriers:

- Inadequate awareness and understanding: Nowadays, IT application is spreading in the country, but herders/farmer families have limited access to information disseminated through mass media due to high tariff on services and inadequate communication infrastructure. Even in the cases where they can receive the information, they are often unable to understand and interpret the information and make use of it.

Network failures:

- Poor coordination between organizations in the current early warning system: Currently, some components of the SPLEWS technology already exist in institutional structure, even though they produce and use information regarding the early warning system. As mentioned above, many institutions and agencies including NAMHEM, IMH, Satellite Data Center, NEMA, Ministry of Industry and Agriculture, and Pasture Management Association NGO are involved in gathering, processing, mapping, analysis, planning and decision making. However, there lacks a coordinating mechanism and a harmonization of different data to generate an integrated point of view in the system in order to take timely action. During disaster response, emergency operations by different national and international organizations are not well planned and coordinated.

2.2.3 Measures to overcome the identified barriers for SPLEWS

Measures to overcome the main barriers are carefully designed on the basis of root cause analysis and identified through stakeholder meeting and consultations. Then, enabling environment were discussed and determined.

2.2.3.1 Economic and financial measures

The measures to overcome economic and financial barriers are as follows.

- Allocation of required amount of funds by the government, as well as exploration for alternative funding sources: Funding is required to strengthen

SPLEWS - including improving computer resources and monitoring equipment in the national hydro-meteorological service and considering investment in a midterm strategic plan. In order to fill the financial gaps in investments and research, the government needs to submit project proposal to donors based on results of feasibility studies and R&D studies. For this purpose, bottom-up information flow among institutions is needed to develop and submit project proposal with strong justification to donors.

- Set up a low tariff communication system for disaster information: Currently rural people and herder/farmer families use mobile phones in their daily life. However, it is relatively expensive to obtain information through mobile phone use. The government needs to set a special low tariff for disaster information transmission.

2.2.3.2 Non-financial measures

Non-financial measures have been identified through the same process as economic and financial measures and are listed below.

Policy, legal and regulatory measures:

- Facilitate periodical consultative meetings at the decision making and implementation levels: Frequent periodical meetings of point staff from different agencies and organizations after disaster periods will help to improve preparedness planning and improving learning. Roles of different organizations should be thoroughly defined. Review of organizational strategy and planning and intentional inclusion of related components of SPLEWS should be done.

- Establish post disaster feedback mechanism: During and after disaster response, feedback from different stakeholders (including the public) should be gathered and analyzed. Lessons learnt and recommendations should be considered in the short and long term planning of different roles and responsibilities of organizations. Advanced and available communication methods (such as internet, mobile phone and others) can be used in the process.

Institutional and organizational capacity measures:

- Support research and development on components of SPLEWS: Researchers and personnel should be supported to study and conduct related research in institutions in the country and in other countries. To increase its capability, research institutions need to collaborate with international climate centers and research institutions and learn about new seasonal forecasting equipment.

- Systematic training for different stakeholders of SPLEWS: Training of skilled personnel, researchers and other related officials need to be trained on SPLEWS and disaster risk management.

Information and awareness measures:

- Strengthen formal and informal network of disaster effective communication: As part of the efforts to promote the application of SPLEWS technology, it is necessary to encourage NGOs and herder/farmer communities to actively promote the technology and disseminate the information to end users.

- Develop message packages and train users through media: To provide information, it is necessary to translate the scientific results into simple messages. A special manual or guidelines should be developed for the public.

2.3 Barrier analysis and possible enabling measures for High quality livestock through selective breeding and animal disease management (HQL)

In order to identify barriers and possible measures to overcome the barriers, a stakeholder workshop was organized (on 6th September 2012) and a key experts' workshop was held in October 2012. During the stakeholder workshop, participants identified barriers for HQL technology through brainstorming, categorization, analysis, and voting. Possible measures to overcome barriers were also listed during the workshop.

Key experts worked on the outcomes of the stakeholder workshop and completed problem tree analysis (see Annex 4) to analyze the barriers and their causal relations as well as to refine measures and conduct market mapping (Annex 4). The results were sent to stakeholders and feedback was received through e mails and phone calls in October 2012.

2.3.1 General description of HQL

In 2012, Mongolia had an estimated 40 million livestock, including horses, cattle, camels, sheep and goats. The genetic pool of local breeds with optimal characteristics exists in Mongolia and can act as a starting point for research and developing for selective breeding technology. Core herd breeding centers have estimated that about 3 million animals have optimal characteristics for climate change adaptation to the local environment. These local breeds have higher survival rates and higher productivity of meat, milk, wool or cashmere. According to the national statistics for 2011, the number of animals infected by disease in 2011 has almost doubled compared to 2008. About 500 incidences of animal infectious diseases were recorded in 2011[19].

19. Mongolia National statistical yearbook 2011

High quality livestock technology aims to improve the quality of all animals based on selective breeding using these core herds as well as improved animal health services. Diffusion of the technology would enable Mongolia to control livestock numbers within its pasture carrying capacity and to reduce overgrazing and desertification.

HQL includes two big components selective breeding and animal disease management. Genetic make-up influences livestock fitness and adaptation capacity and determines an animal's tolerance to shocks such as temperature extremes, droughts, flooding, pests and diseases. Adaptation capacity to harsh environments includes heat tolerance and an animal's ability to survive, grow and reproduce in the presence of poor seasonal nutrition as well as parasites and diseases. Using advanced breeding equipment such as artificial insemination combined with traditional methods would allow for breeding of high quality animals which are resistant to drought, thermal stress, harsh winter and parasites and diseases. The selective breeding technology belongs to 'consumer good' category because it targets animals for commercial and household use by herders and animal breeding farms.

The livestock disease management component consists of prevention and control which help to achieve higher production, lower morbidity and mortality, and less loss of animal production. The major impacts of climate change have been on vector-borne livestock diseases. Climate changes could also influence disease distribution indirectly through changes in the distribution of livestock. A comprehensive disease management system has been identified as essential for livestock to adapt climate change. National level surveillance of infectious diseases in animals and management of appropriate preventive measures are urgently required in Mongolia. Outcomes of HQL are improved livestock health and resilience to climate change, increased food security and safety and better access to urban and international markets.

2.3.2 Identification of barriers to HQL

Based on stakeholder consultation and inputs from key experts on animal husbandry, the barriers to the transfer and application of HQL have been identified. A stakeholder workshop was organized to define barriers through the following steps:

- brainstorming all barriers
- categorization of barriers
- analysis of barriers and root causes
- ranking barriers.

Stakeholders and key experts discussed 8 categories[20] of barriers, including economic and financial, human skills, organizational, technical, legal, market failure, and social and information related barriers. Economic and legal barriers have been identified as the top barrier for the technology.

2.3.2.1 Economic and financial barriers

Economic and financial barriers have been identified as key issues in HQL diffusion. The following economic and financial barriers have been identified:

- Inadequate financial resources from the government for local veterinary/breeding units: Before 1990, a strong breeding and veterinary network system existed in Mongolia but during transition period from 1990, the state system collapsed. Until 2010, few private breeding and veterinary units survived, and material supplies and human capacity at local levels were very problematic. In 2010, veterinary and breeding units were re-established in 329 *soums*. There are 773 veterinary and breeding units, including private units, at the *soum* and district level in Mongolia[21]. The National Veterinary and Breeding Agency is responsible for providing technical support to provincial and local veterinary and breeding units and enforcing policies including the Mongolian Law on Gene Pool and Animal Health, State Policy on Food and Agriculture, National Program of Intensified Animal Breeding, and State Policy on Herders etc. So at the national level, financial and legal frameworks have been developed to some extent. The government budget is inadequate to provide basic veterinary and breeding services, and medicines and facilities to herders. As a result they are not able to diagnose and treat animals in a timely manner. There are very few financial resources for long term disease control and monitoring from the government. Also public goods such as forage and feed research, pasture management, facilitation of commercial market development, improvement of infrastructure and animal health and disease control have not received sufficient funding from the government.

- Lack of financial support for research and development of livestock breeds[22] and diseases: There had been some research on local breeds of cattle, sheep and goat during the period of centralized market economy. Today Mongolia needs to renew and extend its researching, testing, and experimenting with animal breeds to take into account climate change and different regional contexts. Some initial projects on cattle breeding have been implemented, however breeding of sheep, goats, horses and camels and their gene banks have not been studied yet.

20 Boldt, J., I. Nygaard, U. E. Hansen, S. Trжrup (2012). Overcoming Barriers to the Transfer and Diffusion of Climate Technologies. UNEP Risoe Centre, Roskilde, Denmark, 2012UNEP Risoe Centre.

21. Overview of Livestock sector, Ministry of Food, Agriculture and Industry web page

22. Mongolia livestock sector: challenges and options, Findings from World Bank projects and analytical work Andrew Goodland.

- High cost of imported breeding equipment and supplies, veterinary medicines, vaccines and diagnosing facilities. Quality assurance is also low for imported medicines and vaccines. There is few probably only one manufacturer (*Biokombinat*) in the country. This state-owned factory lacks financial resource. Poverty of herders limits access to breeding and veterinary service.

2.3.2.2 Non-financial barriers

There are non-financial barriers to the diffusion of the animal selective breeding technology, which are listed below:

Policy, legal and regulatory barriers:

- Insufficient consideration of livestock adaptation to climate change in legal frameworks: Livestock sector related policies have not included adaptation measures of livestock to climate change related issues, such as climate risks, soil and environmental degradation.

- Inadequate incentive policies and regulations for herders to apply HQL including animals in disease control and animal health.

- Inefficient enforcement of the Mongolian Law of Livestock Gene Pool and Animal Health. The National Mongolian Livestock Program and the Mongolian Law on Gene Pool and Animal Health stress the importance of animal registration and a national database. However the implementation and enforcement of these legal documents have been impeded due to insufficient funding from the government.

- Unclear roles of state and private veterinary/breeding workers and units: the Ministry of Industry and Agriculture assumes that local veterinary/breeding specialists at soum level should implement the government policies and plans and coordinate their implementation. Private veterinary/breeding units are expected to provide actual breeding and veterinary services to herders. But the herders' understanding is different and they are confused about roles and responsibilities of the state and private service.

Human skills barriers:

- Insufficient numbers of animal breeding technicians and veterinarians at *soum* levels: Current animal breeding technicians do not have adequate skills and equipment to provide qualified breeding service to herders. Equipment, facilities and breeding related medicines are not adequately provided to local veterinary and animal breeding units.The number of private veterinarians available to livestock producers, especially the extensively managed livestock production system, is declining. Young veterinarians are reluctant to work in isolated rural areas[23]. Current veterinarians need re-training to update their knowledge and skills.

Market failure barriers:

- Low access to tested and proved breeds, qualified veterinary medicines and services: Research and development of local breeds are not sufficient in the country. There is limited access to qualified veterinary medicines and services. The main reasons of the limited access are the lack of facilities and medicines at veterinary and animal breeding units and laboratories at provincial level and inadequate research and development

23. Mongolia Livestock Sector Study, Volume 1- Synthesis report, World Bank

of veterinary products.

- Underdeveloped market and trade mechanisms: Because of poor infrastructure, remoteness and underdeveloped market and trade system at local level, livestock production has a low value and has experience high volatility and uncertainty. The government should invest in the establishment of an animal product market/trade system at provincial and *soum* levels and invest in improving infrastructure.

Social, cultural and behavioural barriers:

- Reluctance of herders to breed high quality livestock: Herders are reluctant to invest in breed improvement and prefer to increase animal numbers because of the low value of high quality animals due to their remoteness from markets and poor infrastructure.

- Lack of understanding of the importance of HQL: Herders do not fully understand the importance of veterinary service such as vaccines, anthelmintic and dipping etc. and are reluctant to invest in veterinary services as long as high quality and healthy animals are under-valued in the production system. Herders are not lobbying for an improved service, hence there is little incentive to change or improve the system.

Information and awareness barriers:

- Lack of information and awareness. An early warning or prevention system does not exist and herders do not know the legal obligations of themselves and the government. Herders have limited knowledge and information about high quality breeds, animal disease prevention, diagnosis and treatment.

Network failures:

- Poor coordination between key actors including national and provincial veterinary and animal breeding organizations, research institutions, private enterprises and international and national projects and programs.

2.3.3 Identified measures for HQL

After barrier analysis, key experts developed problem trees for the two livestock-related technologies. Selective breeding and animal disease management are interrelated and applied through veterinary and animal breeding units at local and provincial levels. Problem tree analysis helped to see an objective tree and measures have been designed to address root causes.

2.3.3.1 Economic and financial measures

The following measures have been identified in order to overcome barriers to animal selective breeding technology.

- Allocate of financial resources by the government for livestock gene pool, animal registration and database set-up: The Mongolian Law on Gene Pool and Animal Health has articles about budget support from the government, but implementation of the law has not been efficient. It requires more than 30 billion *tugrugs* ($23 million USD) from the government and 50-60 billion *tugrugs* ($40-48 million USD) from private enterprises.

- Acquire funding for the research and development of animal health and breeds: Support for research and development of veterinary medicines and vaccines is required from the government, international and national donors. It needs to be coordinated with national manufacturers of veterinary medicines. Donor agencies and other country government can fund and share other countries experiences.

- Invest into local a market/trade network and infrastructure development at local level by the government and donor agencies: This will enable herders to earn more income from their better breed animals and their production at provincial level at reasonable prices without high volatility.

- Tax exemption of veterinary products and breeding facilities would enable the importing of more veterinary medicines and products until national manufacturing is developed.

- Provision of soft loans to local manufacturing factories and intensified livestock farms is required to expand the gene bank of local breeds of high production. Local manufacturing factories need revolving fund of about 150 billion *tugrugs* ($100 million USD). Soft loans to national manufacturer would allow the production of medicines and vaccines at reasonable price and increase their availability in the country.

2.3.3.2 Non-financial measures

In order to overcome the barriers, the following measures have been suggested.

Policy, legal and regulatory measures:

- Establish an appropriate subsidy policy for herders to promote high quality livestock: Presently, there is no subsidy policy for high quality animals. A government subsidy could be used to encourage herders as well as intensified animal breeding farms.

- Efficient enforcement of Mongolian Law of Livestock Gene Pool and Animal Health will help to improve veterinary service, establishment of a livestock database, registration and labelling.

Human skills measures:

- Develop capacity building programs for animal breeding specialists and veterinarians: Re-training and capacity building of veterinarians and breeding technicians is required to provide qualified veterinary and breeding service. In addition, climate change adaptation and related themes should be included in the curriculums of agriculture colleges and universities, in order to ensure sustainability of adaptation measures and risk reduction in the future.

Institutional and organizational capacity measures:

- Strengthen state and private veterinary and breeding units: Technical and material support is required from the government. Recurrent training should be done for staff.

- Set up animal disease surveillance and prevention system based on veterinary and breeding network: Improving early warning and disease prevention is important measure to reduce risks related to climate as well as infectious diseases of animals.

Information and awareness measures:

- Educate herders about high production breeds: Awareness raising and training of herders are essential in promoting animal breeding technologies as well as veterinary service. Herders also need to understand their legal obligations regarding to laws such as animal health and environmental laws. Information should be disseminated through all channels of media as well as training and demonstration programs. Demonstration and experience sharing events should be facilitated at local levels. Success stories and experiences of other farms and herders who use high quality animals can be shared with other herders at local levels to convince herders about importance of the technology.

Network failure measures:

- Improve coordination between government organizations, private enterprises, research institutions and herder communities. Roles of government organizations such as National Veterinary and Animal Breeding Agency, provincial and local veterinary and animal breeding organizations need to focus to increased public and private partnership and facilitate coordination meetings, forums, exhibition trades and exposure trips at all levels along with government institutions, national and international programs, private enterprises, research institutions, NGOs, herders' communities.

Technical measures:

- Quality assurance by inspection organizations would allow quality assurance of imported and local breeding facilities, semen, veterinary medicines and vaccines, and this will increase herders' willingness to apply high quality livestock technology.

2.4 Barrier analysis and possible enabling measures for Sustainable pasture management (SPM)

Sustainable Pasture Management (SPM) is a climate change adaptation technology in the animal husbandry sector. SPM helps sustain healthy soils and restore degraded pastures which bring many benefits including ensuring sustainable animal husbandry, alleviating rural poverty and building resilience to major environmental challenges. Pasture degradation has already taken place to various degrees and the objective of SPM should be restore degraded land while preventing further degradation and ensuring continued ecosystem health and function.

2.4.1 General description of SPM

Mongolia has an estimated 40 million livestock in an area of 1.1 million km^2 of rangeland. Pastureland is the backbone of Mongolian agriculture. Pasture degradation and desertification are among the most serious environmental problems. In the countryside, pasture degradation is widespread and occurs in all ecosystems at different intensities. Pasture is the main source of livestock food and herders livelihood in Mongolia. Well managed pasture helps to protect the environment and natural resources and also continue to sustain ecological functions and services.

Pasture degradation in the country has manifested in several ways: decreased biomass production, soil fertility decline, and desertification, fewer and more unpalatable plant species. In addition, physical damage by human activities has increased extensively. At present, about 70% of pastureland is degraded in some form. Overgrazing, off-road driving, mining, global warming, low precipitation and lack of land management skills are causing more and more problems for the rangelands in Mongolia. Thus it is becoming increasingly difficult to provide the necessary amount of fodder for the livestock that are the main source of income for more than one third of the population.

There can be different categories of pastures depending on usage[24]:

- Otor pasture – Otor is reserved pasture where herders move to when faced with a critical situation such as changing pasture, or weather conditions. They

24.Mongolian Society for Range Management web page: http://www.msrm.mn/index.php?option= com_content&view=article&id=303%3A-2011-&catid=85%3A2011-03-25-05-27-00&Itemid=453&lang=mn

differ from seasonal moves in that they are not regular and repeated and usually do not include the entire herd and household. This type of pasture also can be classified into smaller types.

- Transit pasture which is used temporarily while animals are moving to other locations
- Peri-urban pasture
- Pasture for intensified livestock which is settled in a fixed location
- Pasture for nomadic livestock.

Comprehensive sustainable pasture management (SPM) will conserve natural resources and thereby increase livestock productivity. All of these directly increase the nation's resilience to withstanding the negative impacts of climate change and the benefits of SPM will be widespread with producers as well as consumers. Socio-economic benefits and environmental benefits of SPM are shown in Table 23.

Table 23: Benefits of SPM

Socio economic benefits	Environmental benefits
• Increased income of herders • Increased food security • Alleviate rural poverty • Improved livelihoods • Sustaining traditional lifestyles • Improved social sustainability and cooperation of different stakeholders	• Increased biomass and vegetation • Restored biological diversity including plant species • Sustained water sources (open and ground) • Increased soil fertility • Reduced greenhouse gas emissions • Reduced risks of natural disasters • Ensured ecological sustainability and ecosystem functions and services

Despite continuing efforts, pasture degradation remains a critical constraint for sustainable development of animal husbandry of the country. This continued pasture degradation indicates that there are barriers that are preventing the effective technology transfer and diffusion mechanism for SPM. Therefore, corrective action should be taken to address issues pertaining to technology transfer and diffusion. These barriers are often complex, and solutions require a systemic and systematic approach.

2.4.2 Identification of barriers to SPM

In order to identify the barriers, several research methodologies including literature survey, questionnaire, and direct interviews with different stakeholders were carried out prior to the stakeholder consultation workshop (held on 6th September 2012). Through an extensive consultative process, a compiled a list of all potent barriers to be faced for technology transfer and diffusion of SPM was prepared and discussed.

According to the stakeholders' final results, ten key barriers to SPM in the context of climate change were identified and ranked (given below).

2.4.2.1 Economic and financial barriers

The adoption of good pasture management practices is influenced by economic and financial barriers which affect the levels of investment in SPM related activities. The most significant economic and financial barrier to technology transfer and diffusion of SPM are given below:

- Lack of financial resources to adapting SPM: Pasture and land management measures and legal enforcement are under-funded by the government. Investment to construct water wells, build winter and spring shelters and other facilities are limited from the government and herders. Sufficient funding for training and educating herders and government officials is not allocated into local administration budget.
- Lack of taxation mechanisms for pasture usage and management:

Animals of herders are private, but pasture and water are common-pool resource. Common-pool resources are often overused if there is lack of well managed controls or regulations. This can be seen in Mongolia[25].

2.4.2.2 Non-financial barriers

Apart from economic and financial barriers, policy, market, human resource and culture related barriers were also identified. Among non-financial barriers, Policy, legal and regulatory barriers was the most essential in the diffusion of the technology.

Policy, legal and regulatory barriers:

- Lack of land tenure rights: Whilst full privatisation of the land has proven a successful countermeasure in some countries, it is not feasible in Mongolia, where livestock requires mobility in order to balance the variability of the available fodder. Pasture is a common-pool resource in Mongolia and the 'tragedy of the commons[26]' is occurring. Presently, Pasture Law has been under discussion for 4-5 years through frequent meeting of stakeholders however progress is slow due to the multitude of different opinions.

Institutional and organizational capacity barriers:

- Lack of regulatory authority and mechanism for pasture usage: According to the Land Law, *soum* governments have the power to control and regulate *soum* land, to allocate possession and user rights to citizens and to impose land fees on land possessors and users. But implementation of the Land Law is very weak at the local level. The ability of the local governments to fulfill their obligations is limited by lack of manpower and budgetary constraints.

Social, cultural and behavioural barriers:

- Complexity of pasture system in Mongolia: Socio economic and natural conditions are quite unique and complex making it difficult to find solutions.

- Mobile herding system: When pasture resources become limited and insufficient, social conflicts arise between herders and *soum* governments. In some cases, herders are not able to use traditional seasonal rotations of pasture. Today the total number of animals is excessive in comparison with the pasture carrying capacity. Therefore, when a drought or *zud* happens, overgrazing exacerbates vulnerable livestock and increases the potential for animal deaths.

- Uncontrolled animal numbers: Pasture land management within Mongolia's mobile herding system is not easy to regulate and it is difficult to legalize ownership of common–pool resources.

25. Chantsallkham J. and Audur H.I., 2009 Sustainable rangeland management in Mongolia: The roles of herder community institutions, Land Restoration Training Programme Keldnaholt, 112 Reykjavнk, Iceland, http://www.unulrt.is/static/fellows/document/jamsranjav-c.pdf
26. The tragedy of the commons is the depletion of a shared resource by individuals, acting independently and rationally according to each one's self-interest, despite their understanding that depleting the common resource is contrary to the group's long-term best interests (Garret Hardin).

Information and awareness barriers:

- Lack of awareness and knowledge of herders: There is no extension organization to increase herders' knowledge and or make new technological improvements available to them. Only private units of veterinary breeding services at the *soum* level provide some services through state subsidies.

Network failures:

- Poor collaboration between key actors including local governments, research organizations, civil society institutions and herder groups: implementation of Land Law is very weak at local government level, because of political divisions, almost no financial resources, lack of manpower or skills and not sharing of some responsibilities with civil society institutions.

Other barriers:

- Frequent drought and harsh winter disasters: Livestock is extremely vulnerable to natural disasters as individual herders cannot overcome excessive consequences of drought and *zud*. Herders groups are weak in term of financial and human capacity.

2.4.3 Identified measures for promoting technology 3– SPM

Stakeholder consultations were carried out (on 6th September 2012), to identify measures to overcome barriers. Measures identified in these consultations were validated using results of analysis reported from national and international projects experiences with managing pasture degradation and promoting SPM.

2.4.3.1 Economic and financial measures

Enforcement of policies and awareness-raising cannot sufficiently ensure herders undertake appropriate SPM practices, unless financial assistance is provided to make them affordable.

- Allocate funding for SPM and Pasture Law implementation (when it is passed): SPM practices including water resource management and establishment of wells and basins, restoration of degraded pasture, pasture and its ecosystems conservation activities, defining boundaries of common properties, and animal forage production. These activities are usually quite expensive and require continued funding. Also, benefits of adopting SPM practices are not immediate and usually spread over several years.

- Secure sufficient finances for research and development of SPM and a pasture monitoring system: SLM Research and Development (R&D) require adequate funding from the government and other donor agencies to study and recommend context specific solutions in diverse situations. The use of modern technology such as GIS mapping, satellite imaging, mobile communication system, and modeling can be used in the pasture monitoring system to provide precise solutions to herders and government officials. As the availability of budgetary resources from the government funding is not sufficient, harnessing donor support should be explored.

- Develop a subsidy program for pasture usage and management: Subsidies will support changing unsustainable practices into better managed pastures and other resources. Animal forage growers and producers should be encouraged with subsidies. Initiatives and projects for alternative income sources for herders should be supported and funding can be accessed from national and international resources.

2.4.3.2 Non-financial measures

Non-financial measures were considered important too during the discussion process. The following non-financial measures were identified:

Policy, legal and regulatory measures:

- Establish an appropriate legal framework for SPM: Whilst full privatisation of the land has proven a successful countermeasure in some countries, it is not feasible in Mongolia, where livestock requires mobility in order to balance the variability of the available fodder. In the Pasture law, Mongolia needs to define the appropriate mechanism, clarify rights holders, and specify roles and responsibilities of entities. Experience and lessons learnt from other countries similar situations as well as national and international projects and pilots are essential in policy formulation. Results of a public survey should be analysed and considered in any improvements to the law. Mechanism to review and change legal documents based on feedback and recommendations need to be considered.

Institutional and organizational capacity measures:

- Strengthen herders groups and organizations: Training package for group formulation and development should be created and made available at *soum* level through the local government and training centres. Package can include comprehensive guidance for herders about legal frameworks, business regulations, environmental issues, and potential options for income diversification (such as ecotourism, and small and medium enterprises using animal raw products). Exposure trips and experience sharing forums should be facilitated at provincial, national and international levels.

- Increase capacity of research institutions: Government and non-government research institutions need to be supported to conduct research and pilot promising practices at a small scale. Win–win solutions with social and ecological sustainability should be developed through R&D and successful outcomes of research, tests and demonstration need to be scaled up to higher levels.

Information and awareness barriers:

- Intensify training and education programs for herders and related government officials: Involve related organizations who could provide qualified training and education programs on pasture management.

- Develop a communication strategy for herders: The government needs to develop a communication strategy with key messages along with the media in order to convince herders and impact their behaviour.

Network failures:

- Set up consultative feedback mechanisms at national and provincial levels: Coordination between key stakeholders including local governments, research organizations, civil society institutions and herder groups should be ensured through periodic consultative meetings.

2.5 Linkages of the barriers identified

The exact barriers were different from technology to technology depending on the categories (Table 24).

Table 24: Key barriers identified for prioritized three technologies in the animal husbandry sector

No	Key barriers identified		
	Seasonal prediction and livestock early warning system	**High quality livestock through selective breeding and animal health system**	**Sustainable pasture management**
Economic and financial barriers			
1	Inadequate of financial resource	Inadequate financial resources from the government for local veterinary/ breeding units	Lack of financial resource to adapting of Sustainable pasture management technology
2		Lack of financial support for the research and development of livestock breeds	Lack of taxation mechanism for pasture usage and management
3		High cost of imported breeding equipment and supplies, veterinary medicines, vaccines and diagnosing facilities	
Non-financial barriers			
	Policy, Legal and Regulatory Barriers		
4		Insufficient consideration of livestock adaptation to climate change in legal frameworks:	Lack of land tenure rights
5		Inadequate incentive policies and regulations	
6		Unclear roles of state and private veterinary/breeding workers and units	
	Human Skills Barriers		
7	Insufficient research and development	Insufficient numbers of animal breeding technicians and veterinarians	
	Institutional and organizational capacity barriers		
8		Inadequate technical and human capacity of local veterinary and breeding units	Lack of regulation authority and mechanism for pasture usage
	Market Failure/Imperfection Barriers		
9		Low access to tested and proved breeds, qualified veterinary medicines and services	
10		Underdeveloped market and trade mechanism	

	Social, Cultural, Behavioral Barriers		
11		Reluctance by herders to use breed high quality of livestock	Complexity of pasture system with different socio economic and natural conditions
12		Lack of understanding of the importance of the technology application	Mobile herding system
13			Uncontrolled animal numbers
	Information and awareness Barriers		
14	Inadequate awareness and understanding	Lack of information and awareness	Lack of awareness and knowledge of herders
	Network Failure Barriers		
15	Poor coordination between organizations in the current early warning system	Poor coordination between key actors	Poor coordination between key actors
	Other Barriers		
16			Frequent drought and harsh winter disasters

There are common characteristics in identified technologies in animal husbandry sector. These common barriers are followed:

- **Lack of financial resource**: Low funding allocation was a barrier for all three selected technologies in the animal husbandry sector. SPLEWS lacks improvements in the current system to provide adequate quality information to prevent or mitigate animal losses during droughts and *zuds*. Financial resources are not sufficient for high quality livestock through selective breeding and animal disease management in order to deliver necessary services to herders. Pasture and land management measures and actions which are milestones for Sustainable pasture management are under-fund. Research and development of all three technologies face financial challenges.

- **Inadequate policy and regulations**: This barrier has high rank for SPLEWS and HQL. With regard to HQL, the livestock sector related policies have not included adaptations to environmental and climate change risks including soil and environmental degradation. Also, the Mongolian Law on Livestock Gene Pool and Animal Health is not enforced efficiently due to lack of finance and human skills. Pasture Law which has been under discussion for more than 4 years is an emerging issue for SPM. For SPLEWS, roles and responsibilities between organizations and institutions are still too vague to make the system complete and efficient.

- **Insufficient awareness and information**: End users of all three prioritized technologies struggle with low access to good information and have low levels of confidence in adapting positive practices. In SPLEWS, the high tariff of communication and the poor infrastructure is an issue to disseminate real time and updated information. With regard to other two technologies, inadequate information and awareness among herders and government officials hinder transfer and diffusion.

- **Lack of partnership**: This barrier affects all three technologies. There are many government agencies and organizations involved in the early warning system, but effectiveness of the coordination cannot ensure to achieve the main goal to deliver accurate, timely, reliable and unambiguous information. In terms of HQL, relations and collaboration between market and non-market players is too weak to deliver advanced breeding equipment and veterinary services to herders. For SPM, the current level of cooperation of among key actors, such as herders groups, NGOs, research institutions, national and international projects implementers and local governments cannot support this technology.

2.6 Enabling framework for overcoming the barriers in animal husbandry

Key measures identified for the technologies in animal husbandry compiled in Table 25.

Table 25: Key measures identified for prioritized three technologies in the animal husbandry sector

No.	Key measures identified		
	Seasonal prediction and livestock early warning system	**High quality livestock through selective breeding and animal health system**	**Sustainable pasture management**
	Economic and financial measures		
1	Allocation of required amount of funds by the government and exploration for alternative funding sources	Allocation of financial resources by the Government for the technology	Allocate funding for SPM and future Pasture Law implementation
2		Acquire funding for the research and development of animal health and breeds	Secure sufficient finances for research and development of SPM and pasture monitoring system
3		Invest into local a market/trade network and infrastructure development	Develop subsidy program for pasture usage and management
4		Tax exemption of veterinary products and breeding facilities	
5		Provision of soft loans to local manufacturing factories	
	Non-financial measures		
	Policy, Legal and Regulatory Measures		
6	Facilitate consultative periodical meetings at decision making and implementation levels	Establish appropriate subsidy policy for herders to promote high quality livestock	Establish appropriate legal framework for SPM

7	Establish post disaster feedback mechanism	Efficient enforcement of Mongolian Law of Livestock Gene Pool and Animal Health	
	Human Skills Measures		
8	Support research and development on components of SPLEWS	Capacity building programs for animal breeding specialists and veterinarians	
9	Systematic training for different stakeholders of SPLEWS		
	Institutional and organizational capacity measures		
10		Strengthen state and private veterinary and breeding units	Strengthen herders groups and organizations
11		Set up animal disease prevention system	Increase capacity of research institutions
	Information and awareness Measures		
12	Strengthen formal and informal network of disaster effective communication	Educate herders about high production breeds	Intensify training and education programs for herders and related government officials
13	Develop message packages and train users through media and press		Develop communication strategy for herders
	Network Failure *Measures*		
14		Improve coordination between government organizations, private enterprises, research institutions and herder communities	Set up consultative and feedback mechanism at national and provincial levels
	Technical Measures		
15		Quality assurance by inspection organizations	

The previous section identified some of the common barriers which can be broadly categorized into the following: lack of financial resources; inadequate policy and regulations; insufficient information and awareness; and lack of partnerships. Thus the enabling framework for the common barriers could be categorized broadly as follows (Table 26):

Table 26: Common barriers to technologies in the animal husbandry

Common barriers	Enabling framework	Technology
Lack of financial resources	• Allocate more funding from the government • Explore funding opportunities from international donors • Support private enterprises to invest into identified technologies with income and import tax deduction/exemption	SPLEWS; HQL; SPM
Inadequate policy and regulations	• Identify appropriate solutions for legal entities for herder groups for Pasture Law • Lobby for required law endorsement • Improve business regulations for livestock production	HQL; SPM
Insufficient awareness and information	• Develop training packages for specific technologies • Identify and certify qualified training organizations at local levels • Conduct awareness and training for livestock specialists and government officials • Facilitate periodical event for discussions, sharing experiences and learning from other countries programs and projects	SPLEWS; HQL; SPM
Lack of partnership	• Set up permanent consultative forum on each technologies • Define clear roles and responsibilities of key actors and seek for opportunities to legalize • Develop and set up related indicators in performance evaluation of government and other organizations	SPLEWS; HQL; SPM

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ANNEX 4: MARKET MAPS AND PROBLEM TREES

A4.1.1 Adaptation technology: SWI– Sector: Arable farming

Selected technology	Category of technology	Explanation for the categorisation	List of actors / market players
1.System of wheat intensification	Consumer goods (Food market and production)	Increases cereals harvest s as a result of maintaining soil fertility and moisture; reduces soil erosion	-Ministry of Industry and Agriculture; Research institutes; Agencies, private enterprises, international and national training centers -Government, Donor agencies, NGOs, Banks and financial institutions

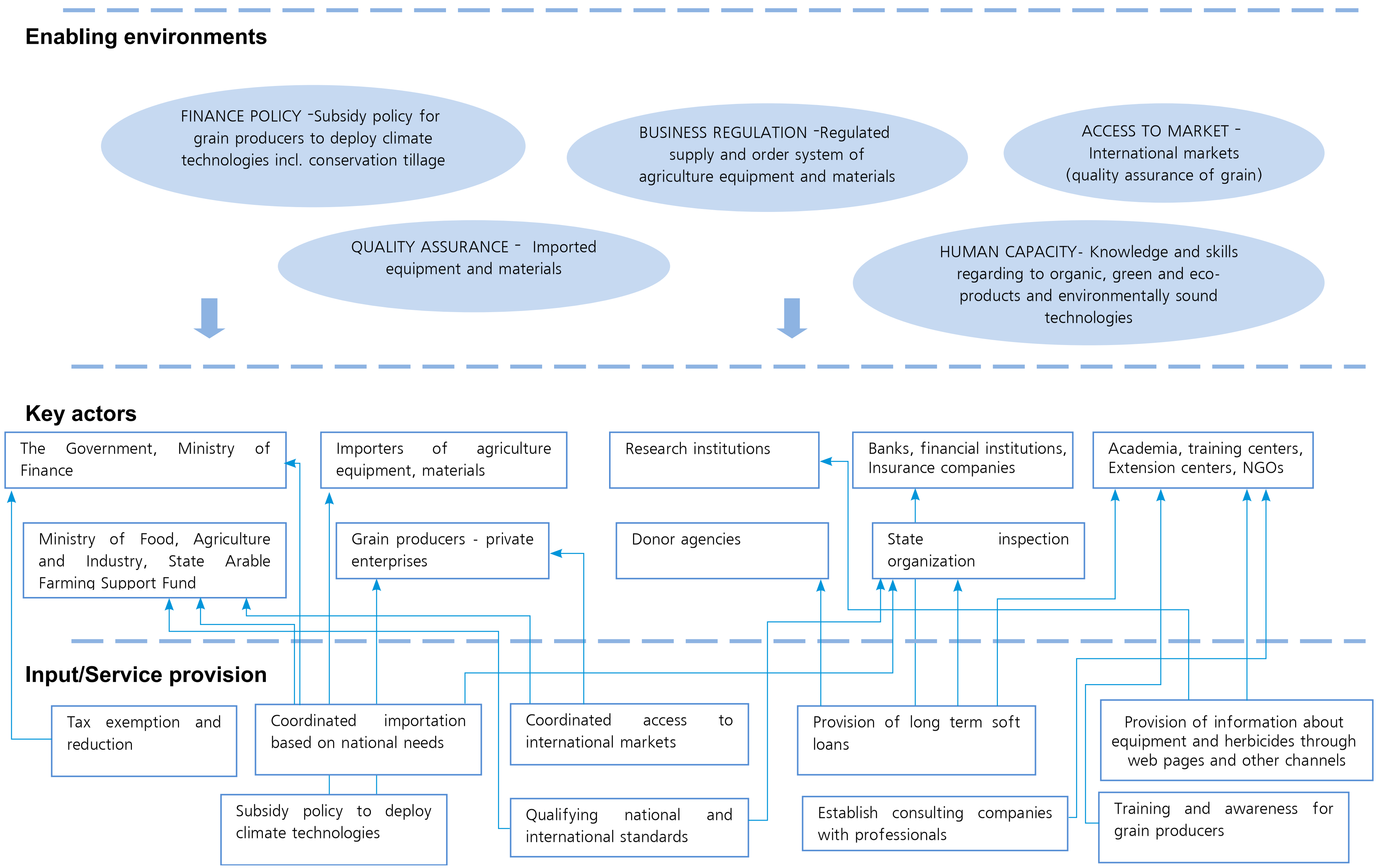
Barriers identified	Rank	Category	List of key barriers	Measures identified to overcome barriers	Service providers	Input/Service provision	Enabling environments
Lack of financial resources	1	Economic and financial barriers	Herbicide, sprayer and seeding equipment costs are high	Establish taxation support mechanism and long term loans with low interests	Government, Ministry of Industry and Agriculture; Ministry of Finance; Arable Farming Support Fund; Ministry of Environment and Green development; Private enterprises	-Reduce taxes of importation and Value added tax -Facilitation of importation based on national requests -Provision of long term and low interest loans to farmers - Machinery and equipment loan can be provided without interest which can be paid after harvest.	The Government policy on conservation tillage with fallow Cost of equipments will drop by 15 %. Because of tax exemption, tax income will be reduced by 35 billion *tugrugs.*
			-Lack of financial resource for arable farming	-Resource acquisition in Arable Farming Fund through legal coordination		More opportunity to export grains and to buy necessary equipment	Arable Farming Support Fund needs 7.6 million USD of revolving fund. Herbicide cost -2.1 million US$ sprayer cost is 2.5 million US$ Seedling machine -3 million US$ Farmers will down payment- 30 % - 2.28 million US$

Lack of knowledge and skills	1	Human skills	-Knowledge and skills are insufficient to use fertilizers and herbicide and deploy climate technologies	Provision of training and capacity building on application of chemicals and fertilizers and develop guidelines and implementation	Government, Ministry of Education and Science; Ministry of Food, Agriculture and Industry; Ministry of Environment and Green development; Chamber of Trade and Industry; Private enterprises; Research institutes; *Aimag* Extension centers	- Training of cereal producers -Establish consulting and dialer companies -Information provision through web pages about equipment and herbicide market	Support awareness and training, establish companies, create information sharing and e service to provide market information
Lack of human resources	2	Human skills	Lack of human resource and professionals	Professional specialist might be required. So about 2 billion *tugrugs* will be required for additional specialists to apply chemicals and herbicide. At least 250-300 professionals are required in order to provide professional supervision.	Government: Ministry of Education and Science; Ministry of Industry and Agriculture; Ministry of Environment and Green Development; State University of Agriculture; Private enterprises; Research institutes; *Aimag* Extension centers	Preparing professionals through academia,	Sufficient number of agriculture professionals
Poor coordination between organizations	3	Network failure	Inefficient coordination between suppliers of equipment and herbicide and grain producers Debt is accumulated	-Establish contract with clear terms according to updated guidelines by Arable Farming Support Fund No additional cost is required.	Ministry of Industry and Agriculture, Arable Farming Support Fund, suppliers of agriculture equipment and materials, Grain producers	Contract with clear terms Thorough monitoring of contract terms	Good coordination between suppliers and users of agriculture equipment and herbicide
			Poor coordination between government organization, research institutions and grain producers	Training for grain producers (There are about 1084 grain producers in Mongolia; 801 of them are small producers with up to 500 ha, 160 of them are big enterprises with more than 1000 ha of land)	Ministry of Industry and Agriculture, Arable Farming Support Fund, Academia, provincial extension centers, grain producers	Training and awareness raising	Grain producers have good understanding of the technology

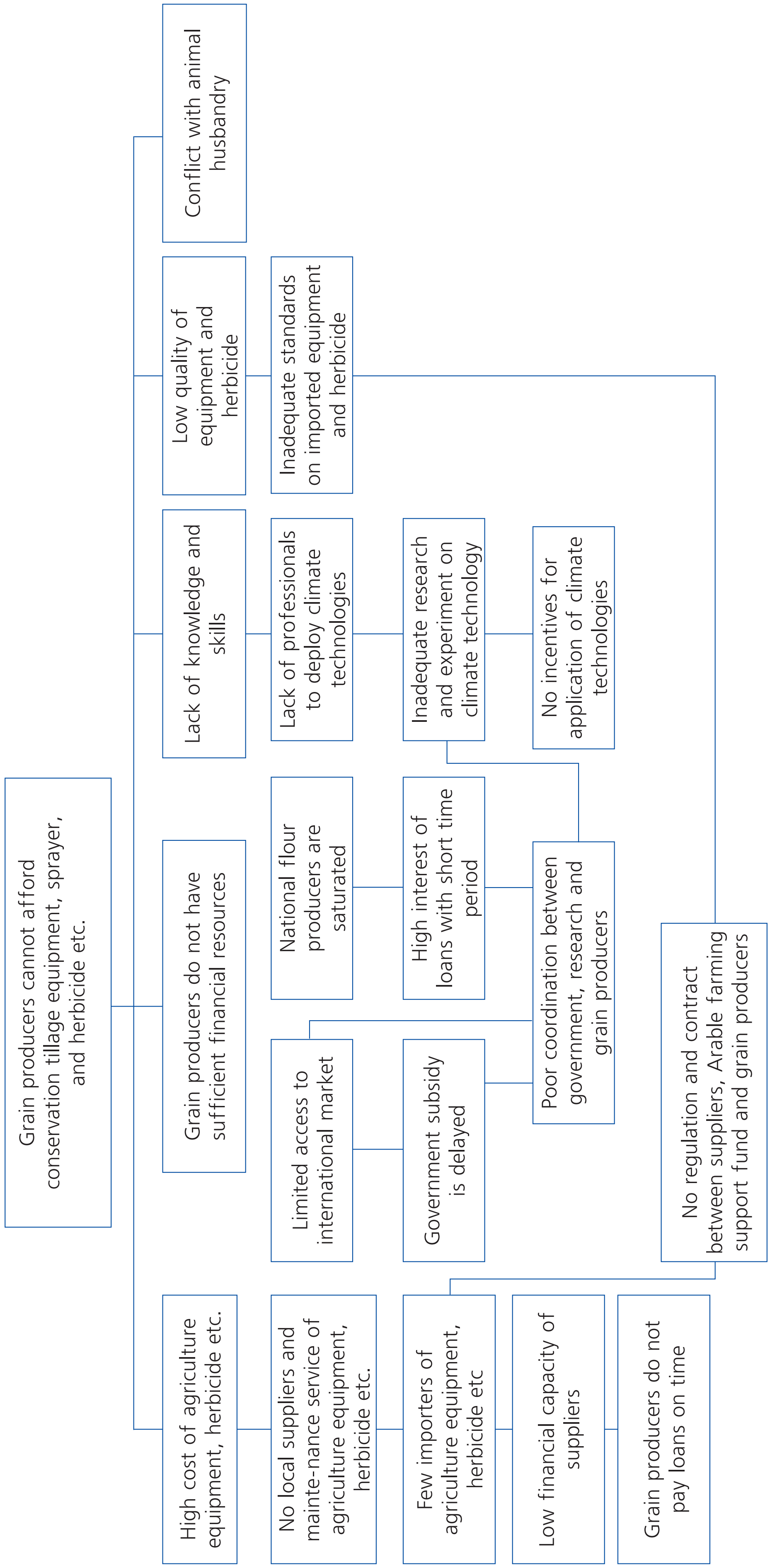
Lack of equipment and technologies	4	Technical	Lack herbicide and sprayer equipment Low quality of herbicide and equipment	Coordinated acquisition of herbicide and equipment can be organized based on national demands 30 % of down payment can be done. Remaining 70 % of cost should be done by importers. Quality assurance and standards should be set and be followed. Proper storage should be built to store herbicide and fertilizers in winter time. Cost of storage 200m3 volume is 350 million *tugrugs* (about 300,000 US$).	Ministry of Industry and Agriculture, Arable Farming Support Fund, importing companies, grain producers State inspection agency		Lower risk of importers because it is based actual order and down-payment Qualified agriculture equipment and herbicide
Insufficient legal framework	2	Management	There is no legal regulations of ordering and down-payment of equipment and herbicide, so Arable Farming Support Fund could be immersed in debt There is no Incentive policy to support conservation tillage and other environmentally sound and climate technologies	-Establish contract with clear terms according to updated guidelines by Arable Farming Support Fund -Amend current incentive policy per metric tons of grain into environmentally sound technologies	The Parliament, the Government, Ministry of Finance, Ministry of Industry and Agriculture, Arable Farming Support Fund, suppliers of agriculture equipment and materials, Grain producers	Contract with clear terms Thorough monitoring of contract terms Subsidy to support to deploy climate technologies and environmentally sound technologies	Good coordination between suppliers and users of agriculture equipment and herbicide Good subsidy policy to deploy technology

Poor infrastructure	3	Market failure/ imperfection	Few importers who can supply agriculture equipment, fertilizers and herbicide No local suppliers at provincial level No maintenance service	Coordinated acquisition of herbicide and equipment can be organized based on national demands 30 % of down payment can be done. Remaining 70 % of cost should be done by importers. Establish local suppliers in 9 provinces where cereals and forage are grown. (1 supplier trade, storage and other facilities would cost 200-300 million *tugrugs* (150-200 thousand US$) per *aimag*. 8 *aimags* would cost about 2.4 billion *tugrugs* (2 million US$)).	Ministry of Industry and Agriculture, Arable Farming Support Fund, importing companies, grain producers		Lower risk of importers because it is based actual order and down-payment Availability of equipment and herbicide would be increased at provincial level.
Conflict between arable farming and livestock	2	Cultural, social and behavioral	Animals graze in out of the growing season Land cannot be fenced.	Herd animals for all day to protect farming lands from livestock grazing	Herders, farmers		
Lack of information	3	Information and awareness	Lack of knowledge about proper application climate technologies	Training should be organized at regional basis Total expense be about 20 million (18,000 US$) *tugrugs.*	Ministry of Industry and Agriculture, Science innovation introduction center		Increased skill and knowledge of the technology

A4.1.2 Market mapping- SWI



A4.1.3 Problem tree – SWI

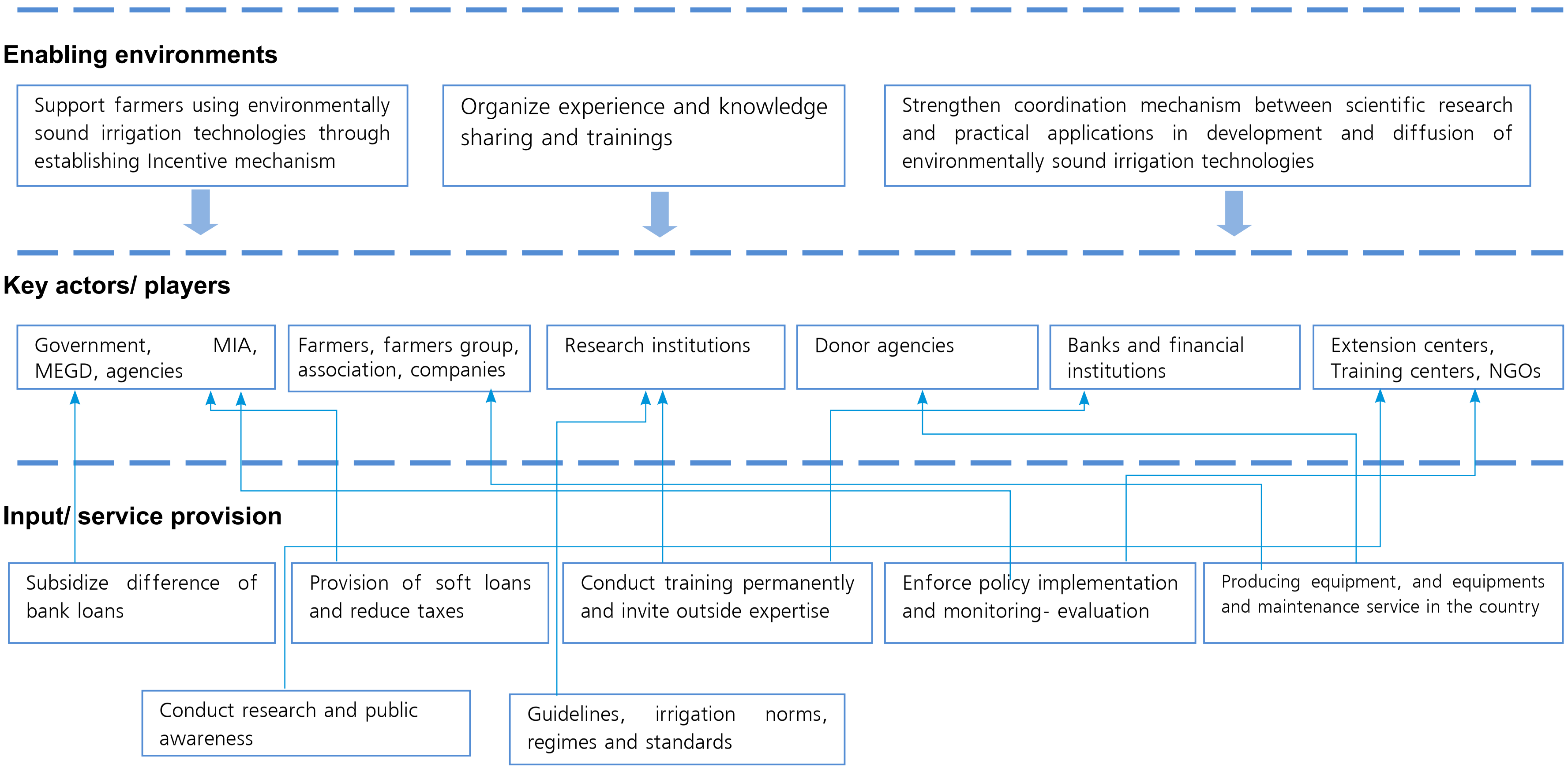


A4.2.1 Adaptation technology: VPS– Sector: Arable farming/ Water

Selected technology	Category of technology	Explanation for the categorization	List of actors / market players
1. **Vegetable Production system with Drip irrigation and mulches (VPS)**	Consumer goods (Food market and production)	Ecosystems support; water saving	-Ministry of Industry and Agriculture; Research institutes; Agencies, international and national training centers -Government, Donor agencies, NGOs, Banks and financial institutions -Private enterprises, farmer groups, association

Barriers identified	Rank	Category	List of key barriers	Measures identified to overcome barriers	Service providers	Input/Service provision	Enabling environments
Lack of financial resources	1	Economic and financial barriers	Availability of imported equipment is low and price is high. It is difficult to apply at bigger farms (17 million *tugrig* is required per hectare)	-Support and soft loans from the Government, Donor agencies and Special Funds -Coordinated importation of equipment based on national demands	Government, Ministry of Industry and Agriculture; Ministry of Finance; WB; ADB, National Fund for Agriculture Support	-Government subsidies to pay bank interest difference -Soft loans -Reduce taxes on imports	Establish Incentive mechanism for farmers to apply environmentally sound irrigation
Lack of knowledge and skills	1	Human skills	-Knowledge and skills of companies, specialists and farmers are insufficient to use drip irrigation	-Conduct systematic training about Integrated water resource management; impact assessment of water usage on river basin; runoff standards supporting ecosystem; irrigation regime and norms etc. -Training on instruction of equipment installation and maintenance	International and national training centers; International and national universities; University of Agriculture of Mongolia; *Aimag* Extension centers	- Education and training at international and national education institutions; -Special non-stop training programs can be organized at national level -International expertise will be required. -	Provide training, experience and knowledge exchange
Poor coordination between organizations	3	Network failure	Poor coordination between Government agencies and NGOs and Civil society organizations to monitor and evaluate	The Government needs to approve regulations on agriculture, environment conservation, and water resource usage NGOs participate in monitoring	Government; Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Government Agencies;	Enforce policy implementation; Monitoring and evaluation	Policy will be implemented as required and NGOs, civil society organizations will be part of monitoring and evaluations
Lack of equipment and technologies	2	Technical	Advanced equipment	Government, donor agencies and special funds	Ministry of Industry and Agriculture; Ministry of Finance; WB, ADB, special funds; companies	Availability of advanced equipment at markets, auctions	Advanced equipment and maintenance service are available at markets
Lack of research on irrigation regimes, rates, defining runoff standards supporting ecosystems	1	Scientific/ Technical	Optimum irrigation regimes have not been defined through research	Research institutions implement research and experiment projects along with private enterprises with international and national financial supports	Ministry of Education and Science; Ministry of Industry and Agriculture; research institutions; Agriculture extension centers; Private companies	-Conduct research and experiments -Public awareness about application of the technology; -Develop guidelines about optimum irrigation regime, norms and standards	Practical application of scientific research will be strengthened in development and application of environmentally sound technologies

A4.2.2 Market mapping - VPS



A4.3.1 Adaptation technology: PSPS – Sector: Arable farming

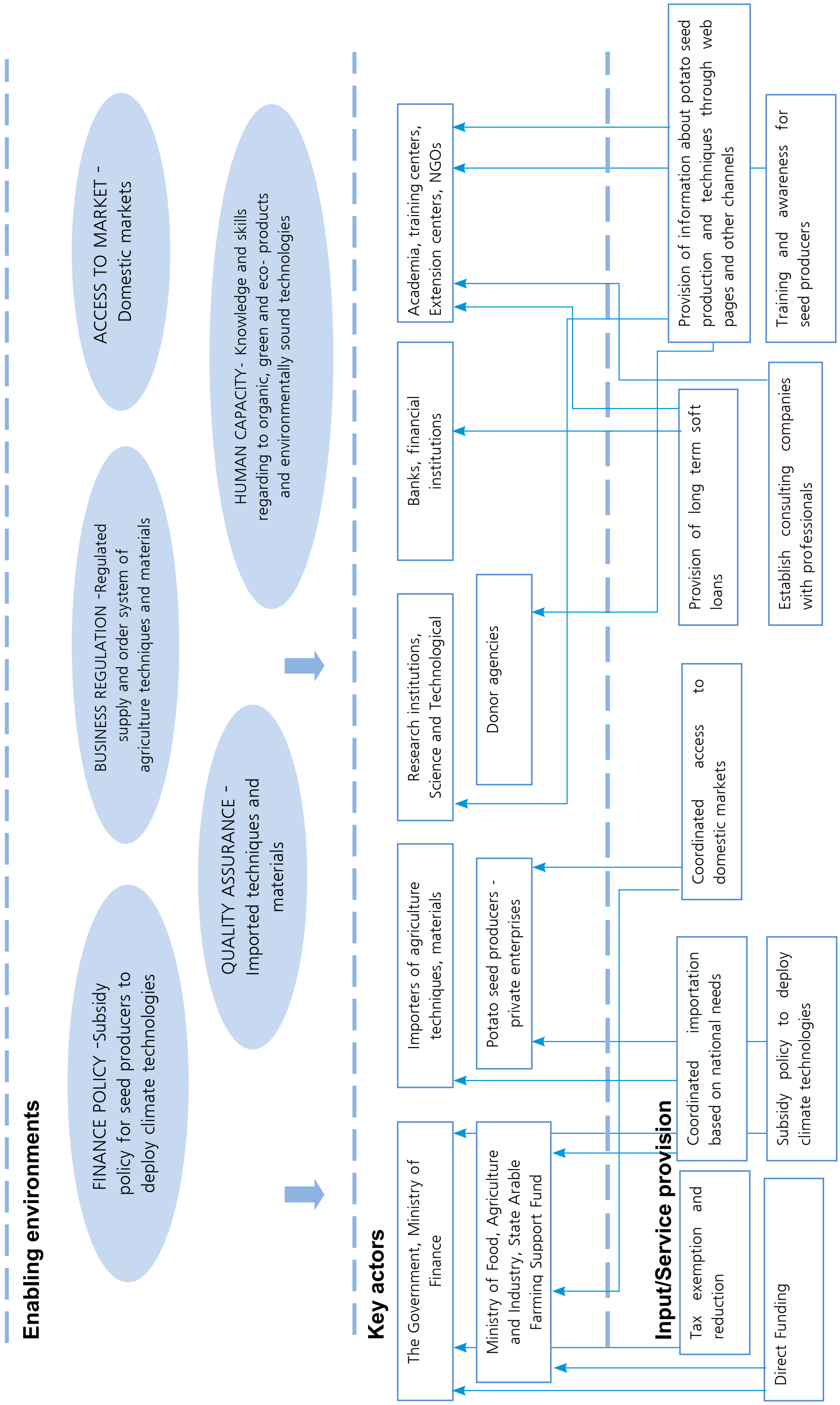
Selected technology	Category of technology	Explanation for the categorization	List of actors / market players
1. Potato seed production system (PSPS)	Consumer goods (Food market and production)	helps to build sustainable, reliable and high quality potato seed production in the country	-Ministry of Industry and Agriculture; Research institutes; Agencies, private enterprises, international and national training centers -Government, Donor agencies, NGOs, Banks and financial institutions private enterprises, farmer groups, association

Barriers identified	Rank	Category	List of key barriers	Measures identified to overcome barriers	Service providers	Input/Service provision	Enabling environments
Inadequate availability of financial resources	1	Economic and financial barriers	Seed producer still have depended on external financial sources	Assuring adequate availability of financial resources	Government, Ministry of Industry and Agriculture; Ministry of Finance; Arable Farming Support Fund; Ministry of Environment and Green development; Banks, financial institutions, Private enterprises	- To fund research on potato varieties and agro-technical practices -At least 3 sites with complex aeroponic systems should be established in the western, the central and the eastern agricultural zones from the state fund -to provide by loans with low interest for 3-5 years from Arable farming fund -Support farmers or companies with low interest loans for building medium and big scale storing facilities.	-Sufficient funding for the technology transfer and diffusion
High cost of equipments and materials	1	Economic and financial barriers	Cost of imported equipments and supplies are increased due to other factors such transportation, importation procedures and limited number of licensed importers.	Taxation support mechanism, long term loans with low interest for aeroponic system and other facilities	Government, Ministry of Industry and Agriculture; Ministry of Finance; Arable Farming Support Fund; Private enterprises	-Reduce taxes of importation and Value added tax -Facilitation of importation based on national requests - Machinery and techniques loan can be provided without interest which can be paid after harvest. -Publicize government support for seed producers	-Lower risk for importers because it is based on actual order and down-payment -Affordable cost of equipments and supplies
Lack of subsidy policy for potato seed producers	2	Policy, Legal, Regulatory	Financial capacity of potato seed producers are limited and cannot afford high cost techniques and equipments	Subsidy policy on Potato seed production using aeroponic	Government, Ministry of Finance; Ministry of Industry and Agriculture		-Increased interest of farmers to produce potato seeds

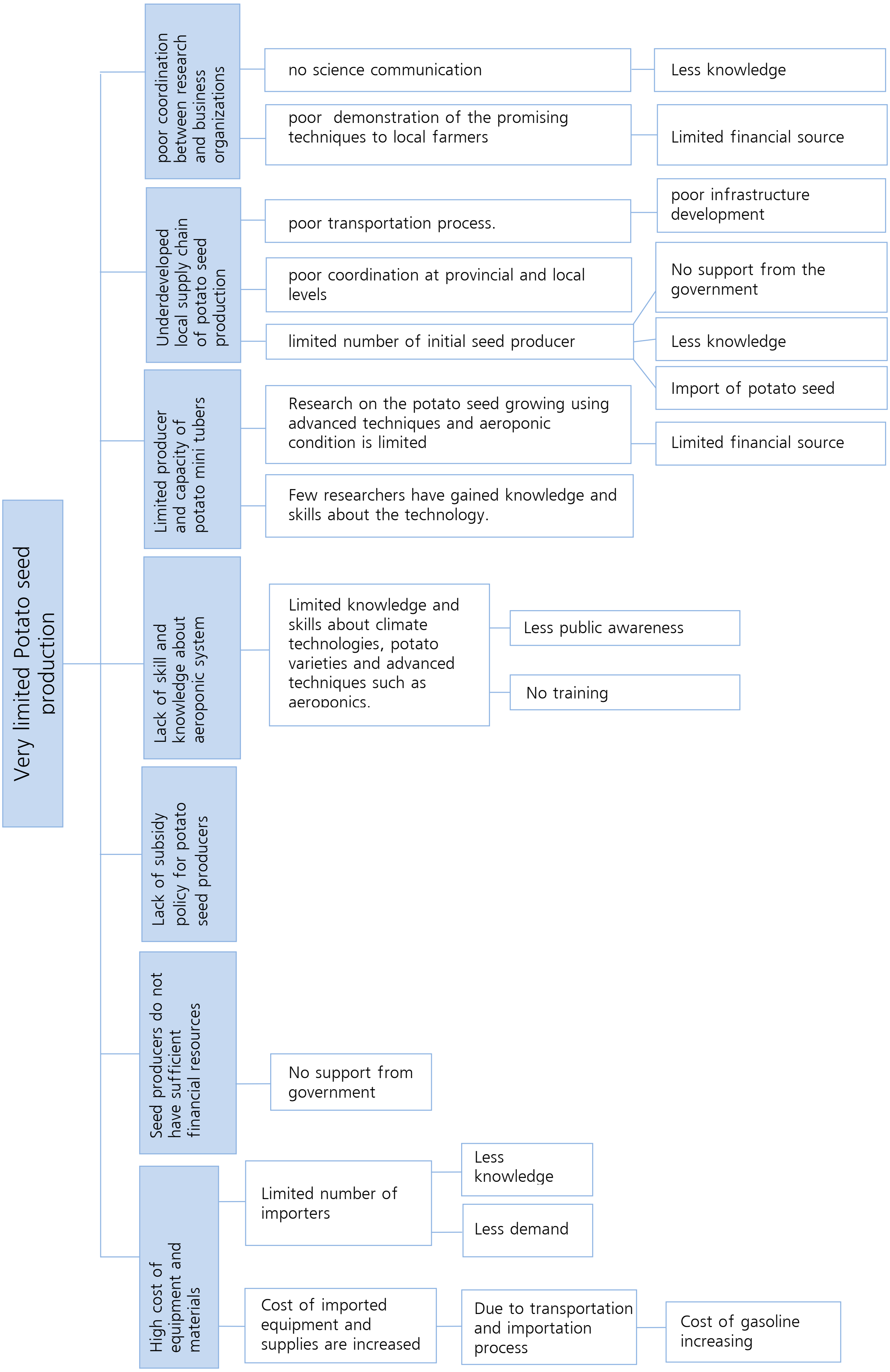
Lack of skills and knowledge about aeroponic system	2	Human skills	Limited knowledge and skills about climate technologies, potato varieties and advanced techniques such as aeroponics.	Training of agriculture professionals on aeroponics and potato seed production	Ministry of Industry and Agriculture Ministry of education the State University of Agriculture private companies	-To provide theoretical and practical knowledge and skills to students studying in the State University of Agriculture and other colleges -To re-train professionals of companies and state agriculture organizations through short term programs and exposure trips to other countries	Increased skill and knowledge of the technology
Limited producer and capacity of potato mini tubers	2	Institutional and Organizational capacity	Agriculture research institute in Darkhan. So, few researchers have gained knowledge and skills about the technology. Research on the potato seed growing using advanced techniques and aeroponic condition is limited.	Expanding research capacity on potato varieties and advanced techniques including aeroponics	Ministry of Industry and Agriculture Ministry of education the State University of Agriculture private companies	-To extend research by specialists and post graduate students focusing on the technology -To fund this kind of research by National Science Fund, other national programs and international projects.	Increased number of agriculture professionals on aeroponic system
				Training of potential potato seed producers	Ministry of Industry and Agriculture provincial agriculture extension centers and local training NGOs private companies	-to provide knowledge and skills on mini tuber producing, seed multiplying, application of fertilizers and pesticide and other technical aspects -to organize practical experience trip and field visits in the country as well as outside	
Underdeveloped local supply chain of potato seed production	3	Market failure	- Limited number of initial seed producer -Poor coordination at provincial and local levels - Limited storage capacity at provinces —Poor transportation process	Invest infrastructure	Government	-Improve local infrastructure including road, proper storages, reliable and constant electricity and water supply system to support local production system.	Supportive infrastructure system especially at local levels

Poor coordination between research organization, provincial agriculture extension centres, potato seed producers and farmers	2	Network failures	- No science communication -Poor demonstration of the promising techniques to local farmers due to financial resources.	Intensify supply chain of potato producers:	Ministry of Finance Ministry of Industry and Agriculture the State University of Agriculture state research organizations provincial agriculture extension centers	-To train researchers on how to distribute their study results in common language not in scientific language -Regularly give financial support to research organizations for demonstrating their research output and promising techniques. -Local government can support and be bridge farmer groups and private companies to be part of supply chain of potato seed production system.	Good coordination between suppliers and users of seed

A4.3.2 Market mapping- PSPS



A4.3.3 Problem tree – PSPS



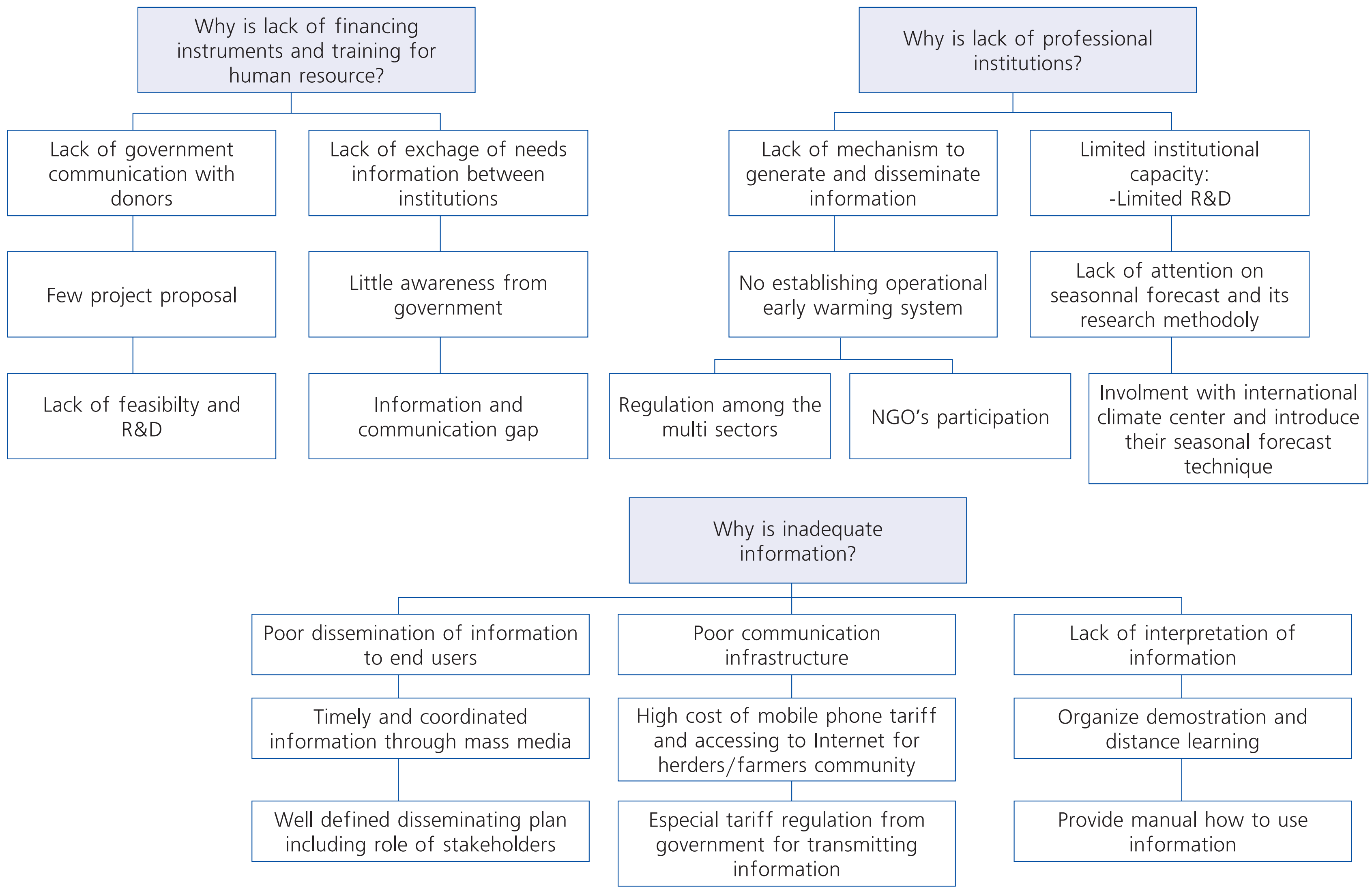
A4.4.1 Adaptation technology: SPLEWS– Sector: Livestock, Arable farming sector

Prioritized technology	Category of technology	Explanation for the categorization	List of actors / market players
1.Seasonal Prediction and Livestock Early Warning System (SPLEWS)	Non market goods	Non-tradable; entails government/ donor funding	-Government, Donor agencies, NGOs, Banks and financial institutions -Ministry of Agriculture and Industry; Research institutes; Agencies, Private enterprises, International and national training centers -Herders/farmers family and community -Mass media

Barriers identified by category	Rank	List of key barriers and its decomposition	Measures identified to overcome barriers	Service providers	Input/Service provision	Enabling environments
Economic and financial	1	Lack or inadequate access to financial resources: -Lack of financing instruments and training for human resource	-Government needs to propose project to donors based on result of feasibility and R&D study -Exchange information from bottom to top and vice versa.	Ministry of Finance, WB, ADB, Ministry Agriculture and Industry, Ministry of Environment and Green Development, Emergency Agency, Agency of Meteorology, Hydrology and Environmental Monitoring	-Behalf of government Ministry of Finance submit project to donors agencies -Reduce tax on imported equipment	Government needs to invest and submit project proposal to donors
Human skills	2	Inadequate training facilities: -Lack of experts to train -Lack of skilled personal for operating system	Carry out systematic training	Training center, Universities, Research Institution, NGOs	-Strengthen of existing training center -Graduate and undergraduate study -Invite foreign experts	-Establish mechanism of specialized training environment
Institutional and organizational capacity	1	Lack of professional institutions: -Lack of mechanism to generate and disseminate information Limited institutional capacity: -Limited R&D	-Establish operational early warning system in terms of regulation environment -Encourage participation of NGOs and herders/famers -Involvement with international climate center and introduce their seasonal forecast technique	Government, Ministry of Agriculture and Industry, Ministry of Environment and Green Development, Agencies, NGOs, Research Institute	-Establish operational early warning system - Develop regulation of organizational activities linkage -Increase participation of NGO and herders/ famers	-Prove and enforce regulation of organizational role of coordination among institutions

Technical	2	Inadequate technical capacity: -Less computing resource and processing software -Lack of density observation and monitoring network	-Enhance and extend current observation network -Increase computation power -Improve satellite receiving and processing system	Space agency, Supporting company, Training center, Research Institute	-Install and upgrade equipment -Training on software and hardware, maintains	-Reducing tax on imports -Training
Information and awareness	1	Inadequate information: -Poor dissemination of information to end users -Poor communication infrastructure -Lack of interpretation of information	-Especial tariff regulation from government for transmitting information -Well defined disseminating plan including role of stakeholders -Provide manual how to use information	Emergency agency, NGOs, Ministry of Agriculture and Industry, All level of governors, Research institute	-Organize demonstration and distance learning -Develop and provide manual -Improve insurance system -Grant aid and provision of long term and low interest loans to farmers -Strengthening of decision makers at all level of governors -Increase capacity of prevention and preparedness of herders/farmers family during natural disaster	-Disseminate disaster information through mobile phone, radio and TV without charge during disasters, -Develop contingency plan
Others	3	High level of poverty of herders family				

A4.4.2 Problem tree –Seasonal Prediction and Livestock Early Warning System



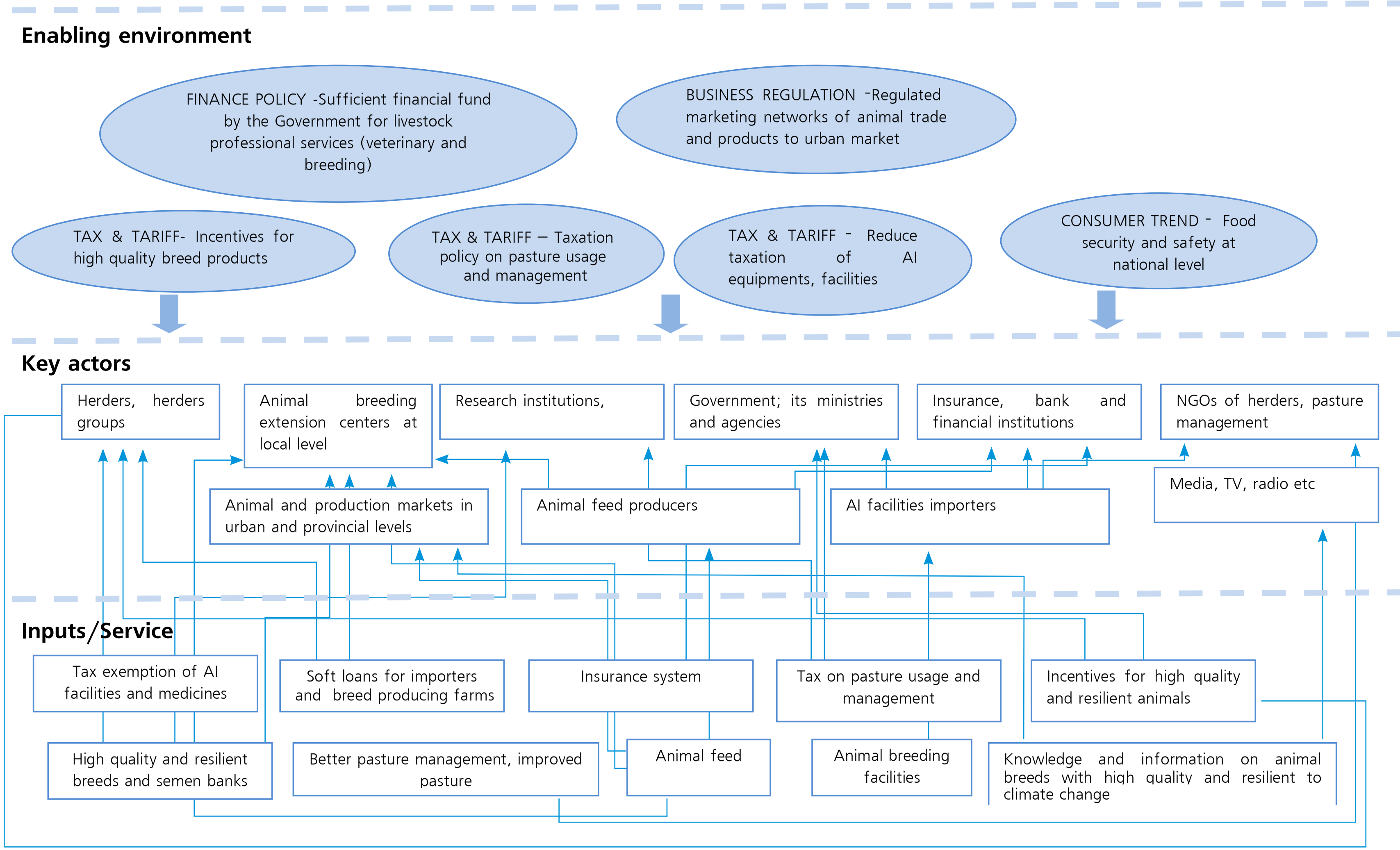
A4.5.1 Adaptation technology: HQL – Sector: Animal husbandry

Selected technology	Category of technology	Explanation for the categorization	List of actors / market players
1.High quality livestock through selective breeding and animal disease management (HQL)	Consumer goods (Food market and production)	- livestock production increase - improved animals resilience to climate change - opportunity to control livestock numbers which can lead to decreased overgrazing and desertification	-The Government, Ministry of Food Agriculture and Industry, - International and national donor agencies, projects and programs, - Herders, herders groups - Research institutes; NGOs, private enterprises, international and national training centers, public media - Banks and financial institutions

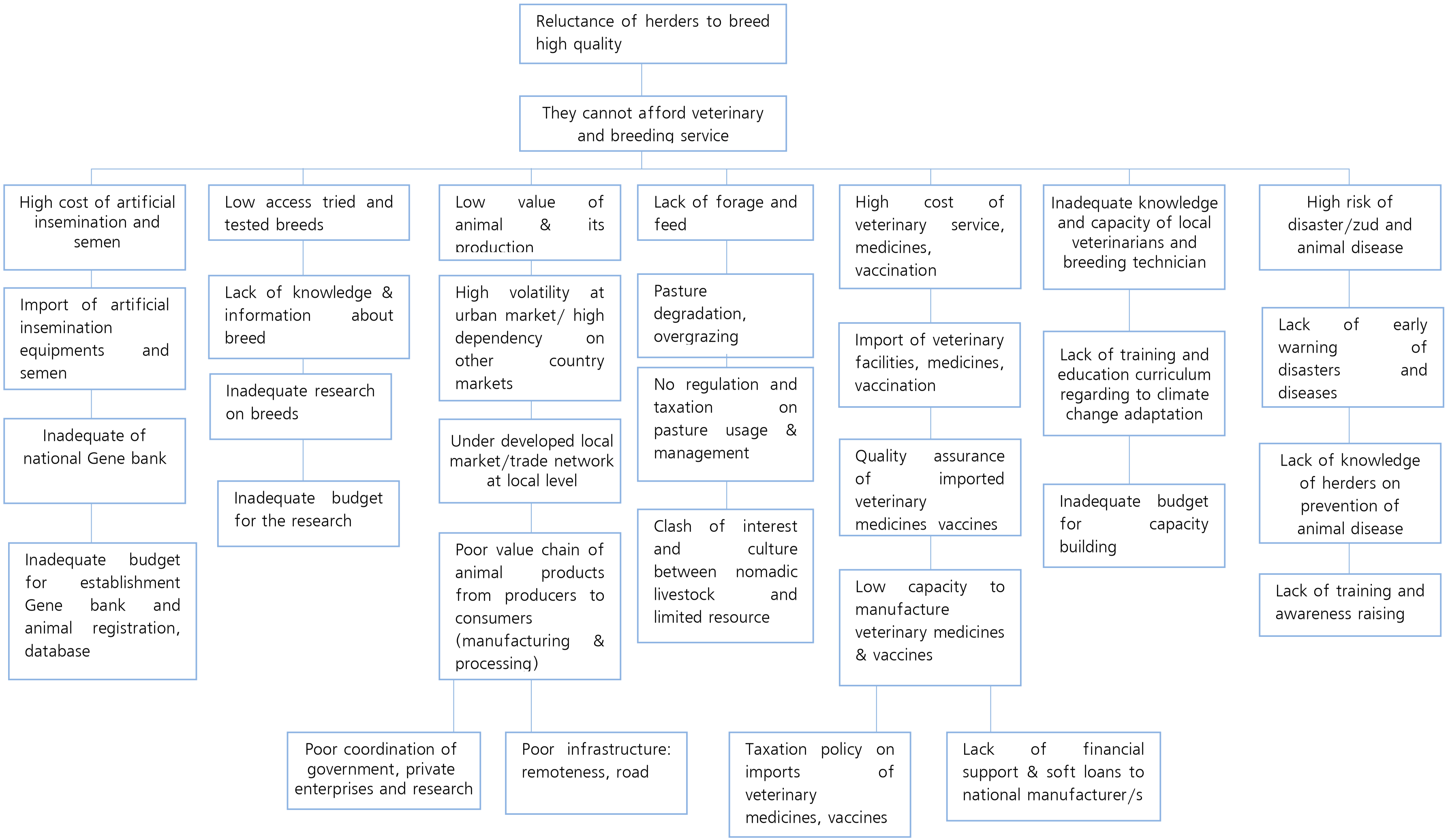
Barriers identified	Rank	Category	List of key barriers	Measures identified to overcome barriers	Service providers	Input/Service provision	Enabling environments
Lack of financial resources	1	Economic and financial barriers	-Lack of financial resource for animal registration, veterinary service, etc. by the Government -High cost of imported animal breed and semen	-Establish financial fund for enforcing laws about animal gene fund and health; -Reduce taxes -Provide soft loans to importers	Ministry of Finance, Ministry of Industry and Agriculture, Ministry of Environment and Green development, World Bank, ADB	-Reduce taxes of importation and Value added tax -Provision of soft loans to importers - Strengthen livestock insurance system -Improved live-stock insurance system	- Establish incentive mechanism for producers of organic production -Improve legal framework with financial resource -Advocate local government to include in the local government budgets -Reduce taxes -Improved insurance service
Lack of human resources	2	Human skills	-Lack of livestock technicians at local level -Skills of current livestock technicians are inadequate .	-Training of livestock technicians	Ministry of Industry and Agriculture, University of Agriculture, Research institute of Livestock, International and national training centers, *aimag* extension centers	-Re- training for livestock technicians -Improve education to prepare -Exposure and experience sharing in and out country	-Strengthened human resource at local level, -Improved animal quality and produc-tion increase by 5-15%
Poor coordination between organizations	3	Network failure	-Low coordination between international and national projects and programs on animal breeding -Poor collaboration of government institutions, private enterprises, research institutions and NGOs at local and national levels	-Workshops, seminars and experience sharing; -Training and awareness for government staff and other institutions workers; -Cooperation and partnership should be one of aspect of job performances; -Cost and expense of joint activities can be contributed;	International donor agencies, Ministry of Industry and Agriculture, University of Agriculture, International and national training centers, *aimag* extension centers	-Training, awareness and experience sharing;	-Livestock quality at regional, *aimag, soum* and bag level will be improved; -Cooperation and partnership at local level will increase; -Financial efficiency will be improved;

Lack of equipment and technologies	4	Technical	-Lack of facilities of artificial insemination at veterinary and breeding units and laboratories	-Reduce taxes of imported AI equipment and medicines -Provide soft loans	Ministry of Industry and Agriculture; AI laboratories and Research institutions; Animal technicians and professionals	- AI equipment and medicines	-Availability of AI equipments and medicines
Insufficient legal framework	1	Legal	-Insufficient legal framework toward adaptation of livestock to climate change and desertification -Inadequate regulatory framework for pasture usage and management - Lack of access to the quantity and quantity of animal feed necessary to support improved breeds in the Mongolian livestock production environment	Pasture usage and management law should be developed based on regional pasture characteristics	The Parliament, Ministry of Finance, Ministry of Industry and Agriculture, Ministry of Environment and Green Development, Pasture management research institutions, NGO on Pasture usage and management	-Establish taxation policy on pasture usage -Control animal numbers regarding to carrying capacity of pasture -Implement projects and programs to restore and improve pasture using fund gathered from pasture taxes;	Controlled animals numbers and improved pasture management
Poor infrastructure	3	Market failure/ imperfection	-Lack of access to tried and tested improved breeds -Lack of demand for higher quality meat products, which would encourage the adoption of improved breeds	-Support to establish private model farming of high quality local breeds and produce semen -Establish Semen Bank of high quality animals	-Herders, private enterprises who breed high quality breeds -Research institutes - Ministry of Finance, Ministry of Industry and Agriculture	-Support organizing fair trade of male animals -provide financial support to establish animal semen bank and genetic pool	Availability of semen and male animals of high production
Lack of willingness	2	Social, cultural and behavioral	-Reluctance of herders to invest in breed improvement (preference to increase animal numbers)	-Awareness raising through different channels including media -Taxation policy which support high quality breed and reduced number of animals	-Herders, private enterprises who breed high quality breeds -International donor agencies, -Ministry of Industry and Agriculture, University of Agriculture, International and national training centers, *aimag* extension centers		-Specialized extension services to assist herders willing to invest in improved breeds are needed-
Lack of information	3	Information & awareness	-Insufficient knowledge and willingness of herders regarding to high quality animals	-Awareness raising through different channels including media -Government subsidy to support high quality breeds	-Training centers -public media-	Knowledge about high quality breeds	Knowledge and willingness of herders to breed high quality animals

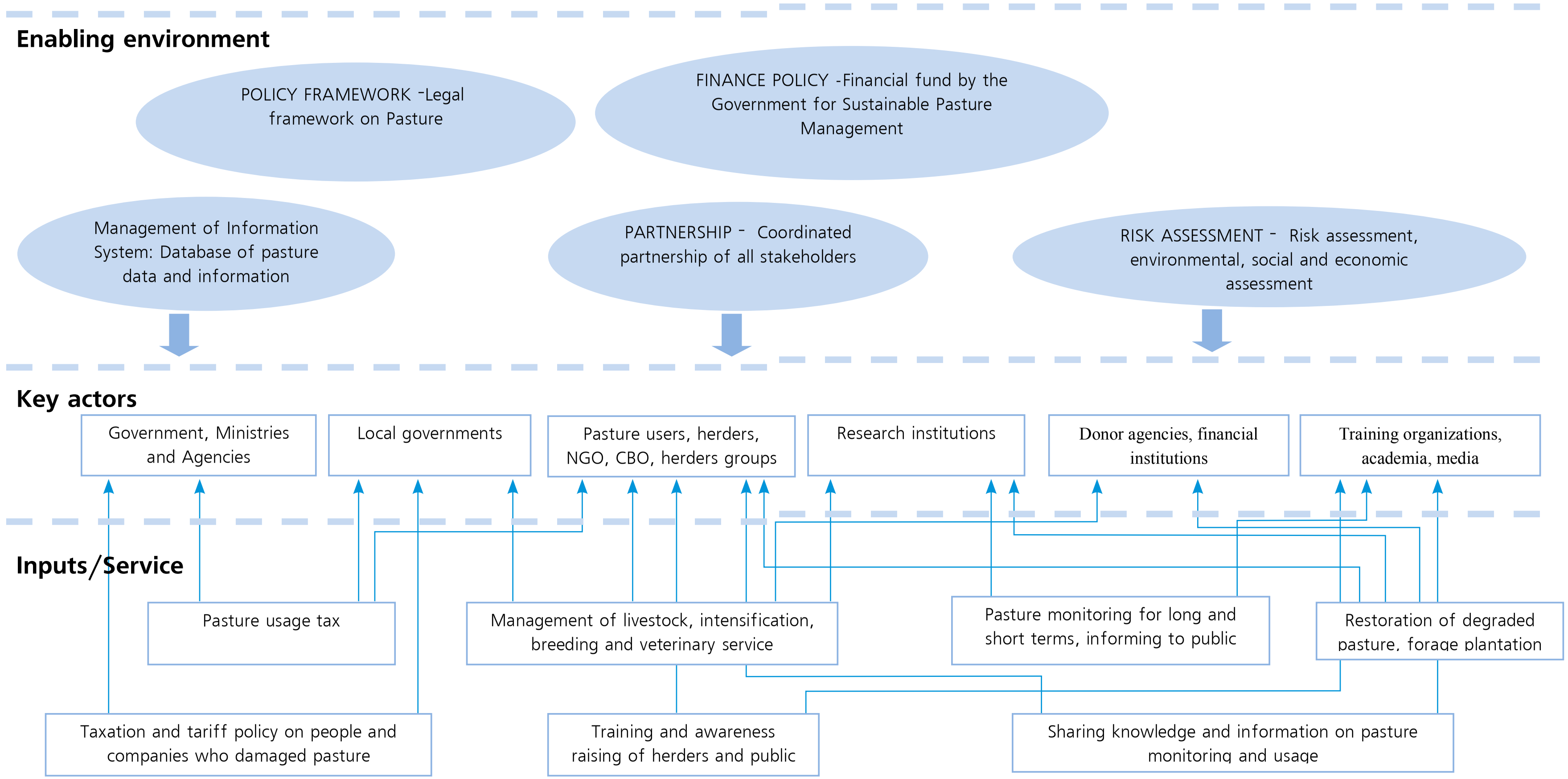
A4.5.2. Marker mapping – HQL



A4.5.3 Problem tree –HQL



A4.6.1 Market mapping of SPM



ANNEX 5: LIST OF STAKEHOLDERS AND THEIR CONTACTS

Sector/ Technology	Expert/ Stakeholder Name	Organization	Approach of consultation	Time	Topic
Key experts:					
Leader	Dr. P.Gomboluudev	Institute of Meteorology and Hydrology; p_gombo@hotmail.com	Leading and supervising all activities	Daily	Barrier analysis and enabling environment
Agriculture/ Arable Farming	B.Bolortsetseg	Climate Change, Nature and Society NGO; ccnsMongolia@gmail.com	Leading Agriculture Working Group	daily	Barrier analysis and enabling environment
Arable Farming	Dr. G.Davaadorj	Project of Desertification and Mitigation, Swiss Development Agency; GDavaadorj2001@yahoo.com	Key consultant	Every week	Barrier analysis and enabling environment for Arable farming 3 technologies
Water	Dr. G.Davaa	Water sector, Institute of Meteorology and Hydrology, watersect@yahoo.com	Key consultant	Every week	Barrier analysis and enabling environment for Drip irrigation
Pasture	B.Erdenetsetseg	Agriculture sector, IMH, erdtsetseg@yahoo.com	Key consultant	Every week	Barrier analysis and enabling environment for Animal husbandry 2 technologies
Natural disaster	Dr. L.Natsagdorj	Consultant, IMH, natsag03@yahoo.com	Key consultant	Every week	Barrier analysis and enabling environment for Early warning & policy fact sheets
Policy analyst	L Oyunjargal	Head of division IMH	Meeting	Monthly	Analysis of related policies and fact sheets
Arable Farming	Dr. G.Bayarsukh	Research Institute of Planting and Arable Farming, National University of Agriculture; bayar67@yahoo.com	Workshop and meeting	Monthly	Barrier analysis and market map for agriculture technologies
Animal husbandry	Dr. Togtokhnyam	Director of Research Institute of Animal Husbandry	Workshop and meeting	monthly	Barrier analysis and market map for livestock technologies
Animal husbandry	Dr. P.Gankhuyag	Head of Livestock Policy Sector, Ministry of Industry and Agriculture,	Workshop and meeting		Barrier analysis and market map for livestock technology
Water	Dr. T.Oyunbaatar	Water sector, IMH,	Meeting	Once a month	Barrier analysis and market map & enabling environment
Water	Dr. Sh.Baranchuluun	Head of Water Departmenr, Ministry of Industry and Agriculture	Meeting	Once a month	Barrier analysis and market map for drip irrigation technology
Desertification	B.Bayarbat	Coordinator, National Committee for Combating Desertification	Workshop and meeting	Every month	Barrier analysis and market map for livestock technologies
Pasture management	D.Bulgamaa	Researcher, Green Gold project; bulgamaa@greengold.mn	Workshop and meeting	Every month	Barrier analysis and market map for livestock technology
Land	J.Davaabaatar	ALACGAC, Head of the Land issues department; jdavaabaatar@yahoo.com	Workshop discussion	1 time	Barrier analysis and market map for agriculture technologies
Pasture management	B.Enhmaa	ALACGAC, specialist; Enkh1106@yahoo.com	Workshop and meeting	2 times	Barrier analysis and market map for agriculture technologies
Pasture management	S.Enhbold	Project of Desertification and Mitigation, Swiss Development Agency	Workshop and meeting	2 times	Barrier analysis and market map for livestock technology

Agriculture/ Livestock	Ts.Batzaya	Rural development specialist, Project of Desertification and Mitigation, Swiss Development Agency	Workshop and meeting	2 times	Barrier analysis and market map for livestock technology
Desertification	N.Mandah	Desertification Study Center, IGE, reseacher	Workshop and meeting	2 times	Barrier analysis and market map for livestock technology
Pasture	Dr. D.Ariungerel	LEWS project, MercyCorps; ariunregel@yahoo.com	Workshop and meeting	2 times	Barrier analysis and market map for livestock technology
Agriculture/ Livestock	B.Erdenebaatar	Expert, Policy Research Center	Workshop and meeting	2 times	Barrier analysis and market map for livestock technology
Pasture/ remote sensing	Dr. M.Erdenetuya	Specialist, Environment Information Center; m_erdenetuya@yahoo.com	Workshop and meeting	Every month	Barrier analysis, market map & enabling environment
Arable farming	T. Tuvshinzaya	Bayantsogt Company; wheat and vegetable farming, Tuvaimag	Interview and discussion	1 times	Barrier analysis and market map for agriculture technologies
Agriculture	S.Tsogoo	Greenhouse company, agriculture supplier	Interview	1 time	Barrier analysis and market map for agriculture technologies
Arable farming	R.Byambasuren	Small scale farmer (vegetable and berry) in Khan-Uul district, UB	Interview and discussion	1 times	Barrier analysis and market map for agriculture technologies
Disaster management	D.Turbat	National Emergency Management Agency	Workshop and meeting	2 times	Barrier analysis and market map for livestock technology
Arable farming	Zandankhuu	Household gardening project manager, NGO	Interview and discussion	1 times	Barrier analysis and market map for agriculture technologies
Arable farming	Lopilmaa	Household gardening project coordinator, NGO	Interview	1 time	Barrier analysis and market map for agriculture technologies

ANNEX 6: POLICY FACTSHEETS

National Programme for Food Security (2009–2016), Resolution No 32, the Government of Mongolia, 02 Feb 2009

POLICY: Name of Policy	**National Programme for Food Security (2009–2016),**
Name of field:	
Date Effective:	04 February 2009 by the Government resolution #32/2009 Updated in 2011 April 11 by the Gov't resolution # 114
Date Announced:	Feb 2009
Date Promulgated:	04 February 2009
Date Ended:	Dec 2016
Unit:	Climate change: Agriculture: Food security
Country:	Mongolia
Year:	2009
Policy Status:	In force
Agency:	Ministry of Food, Agriculture and Industry
Funding:	Public and private funding Public funding will be done through annual budgeting process. Funding from the Government was 752.1 million *Tugrugs* from 2009-2011. In 2011, 210 million *Tugrugs* were spent for the program.
Further Information:	English: http://gafspfund.org/gafsp/sites/gafspfund.org/files/Documents/Mongolia_5_of_9%20National%20Food%20Security%20Programme.pdf
Enforcement:	Yes
Penalty:	No
Related Policies:	
Policy Superseded by:	
Policy Supersedes:	
Stated Objective:	Can include items such as: Climate change mitigation; Market transformation; Advancing industrial competitiveness; Commercial viability; Securing new revenue; etc.
Evaluation:	Monitoring report is in Mongolian: http://www.mofa.gov.mn/mn/images/stories/tailan/2011/162011.pdf
Policy Type:	National program
Policy Target:	Policy targets are followed: *2009-2012* *2013-2016* **Objective 1:** Create enhanced enabling legal, economic and organizational environment for ensuring food supply, quality and safety -Investment, loan, insurance and leasing services for ensuring food security shall be increased by no less than 2.5 times than 2007; -Products of food processing plants will be increased by 30 %than in 2007; -Food safety inspection structure and organization will be restructured and based on integrated methodology, management and information system; -Inspection over food quality, hygiene and sanitation will be upgraded up to the international standards; -Food security assessment will be conducted in accordance with the international methodology and the national standards and outcomes will be transparent to the public.

Policy Target:	**Objective 2.** Stable supply of the population with nutritious, secure and accessible foods and increase the proportion of the industrially processed food in overall consumption -The # of dairy farms in pre-urban zones will be increased up to 8,0 thousand and the milk processing factories will process and sell at least 20,000 tons of milk for consumption of the population; -Meat production will be increased by 35% than in 2007 and 50.0 tons of meat will be industrially processed, and 20.0 thousand tons of meat sent to export, including 10,0 thousand tons of meat purchased from intensified meat farms; - The country will achieve full self-sufficiency in meat, milk, flour, potato and vegetables, while domestic production will meet 65-70% of demands for egg, 15% for butter, 15% for fish and 5-10% for vegetable oil; -Emergency reserves of flour, rice, sugar will sufficient for 10-14 days and strategic food wheat reserve will be increased up to 30-35% in the total consumption, and their locations will be optimized and supply and prices of wheat will be stabilized; -Irrigated wheat fields will increase up to 53.0 thousand and this will enable harvesting not less than25 percent of wheat production from irrigated fields; -Varieties of agricultural crops will be diversified and the number of rotations will be increased while fields of pure fallows are reduced by 20%; -Technological updates of food processing factories will be made and 30% of meat consumption and 20% of milk consumption of urban and settlements will be industrially processed; at least 2 % of the total number of *soums* will be connected to the food wholesale network; -Annual supply of milk from pre-urban dairy farms will increase up to 40.0 thousand tons on average, and volume of industrially processed milk will be doubled in 2012; -Total meat export will achieve 38.0 thousand tons, and 60 % of meat supply of the population of cities and settlements will be processed industrially; -The country will become 100% self-sufficient in eggs and domestic production will supply 20% of butter consumption, 25% of fish, 15 % of berries, 5% of rice, and at least 40 %of vegetable oil; -The disaster reserve of flour will be sufficient for 20 days, rice and sugar for 15 days, and strategic wheat reserve will increase up to 25% of the total consumption; -In total, 30% of fertilizers used in crop sector and 20% of plant pesticide will be produced domestically, and 50% of trailer and towed aggregates and 70% of agricultural motorized machines will be replaced; -60-70% of the soums will be connected to the wholesale trade network and its branches; -At least 25 agro-processing complexes will be established around cities and settlements.
	Objective 3. Improve monitoring and information network to secure hygiene and safety of food products and drinking waters - Inspection over meat and milk origin, hygiene and sanitation will be improved; - Preliminary inspection system of food imports will be improved; -Integrated inspection system of control over every technological phase, including production of food raw materials and ready-made products, will be established; - At least 20% of farms and food producers and service providers will acquire Good Agricultural, Industrial and Hygiene Practices; -Inspection and sensing studies of heavy metals, toxic chemicals in food raw materials and end products will be improved. - Internal inspection system will be introduced in every food processor and a regulation on withdrawal of food products that do not meet quality and safety requirement will be established and adhered to; - 60% of food plants will introduce Hazard Analysis Critical Control Point (HACCP), Good Hygienic practice (GHP) and Good Manufacturing practice (GMP); -At least 55 % of agricultural farmers will introduce Good Agricultural Practice; - Food borne communicable diseases will be decreased.

	Objective 4. Improve nutritious quality of food, supporting adequate, healthy diets and reduce nutrition deficiency, preventing from risk factors of non-communicable chronic diseases - Food and nutrition education curriculum and training standards will be developed and no less than 200 trainers will be trained; - Each *aimag* center and district in the capital city shall have at least 1 child health care resort and 1food education training cabinet established; - Production of fortified and functional food will be increased by 50% than in 2007; -Vitamin D deficiency among under-five year old children will be reduced by 1.2 times, malnutrition, anemia, Vitamin A deficiency and anemia among pregnant women will be reduced by 1.5 times, each, while goiter among children of 7-12 age will be reduced three folds; -Criteria of food deficiencies of social vulnerable groups will be implemented. - Among under five year old children, underweight will be reduced by 3.8%, stunting by 9.8%, wasting by 0.2%, Vitamin D deficiency by 25%, Vitamin A deficiency by 6%, anemia by 10.7%, while goiter prevalence among children between 7-12 ages will be decreased by 3%, Vitamin A deficiency among lactating women by 11.5%, anemia among pregnant women by 10% respectively, thus Mongolia will meet objectives of the Millennium Development Goals (MDGs) based Comprehensive National Development Strategy; -A serving size of the population which consume less than 5 units of fruits and vegetables a day will be reduced by half compared to 2012; -A national safety net system for support of the population shall be established.
URL:	English: http://gafspfund.org/gafsp/sites/gafspfund.org/files/Documents/Mongolia_5_of_9%20National%20Food%20Security%20Programme.pdf
Legal References:	
Description:	The overall goal of the programme is to provide the entire nation with stable supplies of accessible, nutritious and safe food to create healthy livelihoods and high labour productivity. The programme emphasizes the participation of the people, the government, and the public and private sectors. The Programme shall be implemented from 2009- 2016 in two phases: the first phase from 2009-2012; and the second phase from 2013-2016. There are four pillars: Create enhanced enabling legal, economic and organizational environment for ensuring food supply, quality and safety Stable supply of the population with nutritious, secure and accessible foods and increase the proportion of the industrially processed food in overall consumption Improve monitoring and information network to secure hygiene and safety of food products and drinking waters Improve nutritious quality of food, supporting adequate, healthy diets and reduce nutrition deficiency, preventing from risk factors of non-communicable chronic diseases

National Action Programme on Climate Change (2011–2021), Resolution No 317, the Government of Mongolia, 07 November 2011

POLICY: Name of Policy	**National Action Programme on Climate Change (2011–2021)**
Name of field:	**Environment, Agriculture, Livestock husbandry, Energy, Transportation, Health, Socio–economy**
Date Effective:	06 Jan 2011, Government resolution No 2, 2011
Date Announced:	Refers to when the relevant authority announced the policy
Date Promulgated:	06 Jan 2011, Government resolution No 2, 2011
Date Ended:	Dec. 2021
Unit:	**CC|RE|EE**
Country:	Mongolia
Year:	2011
Policy Status:	**In force**
Agency:	• National agency of meteorology and environment monitoring • The agency of National development and reform
Funding:	The state and local budgets, special funds (existing funds such as environment protection, rehabilitation, excise duties and new anticipated funds such as disaster risks, pasture, climate change adaptation fund and etc.), individual and organizations donations and international financial mechanism and funds. Additional funding required for the program implementation will be sought through establishment of special designated fund, international and regional projects, international financial mechanism and special international funds.
Further Information:	
Enforcement:	The implementation of the NAPCC requires a close coordination of policies for various sectors. The implementation of the identified measures also requires good coordination among ministries and agencies. The Government has established the inter-disciplinary and inter-sectoral *National Climate Committee (NCC)* led by the Minister for Nature, Environment and Tourism to coordinate and guide of national activities and measures aimed to adapt to climate change and to mitigate GHG emissions. High level officials such as Deputy Ministers, State Secretaries and Director-Generals of the main Departments of all related ministries, agencies and other key officials are members of the NCC.
Penalty:	None
Related Policies:	This provides the user with links to other entries in the database. Helpful if you can provide the name of the policy, this is added manually by the database manager.
Policy Superseded by:	
Policy Supersedes:	National Action Programme on Climate Change (2000-2015)
Stated Objective:	Climate change mitigation; Advancing industrial competitiveness; etc.
Evaluation:	Department of Public administration and Management of Ministry of NGD has a responsibility of control and monitor the implementation of the programme. According to its unofficial report, by Sept.2012, an accomplishment thewhole action plan is 17%, and plan for 2012 is 90%.
Policy Type:	National Program

Policy Target:	Policy targets are followed: ***2011–2016*** ***2017–2021*** Strategic objective 1 **– 'Set up legal, structural and management systems that support measures against climate change'** Strategic objective 2- **"Ensure ecological balance and reduce socio economic vulnerabilities and risks step by step through strengthening of national adaptive capacity to climate change**: Within the objective framework, the below measures will be taken in order to implement conservation policy of water and forest resources; increase carbon sinks, improve adaptive capacity of vulnerable socio economic sectors, reduce risks of atmospheric disasters and improve management of actions. Strategic objective 3 **– "Mitigate GHG emission step by step and set up low carbon economy through introduction of environment friendly technologies and improvement of effectiveness and efficiency":** To achieve the objective, the following measures to abate greenhouse gas emissions by human actions will be conducted along with activities of environment pollution reduction, improvement of energy production and efficiency and environment friendly technologies Strategic objective 4 – **"Enhance national climate observation network, research and assessment"**: Within framework of the objective, strengthening of hydrology, meteorology, forest, pasture and biome observation networks, enhancing assessment and studies of climate change, its impacts on environment and socio economic sectors, risk research, adaptation and mitigation measures will be conducted based on the best scientific knowledge and practices. Strategic objective 5- "**Conduct public awareness and support citizen and community participation in actions against climate change":** To achieve the objective, transformations in traditions and culture due to changing environment will be supported through wide dissemination of scientific information and knowledge about climate change and active participation of individuals and communities in responsive actions to climate change
URL:	Link to the website of the relevant agency, preferably to a page where the policy is outlined/described. Please make sure to modify if this has changed, or link is no longer active.
Legal References:	Legal framework of development and implementation of NAPCC are the Constitution of Mongolia, the Concept paper of national security, the Millennium development goals based comprehensive sustainable development strategy, Strategy of ecology of Mongolia, Development strategy of Mongolia, National strategy of sustainable development, Strategy of Food and agriculture, Strategy of herders of Mongolia and other national programs, and international laws and conventions ratified by Mongolia such as UN Framework convention on climate change, Kyoto protocol, UN convention to combat desertification, and Convention on biological diversity.
Description:	Goal of the program is to ensure ecological balances, development of socio economic sectors adapted to climate change, reducing of vulnerabilities and risks, mitigation of GHG as well as promoting economic effectiveness and efficiencies and implementation of 'Green growth' policies. NAPCC is strategic plan of policy founded on active engagement of all stakeholders, including individuals, government organization, and non-government organizations. NAPCC will be implemented in two phases in the period of 2011 to 2021. In the first phase(2011-2016), national mitigation and adaptation capacities will be strengthened, legal, structural and management systems will be set up and community and public participation will be improved. In the second phase (2017-2021), climate change adaptation measures will be implemented and start up greenhouse gas mitigation actions.

'Water' National Program, Resolution No 24 of the Parliament, 24 May 2010. Mongolian version

POLICY: Name of Policy	**'Water' National Program**
Name of field:	**Content**
Date Effective:	20 May 2010
Date Announced:	Refers to when the relevant authority announced the policy
Date Promulgated:	20 May 2010, Resolution No 24 of the Parliament
Date Ended:	June 2021
Unit:	**CC|RE**
Country:	Mongolia
Year:	2010
Policy Status:	**In force**
Agency:	
Funding:	Public funds, special funds (existing funds such as environment protection, rehabilitation, excise duties and new anticipated funds such as disaster risks, pasture, climate change adaptation fund and etc.), individual and organizations donations and international financial mechanism and funds. Public funding will be done through annual budgeting process.
Further Information:	http://www.dauriarivers.org/pdf/ 2010National%20Water%20Program%20Action%20Plan-eng.pdf
Enforcement:	The implementation, coordination, and evaluation of the program are led by Water National Committee, which headed by the Minister for Nature and Green development.
Penalty:	If there are any penalties for non-compliance with the policy
Related Policies:	This provides the user with links to other entries in the database. Helpful if you can provide the name of the policy, this is added manually by the database manager.
Policy Superseded by:	None
Policy Supersedes:	None
Stated Objective:	Can include items such as: Climate change mitigation; Market transformation; Advancing industrial competitiveness; Commercial viability; Securing new revenue; etc.

Evaluation:	The supervision and monitoring of the program implementation will be National security council, headed by the president. The state central administrative authority in charge of environment issues shall have the responsibility for implementation of the program. The evaluation criteria of the implementation of the program are clearly defined in the program.
Policy Type:	National Program
Policy Target:	**Objective 1.** To create conditions for accumulation of water resources, provision of potable water that meets the requirements of health standards, improvement of water supply for industry and agriculture to provide an environment for sustainable development; **Objective 2.** Establishment of a water resource and quality-testing network, covering all territories, which has constant and continuous operation and uses new technology to provide efficient information and management; **Objective 3.** To create conditions for the accumulation of water resources, provision of potable water, which should meet the requirements for health standards by improving water supply for industry and agriculture in order to provide sustainable environmental development; **Objective 4.** Proper use of water resources and water conservation; adopt and implement advanced technology for recycling wastewater treatment plants, prevention of flood disaster; and provide support to the activities and initiatives within the legislative framework; **Objective 5.** To advance water resource use and management, develop a legislative environment, and institutional development to coordinate and develop water usage capacity building; **Objective 6.** To publicize information on water resources and their proper use, using advanced technology enriched with customs and traditions, to young people and citizens
URL:	Link to the website of the relevant agency, preferably to a page where the policy is outlined/described. Please make sure to modify if this has changed, or link is no longer active.
Legal References:	The 3rd strategic objective of the Millennium development goals - based comprehensive sustainable development strategy, approved by Parliament resolution No 12, 2008 is a main reason of a development of the program. http://www.mongoliandream.mn/index.php?option=com_content&view=article&id=18&Itemid=335&lang=en
Description:	Goal of the program is to implement government policy to ensure healthy and safe environment for citizens of Mongolia as preventing from water shortage and pollution, creating proper use of potential resources event as well as making it key component of a development. The implementation of the program requires an active engagement of all stakeholders, including individuals, government organization, and non-government organizations. The program will be implemented in two phases in the period of 2011 to 2021, including an active development phase (2010-2015) and a sustainable development phase (2016-2021).

National Livestock Program of Mongolia, 20 May 2012

POLICY: Name of Policy	**National Livestock Program of Mongolia**
Name of field:	**Livestock husbandry**
Date Effective:	20 May 2010
Date Announced:	Refers to when the relevant authority announced the policy
Date Promulgated:	20 May 2010, resolution No23
Date Ended:	Dec. 2015
Unit:	**CC**
Country:	Mongolia
Year:	2010
Policy Status:	**In force**
Agency:	Name of relevant agency or agencies; please note any name changes.
Funding:	The program will use the following financial resources for implementation: State budget; local budget; investment of domestic and international enterprises; and foreign countries and international organizations grants and credits.
Further Information:	Provide a link to a more comprehensive documentation, for example the policy document in question, or the entire text of a law or regulation.
Enforcement:	If any particular enforcement provisions, institutions etc.
Penalty:	If there are any penalties for non-compliance with the policy
Related Policies:	National Development Strategy based on MDG State policy on Herders Main direction of reforming legal framework until 2012 Government Action Plan 2008-2012
Policy Superseded by:	None
Policy Supersedes:	None
Stated Objective:	Can include items such as: Climate change mitigation; Market transformation; Advancing industrial competitiveness; Commercial viability; Securing new revenue; etc.
Evaluation:	The supervision and coordination function of the program will be the national committee, headed by a member of Cabinet of the Ministry of Food, Agriculture and Light industry. • Program implementation reports shall be submitted by *aimag*, city and *soum* professional organizations to the central government administration by January each year. Central government administration shall deliver reports to Cabinet and State Great *Khural* (Parliament) during the first quarter of each year. • Program implementation reports shall be submitted by *aimag*, city and *soum* professional organizations to the central government administration by January each year. Central government administration shall deliver reports to Cabinet and State Great *Khural* (Parliament) during the first quarter of each year. • State administration will undertake control and analysis during program implementation and the Government has the responsibility for reporting program implementation results. • If necessary, a third party could monitor program progress and report to Government.

<table>
<tr><td>Policy Type:</td><td>National Program</td></tr>
<tr><td>Policy Target:</td><td>Within first priority, below stated objectives and activities will be implemented.
Ensure the sustainable development of the livestock sector and create a legal environment that will promote economic turnover.
• Improving the legal framework of the livestock sector
• Strengthening veterinary and breeding services at the local level and bringing services to international standard
• Improve knowledge and education of professionals and herders and introduce an advanced technology
Within the second priority, below stated objectives activities will be implemented.
Improve traditional livestock practices, develop rational livestock herd structure, improve animal breeding services to increase production and improve economic efficiency.
1. Create core (nuclear or stud) animal herds of productivity for a specific type of animal and implement scientifically based selective breeding that uses the full biological potential of Mongolian livestock.
2. Protect the livestock gene pool and introduce advanced biotechnological measures to increase animal productivity
3. Strengthen livestock breeding services and improve access and results
4. Creating an animal registration database and network
Within the third priority, below stated objectives and activities will be implemented
Create an environment where consumers will be guaranteed to receive clean and safe raw and processed products with healthy livestock origin.
1. Early prevention measures, increased preparedness to combat against and prevent infectious animal diseases that are banned for international trade.
2. Bring the veterinary service structure to international standard; strengthen the capacity of veterinary services to the level that can fully meet consumers' demands and requirements.
3. Bringing livestock medicine and veterinary tools to international standards
Within the fourth priority, below stated objectives and activities will be implemented.
Responding to pressures of climate change, social development trends and economic demand, Mongolia will reduce livestock sector vulnerability through extensive livestock management as the dominant form of pasture management, developing intensive production within limited regions by ensuring sustainable use of pasture, and through possessing, improving, protecting and rehabilitating degraded range land.
1. Improving pasture management
2. Increasing fodder and hay production
3. Improve livestock water supply
4. Create livestock risk management capacity
Within the fifth priority, below stated objectives and activities will be implemented.</td></tr>
<tr><td></td><td>1. Develop targeted markets for livestock and livestock products, establish proper processing and marketing systems and increase economic turnover.
2. Create and implement an economic lever to provide incentive for the production of quality livestock products and raw materials
3. Modify and develop livestock industry marketing to capture the intended market</td></tr>
<tr><td>URL:</td><td>http://www.mofa.gov.mn/mn/images/stories/busad/mmeng.pdf
http://www.gafspfund.org/gafsp/node/603</td></tr>
<tr><td>Legal References:</td><td>The Millennium development goals - based comprehensive sustainable development strategy, approved by Parliament resolution No 12, 2008. http://www.mongoliandream.mn/index.php?option=com_content&view=article&id=18&Itemid=335&lang=en</td></tr>
</table>

Description:	The purpose of the program is to develop a livestock sector that is adaptable to climate change and social development and create an environment where the sector is economically viable and competitive in the market economy, to provide a safe and healthy food supply to the population, to deliver quality raw materials to processing industries, and to increase exports. The following priority areas were identified for implementing the above mentioned aim: • Drawing special attention from the State to the livestock sector as the main traditional economic activity of the country, to assist in the formulation of a favorable legal, economic and institutional environment for sustainable development, and to develop a good governance in the livestock sector; • Improving animal breeding services based on social need/demand, increasing the productivity and production of high quality, bio-clean livestock products and raw materials and increasing market competitiveness; • Raising the veterinary service standard to international levels and protecting public health through securing Mongolian livestock health; • Developing livestock production that is adaptable to climatic, environmental, and ecological changes with strengthened risk management capacity; and • Developing targeted markets for livestock and livestock products; establishing proper processing and marketing structures and accelerate economic turnover through an incentive system. The program will be implemented in two phases from 2010-2021. The first phase (2010-2015) of the program will be also implemented in two sub-phases. **The first phase (2010–2015) will achieve the following outcomes from the five priority areas** • Establish favorable legal conditions that will promote the implementation of livestock sector related laws and organizational structures, expand production and economic growth through advancing production, concerted policy on technology transfer, preventing animal diseases and running animal breeding and treatment operations scientifically. • Set up a proper professional service provision structure; improve accessibility, quality and results of those services; Create an opportunity where the livestock sector will supply market responsive, quality and safe raw materials and increase export potential; and improve herder family income and self-sufficiency. • Keep certification from the World Organization for Animal Health regarding Mongolia's disease free status for bovine contagious pleuro-pneumonia, sheep and goat pox, and bovine spongiform encephalopathy (BSE); gain official freedom from foot and mouth disease with 'vaccination not used' status in the western aimags. To eradicate brucellosis in cattle, camels and small ruminants, to eradicate glanders and equine infectious anemia in horses in western region and keep this disease-free condition. • Encourage managed possession and use of pastureland to increase production of hay and fodder; upgrade livestock water supplies; establish livestock industry's capacity to adapt to climate change by decreasing the exposure to risk. • Improve herders' living conditions through State policies related to the creation of market structures for livestock products and raw materials, and protection against falls in livestock product prices. **Second phase (2016–2021) will achieve the following outcomes** • Adopt a law on "Livestock husbandry development"; create a legal environment for support and encourage a structure of livestock husbandry industry development. • Register all livestock and create a database and monitoring structure regarding the origin of livestock, raw materials and products and information regarding their health and condition to supply healthy, natural products for the population and for export; improve conditions for enriching, preserving, protecting and the appropriate use of livestock genetic resources; provide domestic breeding products to satisfy internal demand instead of using imported products. • Upgrade the animal diseases information system regarding registering and informing on new and re-spreading diseases; improve laboratory capacity; provide bio-security status and produce vaccines and diagnostic devices for contagious diseases; create a network for supplying veterinary drugs and sharing equipment. Gain national brucellosis-free status in Mongolia.

Description:	• With regard to climate change, social development trends and economic demands create favorable investment and business conditions for development of the pasture and intensive livestock industries simultaneously; decrease the exposure to natural risk and increase the productivity of the livestock industry. • Fully process raw materials domestically and develop export oriented production in order to substitute imported products.

National Green revolution Program (increase household income)

POLICY: Name of Policy	**National Green revolution Program II**
Name of field:	**Agriculture**
Date Effective:	05 Aug 2004
Date Announced:	Refers to when the relevant authority announced the policy
Date Promulgated:	05 Aug 2004, Government resolution No 169
Date Ended:	2012
Unit:	**CC**
Country:	Mongolia
Year:	2004
Policy Status:	**In force**
Agency:	Ministry of Food and Agriculture
Funding:	The plan of funding sources were as followings: State budget -2856mil. Tug Local/aimag/ budget -48 mil.tug International organizations grants and credits -690 mil.tug Agriculture development fund -1316 mil. Tug Total- 4910mil.tug(~3.5 mil. $USD)
Further Information:	Green revolution program I http://www.forum.mn/res_mat/Green%20Revolution%20National%20Programme.pdf
Enforcement:	If any particular enforcement provisions, institutions etc.
Penalty:	If there are any penalties for non-compliance with the policy
Related Policies:	Green revolution program I http://www.forum.mn/res_mat/Green%20Revolution%20National%20Programme.pdf
Policy Superseded by:	None
Policy Supersedes:	None
Stated Objective:	Can include items such as: Climate change mitigation; Market transformation; Advancing industrial competitiveness; Commercial viability; Securing new revenue; etc.
Evaluation:	http://www.mofa.gov.mn/mn/images/stories/tailan/2010/nogoon.pdf According to evaluation of the program in 2010, overall program implementation is estimated as 91.9%. Percentage of program implementation in aimags varies from 64.0 to 92.0%. As a result of the program, farming family income is increased, and arable land is extended as well. Since commence of the program, 10355.2 mil. Tug. (~7.4 mil $USD) has been spent for the program implementation.

Policy Type:	National Program
Policy Target:	The objectives: • to use irrigation, tunnel, green house, and crop cover technology in urban family farming for planting potato, vegetable and berries, in order first to produce enough products to sustain the family, second to sell surplus products on market. • To lengthen a duration to consume fresh vegetable by planting vegetables in protected soil, and to increase crop by diversifying planting vegetable • To create environment to supply enough amount of early harvesting fresh vegetable to a market continuously • To get accustomed vegetable and berry farming family to use technology to save water of well, snow, and rain. • To increase supply of Green house and crop cover with design and type which are fit in Local environment, and of their materials such as black, white and clear mulches by importing and producing in domestically.
URL:	http://www.mofa.gov.mn/mn/images/stories/busad/mmeng.pdf http://www.gafspfund.org/gafsp/node/603
Legal References:	
Description:	The objective of the Program I were to facilitate increasing the population real income in comparatively short span of time through effectively using internal resources based on the principles of "if the citizen is rich then the country is rich" and by raising consciousness of environmental protection., training people in various skills as well as laying the foundation for intensive development of the country". The objective Program II is to ensure successes, achieved in the program I, to reduce a poverty and unemployment, and to increase a food supply by developing an irrigated farming for vegetable and fruit planting and family and small scale community soil farming. Expected outcomes of 'Green revolution' program II are followings: In 2005-2008: • A number of farming family planting potato, vegetable, and berry would be increased by not less than 30%, and crop production – not less than 25%, compared to current value. • To modify not less than 70% of family farming to irrigated family farming • To get 15% of total crop from protected soil. • To increase crop production per hectare by 25%. • To create 25-30 thousands of new job. • To increase income of family, participated in the program, by 25-30%. • In 2008-2012: • Family and small scale – farming for planting potato, vegetable, and berry became irrigated. • To get 30% of total crop from protected soil. • To increase crop production per hectare by 40% compared to crop production per hectare in 2004. • To supply 100% of total potato consumption and 70% of total vegetable consumption by domestic production. • Size of arable land in urban land will increase by 30%, crop production -50%, compared to that of 2004, and number of new jobs 15%, and family income 40%, compared to that of 2006. • Amount of crop harvested from protected soil will reach 60%, and supply 100% of domestic demand and will start to export. • Income of family farming will increase by 50%, number of new jobs- by 50-60 thousands, compared to those of 2004.

Mongolian Law of Livestock Breeding and Animal Health

POLICY: Name of Policy	**Law of Mongolia on Livestock Breeding and Animal Health**
Name of field:	**Content**
Date Effective:	07 Jun 2001,
Date Announced:	Refers to when the relevant authority announced the policy
Date Promulgated:	07 Jun 2001, amended 2002,2003,2005,2007,2010,2011
Date Ended:	
Unit:	**CC**
Country:	Mongolia
Year:	2001
Policy Status:	**In force**
Agency:	The state administrative organization in charge of livestock breeding and health, Centre of livestock gene pool, national , regional, aimag's, city's veterinary and breeding bureau, local service unit, veterinary laboratory, and Core herd breeding centre are main stakeholders of the policy.
Funding:	The state central and local budgets are stated to cover the following activities fees: • Expenses for prevention activities from foot-and-mouth disease , cattle plague, pig plague, sheep and goat pox, bird influenza, which are defined as emerging infectious diseases by international organization • Cost of bio preparation and medicine for prevention and diagnosis of serious viral and bacterial diseases in livestock such as Anthrax, Brucellosis, Salmonellosis, rabies, and etc. • Cost of medicine to prevent from livestock diseases • Expenses for activities to disinfect infected animals and 90% average cost of **slaughtered** animals • Expenses to create and operate a Gene pool of livestock • Wage and operational cost of veterinary, breeding center in aimag and city, the state administrative body in charge of veterinary and breeding, and national laboratory. • Expenses for activities concerned with classification, confirmation, registration, and creation of database and network of core herd and male animal used for breeding The local budgets are responsible to cover the following activities fees: • Service fee for prevention and diagnose of livestock disease such as Anthrax, Brucellosis, Salmonellosis, rabies, and etc. • Pay 40% average cost of **slaughtered** animals, which are infected • Expenses for inspection of activities of core herd breeding and improving livestock breeding by using advanced biotechnology and genetic engineering • Wage and operational cost of Local breeding centres. Rest of expenses should be covered by customer.
Further Information:	http://www.legalinfo.mn/law/details/314?lawid=314
Enforcement:	If any particular enforcement provisions, institutions etc.
Penalty:	Non-compliance penalties: • Persons in breach of the law shall be liable to criminal or administrative penalties in accordance with the nature and the amount of damage. • State inspector shall impose against a person in breach by the administrative penalties to fine for certain amount of money.
Related Policies:	National Livestock Program of Mongolia
Policy Superseded by:	If the policy has been superseded, this provides a link to the more recent policy
Policy Supersedes:	If the policy has superseded another one, it provides a link back to the previous policy

Stated Objective:	
Evaluation:	Inspection of the law implementation is carried out by state and local professional inspection agencies.
Policy Type:	Law of Mongolia
Policy Target:	Duties of an organization in charge of veterinary and breeding service: • Planning annual activities relating to prevention from animal disease, developing projects, and registering and reporting about the activities properly • To properly follow up technology and standards of veterinary and breeding service • To certify livestock products by checking and determining origin and health • To diagnose animal diseases • To provide information to and to improve knowledge of herders, and to carry out survey • To provide herders and entities by professional and methodological guidance and introduce advanced technology • To provide required condition to transfer, protect, and keep animal medicine, bio preparation and vaccine • To organize livestock fair, to raise stud male animal, and to run trading service Duties of the state administrative organization in charge of veterinary and breeding service: • To provide aimag's and city's veterinary and breeding service by professional and methodological guidance • To create information system relating to livestock breeding and health, and animal Gene and embryo fund • To assess risk of and to make economical estimation of activities for prevention from animal disease and breeding. • To make contract on veterinary and breeding service with International professional organizations, according to permission of the state administrative organization Duties of *aimag's* and city 's veterinary and breeding service and Core herds breeding centre: • To provide local veterinary and breeding units by professional and methodological guidance • To make contract on veterinary and breeding service with Governor of *aimags* and city • To carry out quality assurance testing on livestock products for export and import • To create high quality male core herd and to protect gene pool • To create database on origin of core herd and productivity, to produce breeding products, and to provide by veterinary tools to local service units according to the relating law and rule. Duties of local veterinary and breeding unit: • To regularly carry out local veterinary and breeding service • To make contract on veterinary and breeding service with Governor of soum and district • To do sanitation, disinfection, and prevention activities from animal disease • To select productive animal and core herd by testing local livestock, to carry out activities to improve livestock quality, and protect gene pool • To register and certify the highest quality animal, core herd, and male animal and to define quantity of productivity • To isolate and to treat infected animal, if necessary, to report a reason to put under quarantine and to slaughter to the Governor • To raise breeding animals which meet national standards, and to serve customers by breeding products
URL:	http://www.legalinfo.mn
Legal References:	Constitution of Mongolia http://www.legalinfo.mn
Description:	The purpose of the law is to regulate relations concerning protection livestock, their breeding, and health.

Pasture Law of Mongolia – under discussion

POLICY: Name of Policy	**Pastureland Law of Mongolia**
Name of field:	**Agriculture**
Date Effective:	Not endorsed under the discussion
Date Announced:	
Date Promulgated:	
Date Ended:	
Unit:	**CC**
Country:	Mongolia
Year:	
Policy Status:	**not endorsed under the discussion**
Agency:	The state administrative organization in charge ofAgriculture, Citizen's Representatives' Khural and Governors for the Aimag, Capital city, Soum and District take control over implementation of the Law.
Funding:	
Further Information:	
Enforcement:	
Penalty:	**Article 28. Liability for Violation of Legislation on Pastureland** 28.1. If the violation of the legislation on pasture land is not subject to Criminal Code, the Governor and environmental inspector shall impose the following penalties: - 28.1.1. If livestock is entered the fenced/protected pastureland, the quality people shall be subject to a fine up to twice to five times more of the minimum labor wages; 28.1.2. If the livestock is entered the *otor* reserve pastureland that is shared by *Aimags*, Sums, and Bags without any permits by violating *otor* regimes, the quality entity shall be subject to a fine three to six times more of the minimum labor wages; 28.1.3. If the livestock is entered the state and local fodder fund haymaking fields and hay makings conducted without any permits, the individuals will be subject to a fine three to eight times more of the minimum labor wages and the economic entities and organizations will be a fine of 10- 15 times more of the minimum labor wages; 28.1.4. In cases of breach of planning and procedures stated in the Article 11.2.6 of this Law, the individuals will be subject to a fine twice to five time more of the minimum labor wages and the economic entities and organizations shall be subject to a fine 5-10 times more of the minimum labor wages; 28.1.5. In cases, when buildings and facilities, fences and shelters, winter and spring settlements are constructed in common use pastureland without any permits, the individuals will be subject to a fine of three to eight times more of the minimum labor wages and the economic entities and organizations will be a fine of 10-15 times more of the minimum labor wages; 28.1.6. The pastureland possessor, who is unfulfilled the obligations stated in the Article 18.2 of this Law, the pastureland possessor shall be subject to a fine three to eight times more of the minimum labor wages; 28.1.7. In cases, when the prohibited activities stated in the Article 25 of this Law are conducted, the pastureland possessor and user will be subject ot a fine five to ten times more of the minimum labor wages.

Related Policies:	The legislation on pasture land shall consist of the Constitution of Mongolia, the Mongolian Law on Land, the Mongolian Law on Special Protected Areas, the Mongolian Law on Land Fees, the present Law and other legislative acts issued in conformity with them.
Policy Superseded by:	
Policy Supersedes:	
Stated Objective:	Climate change mitigation;
Evaluation:	UNDP, "Sustainable land management for combating desertification in Mongolia" project conducted the review on draft Pastureland law of Mongolia and gave recommendations.
Policy Type:	Law of Mongolia
Policy Target:	Rights of different entities are defined: Article 6. Plenary Rights of **Parliament;** Article 7. Plenary Rights of **the Government**; Article 8. Plenary Rights of **the State Administrative Central Organization in Charge of Agriculture**; Article 9. Plenary Rights of **the State Administrative Central Organization in Charge of land affairs**; Article 10. Plenary Rights of **Citizen's Representatives' *Khural* and Governors for the *Aimag*, Capital city, *Soum* and District**; Article 11. Plenary Rights of ***Aimag*, Capital City, Sum and District Governors**'; Article 12. Plenary Rights of ***Bag* and *Khoroo* Citizen's *Khural* and Governors**'. Debates are going on legal entity of herders groups and process to establish herders groups by different views.
URL:	http://mofa.gov.mn/coordination/index.php?option=com_2&view=item&id=46:review-o..
Legal References:	The legislation on pasture land shall consist of the Constitution of Mongolia, the Mongolian Law on Land, the Mongolian Law on Special Protected Areas, the Mongolian Law on Land Fees, the present Law and other legislative acts issued in conformity with them.http://www.legalinfo.mn
Description:	The purpose of this draft Law is to identify legislative basis and regulate the relations on the possession, use, protection, restoration of pastureland. The Draft Law contains a number of key legal and institutional elements (i.e. within the Articles) considered necessary for a law of this type, but, overall, the general structure and functionality of the Draft and much of the legal expression could be substantially improved by expanding current procedures; or expanding current procedures and adding additional procedures to close gaps and weaknesses within the Draft. This assessment is based on a detailed examination of the elements in the Draft as well as a comparison of these legal elements against the "standard" elements from the international legal guidelines for pastoral land management. The guidelines include principles and elements distilled from numerous relevant international environmental treaties and strategies and from the examination of many national laws. It is used as a worldwide "standard" for pastoral land law.

SECTION III

Technology Action Plans

EXECUTIVE SUMMARY

The Technology Needs Assessment (TNAs) for climate change adaptation in Mongolia has been a set of activities to identify and determine the adaptation technology priorities of the country. This document provides a report of the development of a national Technology Action Plan (TAP) that identified key sectors, prioritized technologies, recommended an enabling framework for the diffusion of these technologies.

Developing the TAP was a consultative process involving experts and stakeholders in identified key sector and prioritizing technologies, identifying key barriers, and outlining potential measures to overcome these barriers. The arable farming and the animal husbandry sectors were prioritized because they play crucial roles in the Mongolian economy and because a majority of people rely on agriculture for their livelihoods. Many of the government's development policies focus on sustainable development of the agricultural sector.

Seventeen potential technologies were identified and six were selected as key priority technologies.

Table 27: Prioritized sectors and technologies in the TNA, Mongolia

Prioritized sector	**List of prioritised technologies**	**Future Targets**
Arable Farming	System of wheat intensification (SWI)	SWI will target at least 80% grain producers, who are permanent farmers dealing with grain production. The technology diffusion will require at least 8-9 years and is expected to finish by 2021. Outcome of the full deployment of this technology will be national grain security and environment benefits.
	Vegetable production system with drip irrigation and mulches (VPS)	VPS technology will be applied for vegetable production and aims to target at least 50% of farm land under vegetable cultivation depending on availability of water resources and electricity for drip irrigation. Vegetable production system with drip irrigation and mulches will be tested in pilot sites selected for natural zones in 6 years. The full deployment of the technology for up-scaling it for 18 000 hectare will require 10 years and is expected to be completed by 2023.
	Potato seed production system (PSPS)	Potato seed production system will help to meet at least 80% of national demand with high quality of potato seeds by 2016-2018. Potato production is expected to increase at least 60% from the current level of production, which is 200 thousand metric tons.

Animal husbandry	Seasonal prediction and early warning system (SPLEWS)	Precise seasonal prediction and proper preparation for *zud*/ harsh winters would result in saving about 80% of animals which die every winter. In terms of geographical targets, people and communities of all areas will benefit from the technology diffusion which is expected to be completed by 2018.
	High quality livestock through selective breeding and animal disease management (HQL)	The technology is proposed to target all herders in the country through implementing selective breeding techniques and improved veterinary system. It is estimated that diffusion of this technology can cover at least 60 percent of the total 154 thousand herding families. Anticipated time frame for diffusion of the technology is about 6-8 years which is 2018-2020.
	Sustainable pasture management (SPM)	The technology is expected to target all 320 soums of Mongolia and at least 90 percent of herding families can benefit from it. The diffusion of the technology would enable the herders to manage pasture in better ways and reduce pasture degradation and desertification. The technology transfer and diffusion is intended to be done within 6-7 years and completed by 2018.

In Chapter 1 of the report, the arable farming sector is outlined has been briefed and five related national programs and legal documents are described. Then an overview of the three technologies is given, along with barriers, key measures, and an action plan developed through stakeholder consultation.

In Chapter 2 of the report, the animal husbandry sector is outlined and five related national programs and legal documents are described. Then an overview of the three technologies is given, along with barriers, key measures and an action plan which decided through stakeholder participation.

Chapter 3 provides analysis of cross cutting barriers and required measures for the arable farming and the animal husbandry sectors. The most common barriers for both sectors are: inadequate finances, poor policy, legal and regulatory framework, inadequate human skills, institutional and organizational capacity and lack of partnership. The most common key measures for the two sectors are: allocation of the government funding, tax exemption and soft loans, subsidy policy for environmentally sound and climate technologies, systematic capacity building, supporting research and development, and strengthening of international cooperation and networks.

1. Technology Action Plan for Arable Farming

1.1 Actions at sector level

Before 1990, crop production of Mongolia was self-sufficient and met the national needs of grain, potato and vegetable production, and the surplus productions were exported. In 1989, the country produced 8239 thousand metric tons of wheat, 156 thousand metric tons of vegetables, and 551 thousand metric tons of forage through centrally organized and subsidized cooperatives owned by the government (National statistics).

However, Mongolia started the shift towards free market economy in 1990 and state owned large cooperatives were privatized and disintegrated into small private farms. During the transition period, private farms were not able to function normally due to the insufficiency of financial and other resources. In 2007, crop production of the country could only meet 27.5% of the national flour demand, 88% of potato demand, 49% of vegetable demand and 1% of fruit demands (National Statistical Yearbook, 2007).

Whilst the country's economy has strengthened, the government launched several programs, including State Policy for Food and Agriculture Development (2003), National program of food security (2009), and Mongolian Potato Program (2004), Green Revolution Program to support development of the arable farming sector.

Table 28: List of policies and legal documents in arable farming sector

Policy Name	Date of enacted/ revised	Main content
National Programme for Food Security (2009-2016)	Enacted on 04 February 2009 by the Government resolution #32/2009 Revised on 2011 April 11 by the Government Resolution # 114	The National Programme for Food Security is being implemented from 2009 to 2016 in two phases. It has 4 main priorities and 13 objectives to ensure sustainable food security. Under four priority areas such as enabling environment, food security, food safety and nutrition, 27 high priority projects were summarized. Several of them were related to climate change adaptation. For example: meat production, milk production, irrigated crop production, crop diversification, renovation of crop equipment, prevention of food borne disease and drinking water supplies etc.
State Policy for Food and Agriculture Development (2003-2015)"	Enacted in 2003 by the Parliaments resolution #29/2003	The aim of the program was to ensure economy growth; to establish enabling environment for business development; to increase agriculture production; and ensure sustainable development of arable farming, animal husbandry and food security with green and ecology friendly products. It has 5 objectives and two phases of 2003-2008 and 2008-2015.

Project on The Mongolian Potato Programme (2004-2016)	In 2004 The first phase is accomplished.	Based on the achievements of the Phase-I/2004-2007/ and the foundation it created, the Government launched the Phase II-the Mongolian Potato Program for implementation from 2008 to 2016 with the aim to contribute to "better food security and nutrition and higher incomes through enhancing the productivity of the Mongolian potato sector". The programmes objective is that by the end of Phase-II, "potato producers have enhanced their yields and together with other supply chain stakeholders, make affordable potatoes available to all Mongolians, thus improving nutrition". The Program's expected outcomes are listed below: • Sustainable potato seed production systems are established, making seed of adapted varieties and of appropriate quality available to potato growers throughout Mongolia • The capacity of potato producers to obtain better economic returns is strengthened through participatory development and dissemination of appropriate production methods • Potato supply chains are improved and value-addition options are developed • The key stakeholders (from producers to consumers) improved their collaboration and capacity to organize and negotiate for favorable framework-conditions and policies conducive to resource-efficient production
National Program 'Green Revolution II'	Enacted on 05 August 2004 by the Government Resolution #169/2004	The Program II objective is to maintain successes achieved in the Program I, to reduce poverty and unemployment, and to increase food supply by developing irrigated farming for vegetable and fruit planting and family and small scale community land farming. The program proposes two-phases of implementation, 5 priority objectives and clearly defines the expected outcomes of the stated activities in each phase.
National Action Programme on Climate Change (2011-2021)	Enacted on 07 November 2011 by Resolution No 317, the Government of Mongolia	The program was updated in 2010 and its main goal is to adapt socio economic development, to reduce vulnerability and risks of different sectors, to support green economy development and growth through GHGs emission reduction. The program has two implementation phases. Climate change adaptation is one of the four strategic objectives of the program. The entity responsible for the implementation is the interagency and inter-sectoral National Climate Change Coordination Office (NCCO).

As a result of government policies and programs on crop production, development of arable farming has accelerated and farmers could produce sufficient wheat and potato to satisfy the domestic demands in 2012. Even though the total crop production has increased, the efficiency of arable farming sector and yield per hectare is still low. Climate change impacts, such as high temperature, uncertain and highly variable rainfall patterns, intense natural disasters combined with deterioration and dwindling of natural resources, emphasize the necessity of sustainable adaptation technologies to increase the productivity, stability and resilience of the arable farming sector.

The analysis of technology options for climate change adaptation in the arable farming sector in Mongolia was carried out through a participatory process, through compiling a list of all potential technologies available in the arable farming sector to cope with climate change. During the prioritization process, the Multi-Criteria Decision Analysis (MCDA) approach was used to rank the various technologies in order of their as potential to increase climate change. The MCDA process ranked nine identified adaptation technologies considering six economic, environment and social criteria as well as the implementation cost. The scoring system ranked System of Wheat Intensification, Vegetable Production System with drip irrigation and mulches and Potato Seed Production System, as the most promising technologies.

Table 29: Prioritized technologies in Arable farming sector

No	Prioritised technologies	Category of the technology[27]	Brief Description
1	System of wheat intensification (SWI)	Consumer Goods	SWI includes conservation tillage, crop rotation and holistic plant management with overall emphasis on holistic crop management.
2	Vegetable production system with drip irrigation and mulches (VPS)	Consumer Goods	VPS aims to intensify vegetable production through a set of water saving techniques such as drip irrigation, and low cost greenhouses or mulch.
3	Potato seed production system (PSPS)	Consumer Goods	PSPS comprises components of development of varieties, producing mini tubers or elite seeds, multiplying seeds, storage and delivery systems

Current level of deployment and future targets for each technology are described below:

- System of wheat intensification (SWI): There are about 1000 grain producers with approximately 500 000 ha of crop land[28]. Spring wheat is grown in agriculture regions which are mainly the northern and central parts of the country. In 2011, about 30 % of the total fallow was prepared through conservation tillage. Holistic plant management including rotating crops, seed treatments and others are not practiced. Therefore, SWI will target at least 80% grain producers who are permanent farmers. The technology diffusion will require at least 8-9 years and will be completed in 2021. The full deployment of this technology will bring grain security and environment benefits. SWI implementation will be divided into two phases: research and development phase for 4-5 years and expansion and diffusion for 3-4 years. In the first phase, the technology and its components will be studied, contextualized, tested and demonstrated. Capacity building and human resources will be ready for the second phase. In the second phase, the technology will be fully deployed as indicated in targets.
- Vegetable production system with drip irrigation and mulches (VPS): Today farmers grow vegetables on about 8000 ha of land excluding potato. Presently, 11.8% of cropland is irrigated in the country. However, drip irrigation has been applied to only 100ha of land, with support of international projects. Noticeably, water shortage due to climate change is becoming a significant challenge in all sectors, including agriculture. Wide application of drip irrigation can play a vital role in increasing agricultural production and water savings. VPS technology will be applied for vegetable plantation and to the application target is at least 50% of farm land depending on availability of water resources and electricity for drip irrigation. The full deployment of the technology will require 6-8 years and is expected to be completed by 2020.

27. Boldt, J., I. Nygaard, U. E. Hansen, S. Trжrup (2012). Overcoming Barriers to the Transfer and Diffusion of Climate Technologies. UNEP Risoe Centre, Roskilde, Denmark.
28. Overview of arable farming sector, Ministry of Industry and Agriculture, http://www.mofa.gov.mn/

- Potato seed production system (PSPS): In 2011, potato was planted in 14 600ha of land and the total harvest was about 200 000 metric tons in Mongolia. Since 2010, the domestic potato yield has been able to meet 100% of local demand. However, adapted varieties and seed production is not sufficient to increase yields. Mongolia has been piloting the raising of potato tubers in aeroponic systems since 2008. PSPS will help meet at least 80% of national demand with high quality potato seeds by 2016-2018. Potato production is expected to increase at least 60% over the current level of production.

Barrier analysis and enabling framework for the three prioritized technologies in the arable farming sector was done through a consultative process with stakeholders and key experts. In order to identify the barriers to the diffusion and application of technologies, literature survey, interviews, questionnaire, discussions at stakeholder workshops and key experts meetings were used. Then key barriers were prioritized and grouped into different categories, including economic and financial barriers and non-financial barriers. These barriers included policy/legal/regulation, human skills, institutional/organizational capacity, market failure, social/cultural/behavioural, network failure, technical and other barriers.

Common key barriers for the prioritized technologies were identified as followed:

- Inadequate finance: The most commonly cited barrier was the high cost of equipment, supplies and implementation for all three technologies. Mongolia has limited financial and human capacity to locally produce agriculture machinery, equipment and supplies, which have to be mainly imported from other countries. Limited access to long term and soft loans were identified as main barriers for the diffusion of System of wheat intensification (SWI) and Vegetable production system with drip irrigation and mulches (VPS). Inadequate funding was directly identified as a main barrier in the case of Potato seed production system (PSPS). Activities of the arable farming sector concentrated on a few months of the year in Mongolia so access to loan services from banks and micro-finance organizations are limited especially for small new enterprises and poor farmers due to high interest rates, required collateral and re-payment in short term.

- Insufficient policy framework: Policies affect implementation of measures in all three technologies. Subsidies and supportive fiscal policy by the government is needed to support climate and environmentally sound technologies. Tax exemption or deduction policy is required for agricultural equipment, supplies and systems in order to ensure affordability. Efficient enforcement of law of procurement of legumes in the State Emergency Fund is needed to support proper rotation system for cereals.

- Inadequate human skills: College and university curriculum do not sufficiently focus on climate change and adaptation technologies. Systematic development of professionals through the education system is a critically important part of R&D and the promotion technologies.

- Poor research and development: Research on climate change adaptation technologies and their practical applications is not sufficient. This leads to poor understanding and knowledge about climate change adaptation technologies and the improper application of herbicide and fertilizers by farmers and agriculture professionals.

The linkages of different barriers faced by the three prioritized technologies in the arable farming sector are analysed, so as to maximize synergies and optimize the effects of recommended measures. Proposed measures to overcome the common barriers are listed in Table 30.

Table 30: Key measures identified for the common barriers to prioritized technologies in arable farming sector

Common barriers	Technologies affected	Measures to overcome key barriers
Inadequate finance	SWI, VPS, and PSPS	• Set up financing mechanisms for specific technology packages • Import tax exemption of technology-related equipment and supplies and income tax deduction for local manufacturing of equipment and supplies and service providers • Introduce incentive packages for climate technologies
Insufficient Policy framework	SWI, VPS, and PSPS	• Establish consultative mechanisms with the representation of all stakeholders to initiate new set of policies supporting arable farming • Strengthen State Arable Farming Fund and improve its policies and business regulations • Set up legal and financial environment frameworks for professional consulting services at provincial and local levels • Develop insurance scheme for crop production
Inadequate human skills and knowledge	SWI, VPS, and PSPS	• Review current curriculum for agriculture specialist and strengthen them with climate change theories and practices • Develop training packages on climate change and adaptation technologies for different audiences including farmers, agriculture specialists of private enterprises and governments • Develop awareness raising packages for different audiences and conduct systematic awareness raising regarding to climate change impacts and promising adaptation technologies for public through media and press • Train MSc and PhD level researchers as future leaders in these aspects.
Poor research and development	SWI, VPS, and PSPS	• Increase support for public and private R&D institutions • Strengthen provincial agriculture extension centers to test and demonstrate climate technologies in local context and transfer knowledge and skills to farmers • Support researchers and specialists to study in overseas institutions and conduct research on climate technologies

1.2 Action Plan for System of Wheat Intensification

1.2.1 About SWI

Wheat flour is a major staple food for Mongolians. During the transition period of 1990-2000, the wheat system struggled to survive due to financial and management issues. As a result of government investment in recent years, Mongolia was able to increase its total wheat production and meet grain demand for the past two years. However, there is an urgent need for adaptation technologies in wheat production system to minimize potential losses in wheat production, because future climate change impacts and environment degradation can hinder the development of sustainable and resilient wheat production systems.

SWI consists of conservation tillage and holistic plant management, with an emphasis on wheat root management to achieve economically, ecologically and socially sustainable agricultural production. Conservation tillage ensures permanent soil cover and minimal soil disturbance, slow water flow, reduces the amount of soil erosion. In the pilot project on conservation tillage in Mongolia, tillage operations were significantly reduced for cropping (Silke H and others, 2006).

Holistic plant management consists of nutrient and water management, root treatments, and crop rotation. Crop rotation is the practice of growing a series of dissimilar types of crops on the same piece of land in sequential seasons. Crop rotation can generate various benefits to the soil and eliminates the build-up of pathogens and pests that often occur when the same species is continuously planted on the same piece of land for multiple years. It can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants.

In the 1980s, several experiments on crop rotations were conducted in Mongolia using different combinations and rotations of crops including fallow, wheat, oats, barley and peas. But the experiment did not continue during the transition period from 1990-2010. Today more research and experiments in crop rotations are needed. Incorporation of livestock in crop rotation cycles is possible when forage plants are planted. But in Mongolia crop farms do not have the appropriate knowledge and skills for crop rotation, including seeds of legume varieties which can grow well and produce high yield under the Mongolian soil and climate conditions. More research on rotation systems in irrigated planting has only started recently in Mongolia.

SWI through conservation tillage and holistic plant management is a technically viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability.

1.2.2 Targets for SWI

System of wheat intensification will target at least 80% of the grain producers who are permanent farmers dealing with grain production. The technology transfer and diffusion will require at least 8-9 years and will be completed by 2021. By 2021, about 300 thousand ha (60% of the total) of crop land will be farmed by conservation tillage and rotation system of SWI technology. The full deployment of this technology will ensure national grain security and environment benefits.

1.2.3 Barriers to SWI

Economic and financial and non-financial key barriers were identified with key experts and stakeholders.

Table 31: Key barriers identified for SWI

Barrier sub/ category	Key barrier	Brief description of barrier
Economic and financial	High cost of techniques and supplies	The wheat system requires herbicide, fertilizers, seeds of legumes, harvesting techniques. There are few importers of techniques and supplies, and no manufacturing in the country. Importing companies' capacity is limited and cannot meet the demands of grain producers. If legumes are used as rotated crop, additional technique will be required to install in current harvesting machinery.
	Limited financial capacity of grain producers and importers	Limited financial capacity of grain producers to provide up payment to importers: Grain producers struggle to pay loans within given short period because national flour mills have been saturated with grains and the Government procurement and subsidy provision is delayed due to political and macro-economic reasons.
Non-financial		
Policy, legal, regulatory	Lack of incentive policy	There is no incentive policy for grain producers to apply climate adaptation technologies. Presently, subsidy per metric tons of wheat from the Government exists. Now national demand has been met in the past 2-3 years, so the Government needs to focus on more environmentally sound and climate technologies such as conservation tillage, drip irrigation, rotation and etc.
Human skills	Insufficient human resource and professionals	Many private companies engaged in cereal growing do not have professionals with an understanding of soil, environment and agriculture sciences.
	Limited knowledge on the technology and practices	There is limited knowledge and skills to use techniques, crop rotation, fertilizers and herbicide. Long term impacts of chemical usage are not known by farmers.
Institutional, organizational capacity	Lack of adaptive research and foundation research capacity	Demonstration and experiment of environmentally sound and climate change adaptation technologies are not well considered and underdeveloped. Fallow processing options and long-term consequences of using fertilizers and herbicide are not available within the country context. Especially, environmental impacts are ignored and not studied yet in detail.
Market failure	Low quality of agriculture techniques and supplies	Farmers do not have sufficient confidence in the application of new techniques and technologies.
	Limited access to international market	During the last two years, Mongolia produced more grain than national demand. However, the government and private enterprises struggled to sell the surplus due to lack of skills and experience to access to international market. Mongolian grain products are not known by international consumers.
	Inadequate infrastructure	At provincial level there is no supplier of agriculture techniques, herbicide and others and maintenance service of techniques. These lead to high costs and considerable risks to grain producers to buy advanced techniques and materials.
	Lack seed bank of legumes	Legumes seeds availability is limited to supply grain producers because legumes are not planted as rotated crop in large scales. Therefore legumes production market is not developed in the country.

Social, cultural and behavioural	Conflict between animal husbandry and arable farming	Animals graze on cropland during non-growing season. Conservation tillage requires vegetation coverage throughout the year. Not all crop land can be protected with fences.
	Low demand of legumes	Demand of legumes at local market is low because Mongolians are not used to consuming legumes for food and use as animal forage. Access to international and other countries markets is limited to export legumes.
Information and awareness	Inadequate information about legumes	Population including herders lack information and knowledge of legumes benefits.
Network failure	Poor coordination between key actors	Poor coordination between key actors, such as grain producers, Arable Farming Support Fund[29], importers, State inspection agency, Ministry of Environment and Green Development, research organizations as well as provincial agriculture extension centres exists in the country.
Technical	Lack of standards for imported techniques and supplies	There is lack of standards for imported techniques, supplies and chemicals as well as for export market. Grain producers who bear all risks are not satisfied with the quality of imported techniques and herbicides. Standards for accessing international and other countries markets are not known.

1.2.4 Proposed action plans for SWI

Through consultation workshops in September and December 2012 with stakeholders and key experts, measures have been identified (Table 32) to overcome the barriers described for SWI.

29. State fund belongs to Ministry of Industry and Agriculture and aims to coordinate Arable farming affairs and implement related policies and program

Table 32: Key measures identified for SWI and aggregation for strategy formulation

No	Key measure	Priority (1- high, 2- medium, 3-low)	Accelerating RD&D	Accelerating deployment	Accelerating diffusion
Financial incentives					
1	Tax exemption for importers of SWI equipment and supplies	1		Medium	
2	Soft loans to importers through Arable Farming Support Fund	1		Long	Long
3	Allocate Government financial resources to buy legumes for State Emergency Pre-positioning Fund and State Animal Forage Fund	1		Long	Long
Legislation and regulations					
4	Set up incentives for the application of environmentally sound and climate technologies	1	Long	Long	Long
5	Amend current Law on Land fee and Law on State Reserve Fund	2	Short	Short	
6	Set up rigorous system of evaluation and adaptation which ensure to promulgate new policies for education, research and extension.	1	Medium	Medium	
7	Enforce quality assurance and standards within the legal framework	2	Long	Long	Long
8	Develop a national program to support legumes planting	2	Medium	Medium	
Skill training and education					
9	Capacity building for grain producers	1	Short	Medium	
10	Systematic HR development plan of agriculture specialists	1	Long	Long	Long
Mechanism and institutional arrangement					
11	Establish professional consulting service at local level	2	Medium	Medium	
Creation of stakeholder networks					
12	Improve business regulation and legal framework for coordinated procurement	1	Short	Short	
Information and awareness raising					

13	Increase demand of legumes through awareness raising about legumes benefits to human and animals.	2	Short	Short	
Support R&D					
14	Support research and development of crop rotation options, crops, varieties and fertilizer, irrigation and herbicide optimum applications	1	Medium	Medium	Medium
Market system support & financial services					
15	Establish maintenance service of agriculture machineries and equipment at provincial level	3	Short	Medium	
16	Support storage facilities for winter season to keep supplies	3		Medium	
International cooperation and IPR[30]					
17	Facilitate international links and learning events	2	Short	Short	

Fourteen key measures were identified to ensure successful SWI technology development and diffusion. Time scale of each measure implementation have been defined in category of short (1-5 years), medium (up to 10 years) and long (up to 15 years) terms. In Table 32, each measure's role is indicated in different innovation stages like accelerating research, development and demonstration; accelerating deployment.

The key measures which are the highest priority (because these measures are the most emerging and foundational actions for the technology in Mongolia) include financial measures (including tax exemption and soft loans for importers, and allocation of sufficient government funding); setting up incentive policy for climate and environment sound technologies; establishing rigorous system of evaluation and adaptation; improving business regulation for integrated procurement, capacity building and professional human resources development; and supporting research and development of the SWI technology. Detailed characterizations of measures are displayed in Table 33.

30. Intellectual Property Rights

Table 33: Prioritization and Characterization of acceleration measures for SWI

Sector : Arable Farming / Agriculture							
Technology: SWI - Large scale and long term Innovation Stage: Research and development, Deployment and Diffusion							
No	**Key measure/ category**	**Priority (1- high, 2- med, 3-low)**	**Why is it needed?**	**Who?**	**When (0-5 years, 5-10 years, 10-20 years)**	**How much will it cost?**	**Risks and indicators of success**
	Financial incentives						
1	Tax exemption for importers and local manufacturers of SWI equipment and supplies	1	Cost of SWI equipment and supplies are high. The measure will help to reduce cost and increase availability of equipment and supplies.	The Government; Ministry of Industry and Agriculture; Ministry of Finance	8-10 years	Government – about 2.0 million US$; International donors – 1.0 million US$; Private – 4.6 million US$ (with 30 % pre-payment & soft loan)	Risk: Government revenue will decrease by 1.6 billion *tugrugs* (1.2 million US$) per year. Success: Increased number of farmers who procured SWI equipment and supplies;
2	Soft loans to importers through Arable Farming Support Fund	1	Financial capacity of private importers is limited.	Banks and financial institutions coordinated by the Government & Arable Farming Support Fund.	10-20 years	The Fund needs 10.6 million US$ for revolving cash fund from government and international sources. (Herbicide cost -2.1 million US$, sprayer cost is 2.5 million US$, seedling machine -3 million US$, legumes seeds – 600 thousand US$, legumes equipment – 2.4 million US$).	Risk: Importers of equipment and supplies should be identified through appropriate and transparent process. Success: Increased number of imported equipment and supplies;
3	Allocate Government financial resources to buy legumes for State Emergency Pre-positioning Fund and State Animal Forage Fund	1	Legumes market system is not developed in the country. The nutrition value of legumes is high for animal and human than other cereals. So the state reserve funds need to procure harvested legumes.	State Emergency Pre-positioning Fund and State Animal Forage Fund	10-20 years	Animal Forage fund requires 0.7-1.0 US$; State Emergence Pre-Positioning Fund requires 2 million US$ from the Government.	Risk: Reserve material management should be done properly. Success: Better preparedness for disaster including zud, earthquake and others;

	Legislation and regulations						
4	Set up incentives for the application of environmentally sound and climate technologies	1	There is no incentive policy/ mechanism/ packages for adopting environmentally sound and climate technologies for farmers	The Government; Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Ministry of Finance	10-20 years	The government spends about 30 million US$ for providing wheat subsidy. This subsidy can be reviewed within the current parliamentary term (2012-2016) or new financial resource of at least 20 million US$ from the government.	Risk: Efficient system of monitoring and evaluation is required. Success: Increased number of farmers adopting climate technologies;
5	Amend the current Law on Land Fee and the Law on State Reserve Fund	2	Using legumes as rotation crop requires legal enabling environment.	The Ministry of Industry and Agriculture will initiate a law proposal and submit it to the Government and the Parliament	2-3 years	No additional cost	Risk: Financial resources should be indicated in the law and related documents. Success: endorsed laws and supporting resolutions by the Government
6	Set up rigorous system of evaluation and adaptation which ensure to promulgate new policies for education, research and extension.	1	There is lack of legal and structural framework for climate change adaptation technologies	The Government; Ministry of Environment and Green Development; Ministry of Industry and Agriculture;	3-4 years	Establishing system and structure would require about 400 000 US$ from the government and international agencies	Success: Legal and structural foundation of proposed measures to promulgate new policies for education, research and extension will be established.
7	Enforce quality assurance and standards within legal framework	2	Quality of imported equipment and supplies are not sufficient. Review of current standards and improvement is required.	The Government; Ministry of Environment and Green Development; Ministry of Industry and Agriculture; State Inspection Agency	10-20 years	No additional cost.	Success: Improved quality of imported and manufactured SWI equipment and supplies
8	Develop a national program to support legumes planting	2	In order to supply the population with legumes food products, reduce animal loss in winter and restore soil fertility, a national legumes program is required to develop based on legal enabling environment.	The Government; Ministry of Environment and Green Development; Ministry of Industry and Agriculture; local governments;	10-15 years	No additional cost is required for development of a national program.	Risk: Financial resources for the program implementation should be secured by local governments. Success: Approved national program and planning at provincial and soum level;

	Skill training and education						
9	Capacity building for grain producers	1	Grain producers do not have sufficient knowledge and skills about SWI technology practices. Training package should be developed and appropriate trainers can be identified.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Local agriculture extension centres, private and public training organizations	8-10 years	Annual budget would be about 20 thousand US$ each year from the government.	Risk: Demonstration of proved promising practices is required. Success: Increased knowledge and skills of farmers on SWI technology;
10	Systematic human resource development plan of agriculture specialists	1	Knowledge and skills about climate and environmentally sound technologies is not sufficiently taught to students. Curriculum of climate change adaptation and technologies should be developed and endorsed for public and private universities and colleges who prepare agriculture specialists.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Ministry of Education and Science; Public and private educational institutions	10-20 years	No additional budget for curriculum development.	Risk: Young professionals with job and opportunity are required to be supported to apply their knowledge through research funding and jobs. Success: Increased number of skilled agriculture specialists;
	Creation of stakeholder networks						
11	Improve business regulation and legal framework for coordinated procurement	1	Private importers have limited financial capacity and struggle to access to international markets	The government can identify private, consulting and dealer company through tender process.	8-10 years	Same as measure #2.	Risk: Transparency of tender process and monitoring by the government and public should be ensured. Success: Centrally coordinated procurement of equipment and supplies;
	Information and awareness raising						

12	Increase awareness raising about climate technologies and other related factors such as legumes benefits to human and animals.	2	Farmers and population do not have sufficient knowledge about climate technologies benefits.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Local agriculture extension centers,	4-5 years	It will require about 10 000 USD each year.	Success: Increased nutritional status of children and people.
	Support R&D						
13	Support research and development of crop rotation options, crops, varieties and fertilizer, irrigation and herbicide optimum applications	1	There is a lack of R&D and no access to tested and proved techniques and practices of crop varieties, conservation tillage, holistic management and other advanced practices in Mongolia. R&D is background of successful adoption of the technology and should be carried out in the western, the central and the eastern regions of cropland.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Public and private research institutions; researchers, Agriculture extension centers	5 years	Research funding is about 70thousand US$ per year from national funding and international sources.	Success: Crop varieties adapted in local context and resilient to climate change; proper water, fertilizer and herbicide application norms and regimes, tested and proved practices of root treatment and others.
	Market system support & financial services						
14	Establish maintenance service of agriculture machineries and equipment at provincial level	3	There is no repair service of agriculture machineries and equipment at provincial level. Farmers need to get repair service at least at provincial level.	Private enterprises and dealers	5 years	Private companies and dealers can establish their maintenance service at provincial level with soft loans.	Success: -Decreased cost of equipment and machineries maintenance;
	International cooperation and links						
15	Facilitate international links and learning events	2	There is lack of knowledge and skills to adopt climate technologies by grain producers, private enterprises and government officials. International experiences are important to learn and apply in the country context.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Public and private research institutions, universities and colleges;	5-7 years	Exposure trips for international experiences can cost about 10-15 thousand US$ in year from the government. Post graduate studies in national and international educational centres requires about 20-25 US$ every year from international funding.	Success: Increased number of researchers and agriculture professionals with advanced knowledge and skills

1.3 Action Plan for Vegetable production system

1.3.1 About VPS

Vegetable production system with drip irrigation and mulches (VPS) aims to intensify vegetable production through a set of water saving techniques such as drip irrigation, low cost greenhouses or mulch. Drip irrigation is not only related to irrigation regime and techniques, it also includes fertilizer, pesticide and soil management and their proper application. Mulch is a product used to suppress weeds and conserve water in crop production and landscaping. As a whole system, the technology increases farming efficiency and other benefits to farmers.

Mongolia is experiencing water shortages and an increasingly dry climate due to climate change. Therefore, drip irrigation with plastic mulch can reduce water consumption, decrease labour intensity and increase production. Vegetable and other crops such as water melon, cucumber, tomato, and peppers can be planted in plastic mulch. Drip irrigation is based on the constant application of a specific quantity of water to soil crops. There is wide range of drip irrigation systems. However, locally suitable system for specific crop needs to be developed.

VPS can support farmers to adapt to climate change by allowing efficient use of water. This particularly useful in areas subject to climate change impacts (such as seasonal droughts), since VPS reduces demand for water and water evaporation losses (as evaporation increases at higher temperatures). Furthermore, fertilizer application is more efficient since it can be applied directly through the pipes and reach plant roots.

Mongolia has been piloting drip irrigation systems since 1997 and the suitability of this technology has been confirmed. The pilot projects demonstrated suitability and applicability for growing vegetables, berries and bushes in Mongolia. Currently, plastic mulches are used by a small number of Mongolian farmers to grow crops such as peppers, water melon cucumber and tomato. Drip irrigation systems help farmers reduce water consumption for the production of vegetables and berries. Initial cost of equipment is high, however operating cost of irrigation can be lowered due to water saving. Small farms and families can use several small scale drip irrigation systems which each of them can be set up for 0.5 ha. Because of cold winter, irrigation equipment and mulches need to be stored inside storing facilities in winter. The storage space requirement is not big, so it can be solved by farmers and households.

1.3.2 Targets for VPS

Today farmers grow vegetables other than potato on about 8 000 ha of land. Presently, 11.8 percent of crop land is irrigated in the country. However, drip irrigation has been applied on only 100ha of arable land with support of international projects. Noticeably, water shortage due to climate change is becoming a significant challenge in all sectors, including agriculture. Wide application of drip irrigation would play a vital role in agricultural production, saving water and improvement of nutrition for the elderly, children and mothers.

VPS technology will be applied for vegetable farmers and aims to target at least 50% of farm land depending on availability of water resources and electricity for drip irrigation. The full deployment of the technology will require 9-10 years and is expected to be completed by 2023.

1.3.3 Barriers to VPS

As a result of stakeholder inputs, VPS with drip irrigation and mulches was identified as a market good. Ten barriers were identified including two economic and financial and eight non-financial barriers. Non-financial barriers identified for the Vegetable production system with drip irrigation and mulches, included policy, legal and regulatory, human skills, institutional and organizational capacity, market failure, cultural and behavioural, network failure and technical barriers (Table 34).

Table 34: Key barriers identified for VPS

Barrier sub/ category	Key barrier	Brief description of barrier
Economic and financial	High cost of drip irrigation techniques, plastic materials and facilities	There is no manufacturing of drip irrigation and plastic sheets in the country and techniques and supplies are imported from other countries. For big farms cost per hectare of drip irrigation is estimated as high as 17 million *tugrugs* (12,000 US$) including water wells and electricity source.
	Limited access to long term soft loans	Private enterprises, importers and vegetable growers have limited access to long term soft loans for drip irrigation techniques, facilities and greenhouse and mulch materials.
Non-financial:		
Policy, legal, regulatory	Lack of subsidy policy	There is lack of subsidy policy for encouraging farmers to use environmentally sound and climate technologies. Because of high cost of water saving techniques and materials, vegetable growers struggle to buy them.
Human skills	Limited knowledge and skills	Vegetable farmers do not have sufficient knowledge and skills to use water saving techniques such as drip irrigation, low cost and locally affordable greenhouse or mulches.
Institutional, organizational capacity	Lack of training and demonstration of drip irrigation and mulches pilots and experiments	Few research and practical experiments on vegetable varieties, irrigation norms, standards, soil characteristics, application of fertilizers and economic analysis have been done. Application of research and science in practice is very weak.
Market failure	Underdeveloped local market and value chain system	Many rural farmers are isolated from urban market and there are insufficient processing factories and storage to support the conversion of product increase into income growth. Current vegetable production system has a seasonal pattern. Also there is insufficient financial support to strengthen value chains at local level including vegetable processing factories, storage and others;
Social, cultural and behavioural	Lack of knowledge and attitude towards water saving behaviour	Traditionally, Mongolians use water free of charge, which has led to inefficient consumption and undervaluation of water. Farmers in local areas use open water resources such as rivers, springs or free wells.
Network failure	Poor coordination between key actors	Poor coordination between key actors including government, international and national projects and programs, research and farms and provincial agriculture extension centres exists in the country. Sustainability of project outcomes and scaling up of promising practices are not guaranteed with financial and human resources by international and national agencies. Research work is not tested in different regional areas through agriculture extension centres which are located in provincial levels.
Technical	Insufficient quality assurance	Quality assurance of drip irrigation techniques, mulches and supplies is insufficient. Farmers bear all risks and high cost.
	Inadequate investments into infrastructure facilities	Government invested inadequately into infrastructure facilities which can help expand market access, water resource and electricity etc. Current development of infrastructure is centralized in the capital and few cities.

1.3.4 Proposed action plans for technology VPS

Through consultative process with stakeholders key measures were identified and their priority was estimated. Each measure is important in different innovation stages and over different timescale during the technology development and diffusion (Table 35).

Table 35: Key measures identified for VPS and aggregation for strategy formulation

No	Key measure	Priority (1- high, 2- med, 3-low)	Accelerating RD&D	Accelerating deployment	Accelerating diffusion
	Financial incentives				
1	Tax exemption policy for importers of drip irrigation equipment, mulching supplies and facilities	1		Long	
2	Long term and soft loans for importers, local manufacturers, repair service providers of drip irrigation techniques and supplies and recycling factories of plastic waste from mulches	1		Long	Long
	Legislation and regulations				
3	Set up incentive policy to encourage farmers deploy climate and environmentally sound technologies	1	Long	Long	Long
	Skill training and education				
4	Systematic agriculture professionals' development about water saving technologies and Integrated water resource management	1	Long	Long	Long
5	Capacity building for vegetable farmers on agriculture practices and writing proposal from other financial resources	2	Medium	Medium	
	Mechanism and institutional arrangement				
6	Facilitate coordination between business and community groups who grow vegetables, transporters, process, store and retailers to support value chain at local level	2		Medium	Long
7	Organize integrated supply of drip irrigation techniques and supplies	2	Medium	Medium	
	Information and awareness raising				
8	Improve public awareness on water saving and community based environment monitoring	1	Medium	Medium	
	Support R&D				
9	Support research on crop production with drip irrigation and fertilizer application	1	Long	Long	

	Market system support & financial services				
10	Establish maintenance service of agriculture and drip irrigation techniques at provincial level	2		Short	Medium
11	Develop rural infrastructure such as road, power supply system and water resource, to improve access to water and electricity resources, which are required for drip irrigation	2	Long	Long	Long
12	Strengthen guidelines of quality assurance of imported and produced agriculture equipment and supplies	2	Short	Short	
	International cooperation				
13	Facilitate international links and experience sharing events	2	Short	Short	

Comment:
**time scale (short – 1-5 years, medium –up to 10 years and long up to 15-20 years)*

VPS technology development and diffusion requires thirteen key measures. Measures ranked as the highest priority for the VPS technology include financial measures such as tax exemption and soft loans for importers, and allocation of sufficient government funding; setting up incentive policy for climate and environment sound technologies; systematic HR development, strengthening coordination between key actors, increasing public awareness, and supporting research and development. Detailed characterizations of measures are displayed in Table 36.

Table 36: Prioritization and characterization of acceleration measures for VPS

No	Key measure/ category	Priority (1– high, 2– med, 3–low)	Why is it needed?	Who?	When (0–5 years, 5–10 years, 10–20 years)?	How much will it cost?	Risks and indicators of success
Sector : Arable Farming / Agriculture							
Technology: Vegetable production system with drip irrigation and mulches - small and medium scales and long term Innovation Stage: Research and development, Deployment and Diffusion							
	Financial incentives						
1	Tax exemption policy for importers of drip irrigation equipment, mulching supplies and facilities	1	This measure will help to increase availability of equipment and supplies and competitiveness between importers. As a result, cost drip irrigation equipment and other supplies are expected to decrease.	The Government; Ministry of Industry and Agriculture; Arable Farming Support Fund; Ministry of Finance	8-10 years	Government through Arable Farming Support Fund – about 5 million US$; International donors –5 million US$; Private – 5 million US$	Risk: The government revenue will be dropped. Success: Increased number of farmers who use water saving technologies, including drip irrigation and mulches
2	Long term and soft loans for importers, local manufacturers, repair service providers of drip irrigation techniques and supplies and recycling factories of plastic waste from mulches	1	Importers and local manufacturers have limited financial capacity and current loans conditions are short term and with high interest rate. Long term and soft loans are needed for importers, local manufacturers, repair service providers of drip irrigation techniques and supplies and recycling factories of plastic waste from mulches.	Banks and financial institutions coordinated by the Government, Arable Farming Support Fund, and SME Support Fund;	10-20 years	Soft loan of 1 million US$ is required from the government and international donors per year for 4-5 years. Total cost is about 15-16 million US$. Mulches – about 1.3 million US$; local manufacturing and service- 1.4-2.0 million US$; drip irrigation system 12 million US$.	Risk: Importers of equipment and supplies should be identified through appropriate and transparent process. Success: Increased number of imported equipment and supplies; More local manufacturer and service providers of water saving equipment and supplies
	Legislation and regulations						
3	Set up incentive policy to encourage farmers deploy climate and environmentally sound technologies	1	There is no incentive policy/ mechanism/ packages for adopting environmentally sound and climate technologies for farmers. Incentives can be financial and non financial.	The Government; Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Ministry of Finance	10-20 years	Subsidy for water- saving technologies is roughly estimated about 10-15 million US$ from the government.	Risk: Efficient system of monitoring and evaluation is required. Success: Increased number of farmers adopting water saving technologies;

	Skill training and education						
4	Systematic agriculture professionals' development about water saving technologies and Integrated water resource management	1	Preparing farmers and agriculture specialists through systematic tertiary education is essential in future to apply scientific knowledge and practices in arable farming. Climate change adaptation and technologies need to be explicitly and intentionally included in curriculum of public and private colleges and universities.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Ministry of Education and Science; Public and private educational institutions	10-20 years	No additional budget for curriculum development.	Success: Increased number of specialized agriculture and water specialists;
5	Capacity building for vegetable farmers on agriculture practices and writing proposal from other financial resources	2	Sufficient knowledge about proper application of mulches, herbicides and fertilizers along with drip irrigation should be given through frequent trainings by agriculture extension centres and local training centres to farmers. Training can be in different ways as indoors and field practices, audio and visual programs and exposure trips. Frequent training and awareness-raising is critical to successful deployment of technology and to achieve targets.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Local agriculture extension centres, private and public training organizations	8-10 years	Annual budget would be about 25 thousand US$ in year from the government and international donors.	Success: Increased knowledge and skills of farmers on water saving technologies;
	Mechanism and institutional arrangement						
6	Facilitate coordination between business and community groups who grow vegetables, transporters, process, store and retailers to support value chain at local level	2	Coordination between key actors is weak. Poor farmers should be involved intentionally in supply chain process by government as well as other international and national agencies. Coordination between government, international and national projects and program, vegetable farmers and other market actors in value chain should be facilitated focusing on enabling market conditions for farmers.	Ministry of Industry and Agriculture; Local agriculture extension centres, private and public training organizations	8-10 years	No major cost	Risk: Remoteness from local to urban markets might prevent extension of vegetable products. Success: Increased number of farmer groups of vegetable production

7	Organize integrated supply of drip irrigation equipment and supplies	2	Arable Farming Support Fund can facilitate the obtainment drip irrigation techniques and supplies and can act as bridges between farmers and importers.	The government can identify private, consulting and dealer company through tender process.	8-10 years	Same as measure #2.	Risk: Transparency and efficiency of the Fund's operation should be ensured and periodical monitoring and evaluation can be done by NGO of farmers and individual farmers Success: Increased availability of drip irrigation equipment and number of farmers using drip irrigation
	Information and awareness raising						
8	Improve public awareness on water saving and community based environment monitoring	1	Water saving behaviour is very weak among the population. Mongolians use water free of charge which led today inefficient consumption and undervaluation of water. Farmers in local areas use open water resources such as rivers, springs or free wells. Demonstration projects are needed to implement.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Local agriculture extension centres, Chamber of Trade and Industry and other Integrated water resource management organizations	7-8 years	Demonstration projects at three agriculture regions require about 240 thousand US$ for 3-4 years.	Success: Increased knowledge and skills about water saving technologies.
	Support R&D						
9	Support R&D on crop production with drip irrigation and fertilizer application	1	Integrated water management, drip irrigation techniques, norms, regimes, and standards, fertilizer application and other soil tillage techniques should be defined for vegetable crops based on scientific knowledge and experiences from other countries and experiment and tests in the Mongolian context. Research outcomes and results need to be scaled up through provincial agriculture extension centres and local training centres.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; National Water Agency, Public and private research institutions; researchers, Agriculture extension centers	5 years	Research funding is about 40 thousand US$ per year for 5 years from national funding and international sources.	Success: Water management, regime, irrigation norms and proper application of mulches and demonstration will be defined according to local environment.
	Market system support & financial services						
10	Establish maintenance service of agriculture and drip irrigation techniques at provincial level	2	There is no trade and repair service of irrigation equipment and mulch materials at provincial level.	Private enterprises and dealers	5 years	Private companies and dealers can establish their trade and maintenance service at provincial level with soft loans.	Success: - Increased availability of water saving equipment and supplies at provincial level

11	Develop rural infrastructure such as road, power supply system and water resource, to improve access to water and electricity resources using potential renewable energy	2	Infrastructure of water and electricity system is the main limiting factors to use irrigation technologies.	Ministry of Industry and Agriculture; Ministry of Energy; Provincial and *soum* governments;	10-20 years	Government will invest through long term strategy of rural development.	Success: Increased access to electricity and water resources.
12	Strengthen guidelines of quality assurance of imported and produced agriculture equipment and supplies	2	Quality of imported irrigation equipment and supplies are not sufficient. Quality standards and strict monitoring mechanism should be set up for equipment and materials of drip irrigation and plastic mulch materials	The Government; Ministry of Environment and Green Development; Ministry of Industry and Agriculture; State Inspection Agency	10-20 years	No additional cost.	Success: Improved quality of imported and manufactured water saving technology equipment and supplies
	International cooperation						
13	Facilitate international links and experience sharing events	2	There is lack of knowledge and skills to adopt climate technologies by grain producers, private enterprises and government officials. International experiences are important to learn and apply in the country context.	Ministry of Environment and Green Development; Ministry of Industry and Agriculture; Public and private research institutions, universities and colleges;	5-7 years	Exposure trips for international experiences can cost about 10-15 thousand US$ in year from the government. Post graduate studies in national and international educational centres requires about 20-25 thousand US$ every year from international funding.	Success: Increased number of researchers and agriculture professionals with advanced knowledge and skills

1.4 Action Plan for Potato seed production system

1.4.1 About PSPS

Potatoes are Mongolia's "second bread" in terms of the scale of production and food value. In the past two years, Mongolia could meet 100% of national demand for potatoes. Limited accessibility to high quality potato seed is a perennial problem amongst many growers and is partly attributable to inefficiencies in various links of the seed production system. Third prioritized technology is potato seed production system which aims to enable sustainability and reliability of high quality of potato varieties in the country.

PSPS comprises components of development of varieties, producing mini tubers or elite seeds, multiplying seeds, and storage and delivery systems. Today, most mini tubers or elite seeds are imported from other countries. Some initial research and development of local varieties of potato which adapted to climate change has been conducted in research institutions of Mongolia. As a vegetative propagated crop, potato is highly vulnerable to a plethora of diseases that in turn drastically reduce the amount and quality of yields. In climate change scenarios more vectors and viral diseases are expected. Through technology transfer and diffusion, the research will be expanded to improve potato varieties which are resistant to diseases.

Production of potato mini tubers or elite seed can be done using aeroponics which is a more efficient technique to breed seed potatoes. The technique has potential to eliminate all but one generation of seed potato multiplication in the field, thus lowering costs and raising the plant health quality of the first field production generation.

Potato seed production system has three main steps:

- Produce mini tubers using aeroponics (a crop environment including nutrients, temperature and moisture can be artificially created.)
- Produce potato seeds using mini tubers in greenhouses and at agriculture extension fields of *aimags* or seed producer's fields
- Deliver healthy potato seeds to local markets and farmers.

Producing potato mini tubers in aeroponics has high reproduction coefficient and requires less labour, time and financial resources than potato seed production in soil. The technology can improve the supply of good and healthy potato seeds and increase the potato production per area.

Initial research on growing potato tubers in aeroponic systems with optimal conditions in air has being carried out by the Mongolian National Agriculture Research Institute under the "Mongolian Potato Program" in the first period from 2008-2012. Mongolia has become the fifth country in Asia to pilot this technology. The results were promising and proved in local contexts. The technology will improve sustainable supply of potato seed of adapted potato varieties which will be free of viral diseases. Establishment of local production systems would save labour, time and cost.

Possible areas of research to improve productivity include optimizing nutrient solutions, plant density, number of harvests and harvesting intervals. Resources such as greenhouses and capacity building are required.

1.4.2 Target for PSPS

In 2011, 14 600ha of land was plated with potatoes and the harvest was about 200 000 metric tons. From 2010, potato growers have met 100 % of local demand of potato. However, adapted varieties and seed production is not sufficient. Mongolia has being piloted raising potato tubers in aeroponic system since 2008. PSPS will help to meet at least 80 % of national demand with high quality potato seeds by 2016-2018. Potato production is expected to be increased at least 60% over the current level of production.

1.4.3 Barriers to the technology diffusion

Identification of barriers was done through stakeholder participatory process and other methodologies including a desk review of literature. Interviews and surveys were facilitated by key experts. Several meetings were held with key resource persons who had conducted research on the subject and been involved in the piloting of related techniques and range of tools for barrier analysis. These barriers are described in Table 37.

Table 37: Key barriers identified for PSPS

Barrier sub/ category	Key barrier	Brief description of barrier
Economic and financial	Inadequate availability of financial resources	Presently, much of these finances (especially for obtaining potato mini tubers and elite seeds) are met from a variety of sources such as donor-funded projects. Ideally, after initial years of assistance from various state and non-state sources, potato seed producers should have built up finance and operate according to the market principles. But it is often seen that the potato seed producers continue to depend on external sources to secure investments.
	High cost of equipment and materials	Currently, potato seed production depends largely on imports of seeds or mini tubers, aeroponic systems, greenhouses and other supplies. Cost of imported equipment and supplies are increased due to other factors such transportation, importation procedures and limited number of licensed importers.
Non-financial:		
Policy, legal, regulatory	Lack of subsidy policy for potato seed producers	Financial capacity of potato seed producers is limited and they cannot afford technology and equipment.
Human skills	Lack of skills and knowledge about aeroponic system	Aeroponic system is a new technique in Mongolia and only tested very recently. Potato seed producers and farmers have very limited knowledge and skills about climate technologies, potato varieties and advanced techniques such as aeroponics.
Institutional, organizational capacity	Limited producer and capacity of potato mini tubers	Aeroponic growing of potato is tested and demonstrated in a laboratory in the Agriculture Research Institute in *Darkhan*. Few researchers have gained knowledge and skills about the technology. Research on the potato seed growing using advanced techniques and aeroponic condition is limited.
Market failure	Underdeveloped local supply chain of potato seed production	There is a limited number of initial seed producers and formal and informal potato seed multipliers are not well coordinated at provincial and local levels. Storage capacity at provinces is limited and transportation process is not strongly established.

Network failure	Poor coordination between research organization, provincial agriculture extension centres, potato seed producers and farmers	Research results and outcomes are not disseminated to farmers and scaled up. Provincial agriculture extension centres do not sufficiently carry out demonstration of the promising techniques to local farmers due to financial resources

In total, seven barriers were identified as key to the technology diffusion. The two most critical barriers identified for the diffusion of PSPS arise from financial and economic constraints for undertaking increased investments, namely inadequate availability of financial resources for such investments and the high risk of investments.

1.4.4 Proposed action plans for PSPS

The key measures have been identified by stakeholder consultations held in September 2012, to overcome the barriers discussed in the above section.

Table 38: Key measures identified for PSPS and aggregation for strategy formulation

No	Key measure	Priority (1- high, 2- med, 3-low)	Accelerating RD&D	Accelerating deployment	Accelerating diffusion
	Financial incentives				
1	Assuring adequate availability of financial resources	2	Medium	Medium	
2	Provision of long term and soft loans to potato seed producers	1	Medium	Long	Long
3	Tax exemption of imported aeroponic system and other facilities	1		Medium	
	Legislation and regulations				
4	Set up subsidy policy on application of environmentally sound and climate technologies	1	Medium	Long	Long
	Skill training and education				
5	Training of agriculture professionals on aeroponics and potato seed production	1	Short	Medium	
6	Training of potential potato seed producers	2	Short	Medium	
	Support R&D				
7	Expanding research capacity on potato varieties and advanced techniques including aeroponics	1	Medium	Medium	
	Market system support & financial services				
8	Invest infrastructure	2	Medium	Long	Long
9	Intensify supply chain of potato producers	3	Medium	Long	Long
	International cooperation				

10	Strengthen international cooperation of experience sharing and learning through different activities and networks	2	Short	Short	

Among ten identified measures, the highest priority ranked by stakeholders and key experts were financial measures including provision of soft loans and tax exemption and non- financial measures such as establishing subsidy policy for environmentally sound and climate technologies, training for professionals and supporting R& D. Each measure has had time scale (short – 1-5 years, medium –up to 10 years, long- more than 10 years). Detailed information of each measure is given in Table 39.

Table 39: Prioritization and Characterization of acceleration measures for PSPS

Sector : Arable Farming / Agriculture							
Technology: Potato seed production system - small and medium scales and long term Innovation Stage: Deployment - Diffusion							
No	Key measure/ category	Priority high, 2- med, 3-low)	Why is it needed?	Who?	When (0-5 years, 5-10 years, 10-20 years)	How much will it cost?	Risks and indicators of success
	Financial incentives						
1	Assuring adequate availability of financial resources	2	Funding from different sources such as public and private sources is required. Research on potato varieties and agro-technical practices can be funded from the government and other donor agencies. At least 3 sites with complex aeroponic systems should be established in the western, the central and the eastern agricultural zones.	Ministry of Finance; Ministry of Industry and Agriculture, Research institutions at three agriculture zones	4-5 years	Initial capital investment costs are estimated about 120,000 USD (40,000 USD each location) from the government and international agencies.	Success: Increased number of laboratories which produce mini tubers; Decreased import of mini tubers or potato seed
2	Provision of long term and soft loans to potato seed producers	1	Arable farming fund can provide loans with low interest for 3-5 years can support farmers to be strong market actors. Micro-financial organizations can reach out poor farmers to be potato seed multiplier which is a part of supply chain of potato production. Farmer groups and companies can build storing facilities of medium and big scales using loans.	Ministry of Finance; Ministry of Industry and Agriculture, Bank and financial organizations	5-6 years	Revolving fund of about 1 million US$ is required from the Government and private sources.	Success: Increased number of potato seed producers;
3	Tax exemption of imported aeroponic system and other facilities	1	Considering the importance of this technology, government should give import tax exemptions/relief and subsidiary on interest rates for loans for importers/ local producers of aeroponic system, equipment, and other supplies. Technical support and quality assurance should be given by researchers and engineers to local producers.	Ministry of Finance; Ministry of Industry and Agriculture, Bank and financial organizations	5-6 years	No additional cost. But the Government revenue will decrease.	Risk: Requirements and license obtaining information of potato seed producing and importing should publicly announced by the MIA through media and press in order to ensure on availability of such equipment should be provided through information campaigns. Success: Increased availability of imported PSPS equipment and facilities

	Legislation and regulations						
4	Set up subsidy policy on application of environmentally sound and climate technologies	1	Current subsidy policy of the government need to include Potato seed production using aeroponic, water saving and green technologies.	Ministry of Finance; Ministry of Industry and Agriculture, Ministry of Environment and Green Development; Environment NGOs, farmers organization	10-20 years	It would require about 1-2 million US$ per year from the government.	Success: Increased number of farmers who adopted PSPS technology;
	Skill training and education						
5	Training of agriculture professionals on aeroponics and potato seed production	1	Theoretical and practical knowledge and skills should be given to students studying in the State University of Agriculture and other colleges on the subject.	Ministry of Finance; Ministry of Industry and Agriculture, Ministry of Environment and Green Development; public and private colleges and universities	4-5 years	No additional cost is required.	Success: Increased number of skilled professionals and specialists
6	Training of potential potato seed producers	2	Knowledge and skills on mini tuber producing, seed multiplying, application of fertilizers and pesticide and other technical aspects can be provided by provincial agriculture extension centres and local training NGOs. Practical experience and field visits in the country as well as outside can be good witness of successful practices.	Ministry of Finance; Ministry of Industry and Agriculture, Ministry of Environment and Green Development; Provincial agriculture extension centres; Training organizations;	4-5 years	It will require about 32,000 US$ per year for 4 years.	Success: Increased number of potato seed producers using PSPS technology;
	Support R&D						
7	Expanding research capacity on potato varieties and advanced techniques including aeroponics	1	Research by specialists and post graduate students can be extended focusing on the technology.	Ministry of Finance; Ministry of Industry and Agriculture, Ministry of Environment and Green Development; public and private research institutions; researchers	7-8 years	It will cost about 300,00 US$ in total for 5-6 years. This kind of research can be funded by National Science Fund, other national programs and international projects.	Success: Increased access to tested and proved potato varieties and potato seeds; Improved number of farmers who produce potato seeds using the technology;
	Market system support & financial services						
8	Invest infrastructure	2	Local infrastructure including road, proper storages, reliable and constant electricity and water supply system should be an essential focus of the Government to support local production system.	Ministry of Finance; Ministry of Industry and Agriculture, Ministry of Environment and Green Development; Provincial government	10-15 years	It should be done through related infrastructure projects of the Government for long term period.	Success: Improved infrastructure at local level;

9	Intensify supply chain of potato producers	3	Awareness raising and coordination of different actors of the potato seed production system can be start of process. Local government can support and be bridge farmer groups and private companies to be part of supply chain of potato seed production system. Procurement, delivery, transportation and storing processes are necessary part of the supply chain system. Systematic and continuous supply of potato products to the bigger market in cities should be coordinated.	Ministry of Finance; Ministry of Industry and Agriculture, Ministry of Environment and Green Development; Provincial government; farmer organizations	5-6 years	Coordination would not require additional funding. For capacity building please see measure #6.	Risk: Farmer groups including poor farmers can be strengthened through training and micro financial services. Success: Increased number of farmer groups/cooperatives with different actors of supply chain;
	International cooperation						
10	Strengthen international cooperation of experience sharing and learning through different activities and networks	2	Working professionals of companies and state agriculture organizations should be re-trained through short term programs and exposure trips to other countries.	Ministry of Finance; Ministry of Industry and Agriculture, Ministry of Environment and Green Development; national and international training organizations	3-4 years	In total, it would cost about 80,000 US$ from the government and international donors.	Success: Increased number of skilled farmers, specialists and government officials;

2. Technology Action Plan for Animal husbandry

2.1 Actions at sectorial level

Animal husbandry sector is still the main livelihood and source of wealth for many Mongolians. Animal husbandry plays a vital role in the country's economy - in 2011, agriculture sector comprised about 13% of the GDP of Mongolia. Animal husbandry makes about 73% of the agriculture sector (National statistical yearbook, 2011).

The livestock herd is estimated to be around 40 million including horses, camels, cattle, sheep and goats. Animal husbandry is recovering after a severe winter disaster in 2009-2010 when 8 million livestock were lost. This shows that animal husbandry is heavily affected by weather and natural disasters. Pasture degradation has become a serious issue due to increased livestock and desertification.

Climate change will undoubtedly influence animal husbandry. Climate changes such as temperature, precipitation and variations in snow coverage could have an effect on animal energy cycle and dynamics. According to research (Climate change studies, 2003 and 2006), climate change is expected to negatively affect more negatively on animal husbandry through pasture degradation and desertification, decreasing animal productivity and increased natural disasters especially droughts and heavy snow in winter.

In recent years, the Parliament and the Government of Mongolia have passed several important laws and programs in order to support herders and livestock sector development. The list of programs and laws related to climate technologies in the animal husbandry is presented in Table 40.

Table 40: List of policies and legal documents in the animal husbandry sector

Policy Name	Date of enacted/ revised	Main content
National Mongolian Livestock Program	Enacted on 20 May 2010 by Resolution No 23, the State Great *Khural* /Parliament of Mongolia	The National Mongolian Livestock Program's goal is 'to develop a livestock sector that is adaptable to changing climatic and social conditions and create an environment where the sector is economically viable and competitive in the market economy, to provide a safe and healthy food supply to the population, to deliver quality raw materials to processing industries, and to increase exports'. The program's implementation period is 2010-2021 and includes two phases. Five priority areas have been identified in the Program and the fourth priority area is 'Developing livestock production that is adaptable to climatic and ecological changes with strengthened risk management capacity'. Under the fourth priority area, four major measures were stated - improving pasture management, increasing hay and fodder production, livestock water supply and livestock risk management.
Water National Program	Resolution No 24 of the Parliament, 24 May 2010. Mongolian version	The National Program on Water was endorsed as a supporting program to the MDG based CNDS in 2010. The program aims to support development through protecting water resources from depletion and pollution, to implement the state policy toward providing a healthy and safe environment for the population. The program proposes two-phases of implementation and six priority objectives. Water resource related adaptation measures have been included in the program. For example: establishing water ecosystem monitoring, construction of a water harvesting system in mountain areas of the cryosphere, and awareness raising among the public including youth.
Law on Livestock Gene Pool and Animal Health Protection of Mongolia	Enacted on 08 July 2001. Amended in year of 2002, 2003, 2005, 2007, 2010 & 2011	The purpose of the law is to regulate relations concerning protection livestock, their gene pool and health. The law defined the plenary rights of all stakeholders, non-compliance penalties, and allocation of funding.
Pasture Law of Mongolia	Under discussion	The purpose of this draft law is to identify the legislative basis and regulate relations on the possession, use, protection, restoration of pastureland. The draft law contains a number of key legal and institutional elements (i.e. within the Articles) considered necessary for a law of this type. The legislation on pasture land shall consist of the Constitution of Mongolia, the Mongolian Law on Land, the Mongolian Law on Special Protected Areas, the Mongolian Law on Land Fees, the present law and other legislative acts issued in conformity with them.

National Program to support development of Intensive Livestock Farming	Enacted on 24 June 2003 by Resolution No 160, the Government of Mongolia	The aim of the Program is to support food supply, to reduce food import, and to produce products, demanded by market and met the international standards by sustainably developing the agricultural industry, combining agriculture and intensive livestock farming based on the policy on regional development. The objectives of the program are: • To improve the legal and economic environment to develop an intensive livestock farming • To support the regional development of intensive livestock farming, creation and expansion of a model unit. • To support capacity building to run an intensive livestock farming. The program's implementation period is 2003-2015 and includes two phases: 2003-2008 and 2009-2015.

In recent years, the number of livestock has increased, and the legal environment has been improved. There are some achievements and outcomes of projects for improving dairy and meat products in urban areas, peri-urban land management, pasture management and others. But there are emerging socio-economic and environmental challenges including: rural poverty (mainly of herders), high vulnerability of livestock to natural disasters, lack of animal product processing, volatile price of meat and dairy products in urban areas, and pasture degradation and desertification. Without appropriate adaptation technologies in the animal husbandry sector, herders would experience more negative consequences exacerbated by climate change impacts.

Within the TNA process, technology options for climate change adaptation in the animal husbandry sector in Mongolia were analysed with stakeholders and experts. Eight potential technologies available for the animal husbandry sector, were identified and prioritized utilizing the Multi-Criteria Decision Analysis (MCDA) approach. The criterion included: cost of technologies, and economic, social, and environmental benefits. The most suitable adaptation technologies for the animal husbandry sector were prioritized by the stakeholders by using MCDA.

Table 41: Prioritized technologies in the Animal husbandry sector

No	List of prioritised technologies	Category of the technology	Brief Description
1	Seasonal prediction and livestock early warning system (SPLEWS)	Other Non-Market Goods	SPLEWS is a system that provides precise and effective information through institutions that allows herders and government officials to prepare an effective response to slow onset disasters including drought and *zud* and to avoid or reduce risks.
2	High quality livestock through selective breeding and animal disease management (HQL)	Consumer Goods	HQL technology aims to improve the quality of sheep, goat, horse, cattle and camel utilizing selective breeding methods and improved animal disease management.
3	Sustainable Pasture Management (SPM)	Other Non-Market Goods	SPM is appropriate and improved management of open sources including pasture, land and water, ensuring increased livestock breeding, restoration of degraded environment, and building socio-economic and environmental resilience.

Preliminary targets for selected three technologies in the animal husbandry were estimated during the TNA and barrier analysis processes.

- Seasonal prediction and early warning system: Precise seasonal prediction and proper preparation for *zud* would result in saving about 80% of animals which usually die every winter. This technology belongs to non-market goods and its targeted beneficiary groups are the whole society, including herding and farming communities and other citizens. In terms of geographical targets, people and communities of all areas will benefit from the technology diffusion which is expected to be completed by 2018.

- High quality livestock through selective breeding and animal health system: The technology is proposed to target all herders in the country through implementing selective breeding techniques and improved the veterinary system. It is estimated that diffusion of this technology can cover at least 60% of the total 154 000 herding families. Anticipated time frame for diffusion of the technology is about 6-8 years - by 2018-2020.

- Sustainable Pasture Management: The technology is expected to target all 320 *soums* of Mongolia and at least 90% of herding families can benefit from it. Diffusion of the technology would enable herders to manage pasture in better ways and reduce pasture degradation and desertification. The technology transfer and diffusion is intended to be completed within 6-7 years by 2018.

Key experts and stakeholders did an analysis of barriers and enabling measures for three prioritized technologies in the animal husbandry sector using different methodologies such as desk review of existing scientific, legal and other documents, interviews, questionnaires, discussions at stakeholder workshops and key experts meetings. Barriers for each technology were analysed, compiled and common characteristics were explored.

Common barriers of three technologies in the animal husbandry sector are explained below.

- Lack of financial resource: Low funding allocation was a barrier for all three selected technologies. The seasonal prediction and early warning system (SPLEWS) requires improvement in the current system to adequately communicate good information to prevent or mitigate animal losses during drought and *zud*. Financial resources are not sufficient for high quality livestock through selective breeding and animal disease management (HQL) in order to deliver necessary services to herders. Pasture and land management measures and law implementation actions which are milestones for Sustainable Pasture Management (SPM) are under-fund from the government and other resources. Research and development of all three technologies face financial challenges.

- Inadequate policy and regulations: This barrier has high rank for HQL and SPM. With regard to HQL, livestock related policies have not included adaptation measures for climate change related issues, such as climate risks, soil and environmental degradation. Also, the enforcement of the Mongolian Law of Livestock Gene Pool and Animal Health has been inefficient due to lack of finance and human skills. Pasture Law has been under discussion for more than ten years and is an emerging issue for SPM. For SPLEWS, roles and responsibilities between organizations and institutions are still too vague to make the system complete and efficient.

- Insufficient awareness and information: End users of all three prioritized technologies struggle with low access to sufficient information about technologies and have low confidence to adapt positive practices of prioritized technologies. For SPLEWS, the high cost of communication technology and infrastructure is an issue to disseminate real-time and updated information. With regard to HQL and SPM, inadequate information and awareness among herders and government officials hinder transfer and diffusion of these two technologies.

- Lack of partnership: This barrier exists and affects all three technologies implementation. There are many government agencies and organizations involved in SPLEWS, but poor coordination hinders the goal to deliver accurate, timely, reliable and unambiguous information. In HQL, relations and collaboration between market and non-market players is weak to deliver advanced breeding techniques and veterinary services to herders. For SPM, current level of cooperation between key actors (such as herders groups, NGOs, research institutions, national and international projects implementers and local governments) is insufficient.

Key measures were based on identification and analysis of barriers to the technologies of the animal husbandry sector. The process of key measures identification was consultative through stakeholder discussions and key experts review.

Table 42: Key measures identified for the common barriers to technologies

Common barriers	Enabling framework	Technology
Lack of financial resources	• Allocate more funding from the government • Explore funding opportunities from international donors • Support private enterprises to invest into identified technologies with income and import tax deduction/exemption	SPLEWS; HQL; SPM
Inadequate policy and regulations	• Identify appropriate solutions for legal entities for herder groups for Pasture Law • Lobby for required law endorsement • Improve business regulations for livestock production	HQL; SPM
Insufficient awareness and information	• Develop training packages for specific technologies • Identify and certify qualified training organizations at local levels • Conduct awareness and training for livestock specialists and government officials • Facilitate periodical event for discussions, sharing experiences and learning from other countries programs and projects	SPLEWS; HQL; SPM
Lack of partnership	• Set up a permanent consultative forum on each technologies • Define clear roles and responsibilities of key actors and seek for opportunities to legalize • Develop and set up related indicators in performance evaluation of government and other organizations	SPLEWS; HQL; SPM

2.2 Action Plan for Seasonal prediction and livestock early warning system

2.2.1 About SPLEWS

SPLEWS is a system that provides precise and timely information through key institutions allowing herders and government officials to prepare effective responses to slow onset disasters including drought and *zud*. Due to the large economic losses, the primary focus of SPLEWS is mitigating the disaster risk from drought and *zud* (slow onset disasters- caused by extreme climate). However, rapid onset disasters such as flood, storms and others (extreme weather) are considered as well.

The current livestock sector is based on the traditional nomadic pasture system, and herder family livelihood is highly dependent on and influenced by weather and climate. Herder families need to make preparations for winter and spring to reduce their livestock loss. For winter preparation, the conditions of the previous summer (in terms of vegetation growth, coming winter weather and climate outlook) are essential information for planning migration of herders families, preparing hay and fodder as well as other measures from decision makers at *soum*, *aimag* and country level. Annual economic losses caused by extreme weather and climate related natural disasters have increased in Mongolia. The tendency for increased frequency of climate extremes is expected to continue in the future. As a result, drought and harsh winter is highly likely to occur more frequently, bringing risks for agriculture and livestock. Also, there is clear evidence of drought intensification in Mongolia under global climate change (MARCC, 2009).

SPLEWS has four main components:

- Risk Knowledge: Risk assessment provides essential information to set priorities for mitigation and prevention strategies and designing early warning systems. Research on future climate change, its potential impacts, and associated risks is important.
- Monitoring and predicting: Systems with monitoring and predicting capabilities provide timely estimates of the risks faced by herding communities, economies and the environment. This component allows for a three to six months weather forecast and provides important information for planning and preparations. Seasonal forecasts are based on existing climate data, in particular on sea surface temperatures, which are then used in ocean-atmosphere dynamic models, coupled with a synthesis of physically plausible national and international models.
- Disseminating Information: Communication systems are needed for delivering warning messages to the potentially affected locations to alert local and regional governmental agencies. The messages need to be reliable, accurate and simple so they can be understood by authorities and public.
- Response: Coordination, good governance and appropriate action plans are a key point in effective early warning systems. Likewise, public awareness and education are critical aspects of disaster mitigation.

The main idea behind SPLEWS is that the earlier and more accurately we are able to predict short and long-term potential risks associated with natural and human-induced hazards, the more likely we will be able to manage and mitigate disasters' impact on society, economies, and environment.

The situation in Mongolia: National Agency of Meteorology, Hydrology and Environment Monitoring (NAMHEM) produce weather forecast and seasonal prediction and conduct research on weather related disasters. The mandate for development of all hazards Early Warning System is the responsibility of the National Emergency Management Agency (NEMA).

Seasonal outlook for winter and winter pasture capacity is estimated and mapped by Institute of Meteorology and Hydrology (IMH) based on weather and pasture monitoring at the end of summer. The Ministry of Food, Agriculture and Industry finalize livestock migration scheme six months ahead. Local governments and local emergency departments are responsible for coordinating and implementing the livestock migration scheme with herders. It is also important to note that agencies in Mongolia are organized according to the specialized tasks for different hazards (National Emergency Management Agency, National Agency of Meteorology, Hydrology and Environment Monitoring, Institute of Meteorology and Hydrology, Ministry of Industry and Agriculture), without much information sharing or partnership with other agencies. It is these gaps that have to be addressed by bringing together all concerned agencies.

Another key issue is accuracy of prediction pasture condition and migration scheme at the smallest level of *soum*. The issue in Mongolia is not the establishment of a new early warning system, but converting the existing early warning system to an effective one. For this purpose the agencies responsible shall fulfill the four components (above) according to their functions and responsibilities to make the early warning system reliable, timely, cost-effective, sustainable, and a user friendly tool.

2.2.2 Target for SPLEWS

Precise seasonal prediction and proper preparation for zud would result in saving about 80 % of animals which usually die every winter. This technology belongs to non-market goods and its targeted beneficiary groups are the whole society, including herding and farming communities and other citizens. In terms of geographical targets, people and communities of all areas will benefit from the technology diffusion which is expected to be completed by 2018.

2.2.3 Barriers to SPLEWS

Barriers to the diffusion of the SPLEWS technology were initially gathered through a survey using a questionnaire. Then constructive discussions were facilitated during a stakeholder workshop and the barriers were then categorized, ranked, and decomposed to identify their root causes and enabling environments.

Overall six categories of barriers have been identified. Among these, three main types of barriers (economic and financial, institutional and organizational capacities, and information awareness barriers) are prioritized and their root causes defined by problem trees.

Table 43: Key barriers identified for SPLEWS

Barrier sub/ category	Key barrier	Brief description of barrier
Economic and financial	Inadequate financial resources to intensify the technology	The prime objective of SPLEWS is to provide timely, accurate, unambiguous and credible information to the population and decision makers at risk of a disaster. Quality and reliability of information (specifically predictions) is an issue for drought and *zud*. Mongolia's territory is relatively large compared to its population. The existing networks are not sufficient to cover the whole country with high density of observation and monitoring stations. There are nearly 130 meteorological stations and the distance between them is 150-300km. Such low resolution affects the accuracy of monthly and seasonal climate forecast. There is a lack of financial resource to increase the resolution and number of meteorological stations, especially to purchase monitoring equipment and to build communication infrastructure.
Non-financial		
Institutional, organizational capacity	Insufficient research and development of a comprehensive scientific approach to produce timely and user oriented information	Existing institutions, especially the research community, need to carry out more research to develop and introduce new seasonal prediction, satellite processing and pasture yield modeling techniques. There is a lack of experts and skilled personnel for operating the systems, lack of computing resource to run models and to process satellite images, and lack of a high density observation and monitoring network. Monthly and seasonal prediction accuracy is currently less than 60% and sometimes the skill level is very diverse and especially weak in seasonal forecasting.
Information and awareness	Inadequate awareness and understanding	Nowadays, information technology application is spreading in the country, but herders and farmers have limited access to information disseminated through mass media due to high cost of service and inadequate communication structure. Even in cases they receive the information, they are often unable to understand and interpret the information and make use of it.
Network failure	Poor coordination between organizations in the current early warning system	Currently, some components of the SPLEWS technology already exist in institutional structures, even though they produce and use information regarding the early warning system. As mentioned above, many institutions and agencies including NAMHEM, IMH, Satellite Data Centre, NEMA, MIA and Pasture Management Association NGO are involved in gathering, processing, mapping, analysis, planning and decision making. However, there lacks a coordinating mechanism and a harmonization of different data to generate an integrated point of view in the system in order to take timely action. During disaster response, emergency operations by different national and international organizations are not well planned and coordinated.

2.2.4 Proposed action plans for SPLEWS

Measures to overcome main barriers are carefully designed on the basis of root cause analysis and identified through stakeholder meeting and consultations. Then, enabling environment were discussed and determined.

Table 44: Key measures identified for SPLEWS and aggregation for strategy formulation

No	Key measure	Priority (1- high, 2- med, 3-low)	Accelerating RD&D	Accelerating deployment	Accelerating diffusion
	Financial incentives				
1	Allocation of required amount of funds by the government and exploration for alternative funding sources	1	Long	Long	Long
2	Set up low tariff communication system for the disaster information	2		Medium	
	Skill training and education				
3	Systematic training for different stakeholders of SPLEWS	2	Short	Short	
4	Develop message packages and train users through media and press	2		Short	Short
	Mechanism and institutional arrangement				
5	Facilitate consultative periodical meetings at decision making and implementation levels	1	Short	Short	Short
6	Establish post disaster feedback mechanism	2	Short	Short	Short
	Support R&D				
7	Support research and development on components of SPLEWS	1	Medium	Medium	
	International cooperation				
8	Strengthen international collaboration and experience sharing activities	2	Short	Short	

***Comment: *Time scale** *(short – 1-5 years, medium –up to 10 years and long up to 15-20 years)*

Prioritization and characterization of the technology acceleration measures are presented in Table 2.6.

Table 45: Detailed action plan of key measures for technology Seasonal prediction and livestock early warning system

No	Key measure/ category	Priority (1- high, 2- med, 3-low)	Why is it needed?	Who?	When (0-5 years, 5-10 years, 10-20 years)	How much will it cost?	Risks and indicators of success
Sector : Animal husbandry / Agriculture							
Technology: SPLEWS - large scales and long term Innovation Stage: Deployment - Diffusion							
	Financial incentives						
1	Allocation of required amount of funds by the government and exploration for alternative funding sources	1	The government has to allocate sufficient financial budget for strengthening SPLEWS including improving computer resource and monitoring equipment in the national hydro meteorological service and the need to consider investments in a midterm strategic plan. In order to fill the financial gaps in investments and research support, the government needs to submit project proposals to donors based on results of a feasibility study and R&D study. For this purpose, bottom-up information flow among institutions is needed to develop and submit project proposal with strong justification to donors.	Ministry of Finance; Ministry of Environment and Green Development; National Meteorological Agency; National Emergency Management Agency;	10-20 years	Present budget is about 2 million US$ including operational and research expense. Additional 500thousand US$ per year for 5-6 years is required from the Government and international donors.	Success: Improved SLPEWS components including risk assessment, monitoring and prediction, information dissemination and response. Risk: The system covers many organizations so it might affect efficiency. Better coordination is required.
2	Set up low tariff communication system for the disaster information	2	Currently rural people and herder/farmer families use mobile phones in their daily life. However, it is relatively expensive to obtain information through mobile phone use. The government needs to set special low tariff for disaster information transmission.	Ministry of Finance; Ministry of Environment and Green Development; National Emergency Management Agency; IT and Communication Agency; Public and private communication companies	8-10 years	Special contract with related communication organizations should coordinate. Difficult to estimate.	Success: Increased information dissemination to users and organizations
	Skill training and education						
3	Systematic training for different stakeholders of SPLEWS	2	Training of skilled personnel, researchers and other related officials need to be trained on SPLEWS and disaster risk management.	Ministry of Finance; Ministry of Environment and Green Development; National Meteorological Agency; Ministry of National Emergency Management Agency;	5-8 years	Training will cost about 30000 US$ per year from the government and international agency.	Success: Increased number of personnel with knowledge and skills of SPLEWS technology

4	Develop message packages and train users through media and press	2	To provide information, it is necessary to translate the scientific results into simple word. Special manual or guidance should be developed for the public.	Ministry of Finance; Ministry of Environment and Green Development; National Meteorological Agency; National Emergency Management Agency; Public and private training organizations, Media and press	2-4 years	Development of package will cost about 10,000 USD once. Training would cost about 20,000 US$ per year. Funding can be done from the government and international donors.	Success: Ready message packages for audiences and periodical media and press spots and events
	Mechanism and institutional arrangement						
5	Facilitate consultative periodical meetings at decision making and implementation levels	1	Frequent periodical meeting of different agencies and organizations in after disaster period help to improve preparedness planning and learn from lessons. Roles of different organizations should be defined thoroughly. Review of organizational strategy and planning and intentional inclusion of related components of SPLEWS should be done.	Ministry of Finance; Ministry of Environment and Green Development; National Meteorological Agency; Ministry of Industry and Agriculture; National Emergency Management Agency;	7-8 years	No additional cost.	Success: Improved coordination of stakeholders;
6	Establish post disaster feedback mechanism	2	During and after disaster response, feedback from different stakeholders, including the general public, should be gathered and analyzed. Lessons learnt and recommendations should be considered in short and long term planning of different roles and responsibilities of organizations. Advanced and available communication means such as internet, mobile phone and others can be used in the process.	Ministry of Finance; Ministry of Environment and Green Development; National Meteorological Agency; Ministry of Industry and Agriculture; National Emergency Management Agency; public and private institutions, NGOs	7-8 years	System development cost is 10-15 thousand US$.	Success: Improved citizen's participation in planning and implementation and evaluation process of SPLEWS.
	Support R&D						
7	Support research and development on components of SPLEWS	1	Researchers and personnel should be supported to study and conduct related research in institutions in Mongolia and other countries. To increase capacity, research institutions need to collaborate with international climate centres and research institutions to learn about new seasonal forecasting techniques.	Ministry of Finance; Ministry of Environment and Green Development; NAMHEM; Ministry of Industry and Agriculture; National Emergency Management Agency; public and private research institutions, NGOs; researchers	4-5 years	R&D requires about 500 thousand US$ per year for 5-6 years.	Success: Strong scientific background of SPLEWS improved accuracy of seasonal prediction;
	International cooperation						
8	Strengthen international collaboration and experience sharing activities	2	Learning from other countries' research and experiences will allow accelerating SPLEWS technology transfer and diffusion.	Ministry of Finance; Ministry of Environment and Green Development; National Meteorological Agency; National Emergency Management Agency; public and private educational institutions, researchers	2-3 years	Cost will be about 30,000 US$ for 3 years for exposure trips and short and long term studies	Success: Increased number of specialists who gained more knowledge and skills to utilize in SPLEWS related jobs

2.3 Action plan for High quality livestock

2.3.1 About HQL

In 2012, Mongolia had an estimated 40 million livestock, including horses, cattle, camels, sheep and goats. The genetic pool of local breeds with optimal characteristics exists in Mongolia and can act as a starting point for research and developing the selective breeding technology. Core herd breeding centres have estimated around three million animals have optimal characteristics for climate change adaptation to the local environment. These local breeds have higher survival rate and higher productivity of meat, milk, wool or cashmere. According to the national statistics for 2011, the number of animals infected by disease in 2011 has almost doubled compared to in 2008. About 500 incidences of animal infectious diseases were recorded in 2011 (National statistical yearbook) in the country.

HQL technology aims to improve the quality of all animals based on selective breeding using core herds as well as improving animal health services. In addition, diffusion of the technology would enable Mongolia to control livestock numbers within its pasture carrying capacity and reduce overgrazing and desertification.

HQL includes two large components - selective breeding and animal disease management. Genetic make-up influences livestock fitness and adaptation capacity and determines an animal's tolerance to shocks such as temperature extremes, droughts, flooding, pests and diseases. Adaptation capacity to harsh environments includes heat tolerance and an animal's ability to survive, grow and reproduce in the presence of poor seasonal nutrition as well as parasites and diseases. Using advanced breeding techniques such as artificial insemination combined with traditional methods would allow for breeding of high quality animals which are resistant to drought, thermal stress, harsh winter and parasites and diseases.

The selective breeding technology belongs to 'consumer good' category because it targets at animals for commercial and household use by herders and animal breeding farms. Livestock disease management component consists of prevention and control which help to achieve higher production, lower morbidity and mortality, and fewer losses in animal production. The major impacts of climate change on livestock diseases have been on diseases that are vector-borne. Climate changes could also influence disease distribution indirectly through changes in the distribution of livestock. A comprehensive disease management system has been identified as essential for Mongolian livestock for climate change adaptation. National level surveillance of infectious diseases in animals and management of appropriate preventive measures are urgently required in Mongolia. Outcomes of HQL are improved livestock health and resilience to climate change, increased food security and safety and better access to urban and international markets.

2.3.2 Target for HQL

The technology proposes to target all herders in the country through implementing selective breeding techniques and improved veterinary system. It is estimated that the diffusion of this technology can cover at least 60% of the total 154 000 herding families. Anticipated time frame for diffusion of the technology is about 6-8 years which is 2018-2020.

2.3.3. Barriers to HQL

Through stakeholder consultation and inputs from key experts on animal husbandry, the barriers to the transfer and application of HQL have been identified.

A stakeholder workshop was organized to define barriers through the following steps:

- brainstorming all barriers
- categorization of barriers
- analysis of barriers and root causes
- ranking barriers.

Stakeholders and key experts discussed eight categories of barriers, including economic and financial, human skills, organizational, technical, legal/policy/regulation, market failure, social and information related barriers (Table 46). Economic and legal barriers have been identified as the top barrier out of fourteen identified barriers for the technology.

Table 46: Key barriers to HQL

Barrier sub/ category	Key barrier	Brief description of barrier
Economic and financial	Inadequate financial resources from the government for local veterinary/ breeding units	There are 773 veterinary and breeding units, including private units, at *soum* and district level in Mongolia (www.mofa.pmis.gov.mn). The National Veterinary and Breeding Agency is responsible for providing technical support to provincial and local veterinary and breeding units and enforcing policies such as the Mongolian Law on Gene Pool and Animal Health, State Policy on Food and Agriculture, National Program of Intensified Animal Breeding, and State Policy on Herders etc. At the national level, financial and legal frameworks have been developed to some extent. However, the government budget is inadequate to provide basic veterinary and breeding services, and medicines and facilities to herders - they are not able to diagnose and treat animals on timely manner. The Government has limited financial resources for long term disease control and monitoring. Also public goods such as forage and feed research, pasture management, facilitation of commercial market development, improvement of infrastructure and animal health and disease control have not received sufficient government funding.
	Lack of financial support for the research and development of livestock breeds and diseases	There had been some research on local breeds of cattle, sheep and goat during the period of centralized market economy. Today Mongolia needs to renew and extend the research, tests, and experiments on animal breeds to take into account climate change and different regional contexts. Some initial projects on cattle breeding have been implemented, however breeding of sheep, goats, horses and camels and their gene banks have not been studied yet.
	High cost of imported breeding equipment and supplies, veterinary medicines, vaccines and diagnosing facilities	Quality assurance is low for imported medicines and vaccines. There is probably only one manufacturer (*Biokombinat*) in the country. This state-owned factory lacks financial resources. Poverty of herders limits access to breeding and veterinary service.
Non-financial:		
Policy, legal, regulatory	Insufficient consideration of livestock adaptation to climate change in legal frameworks	Livestock sector related policies have not included adaptation measures of livestock and climate change related issues, such as climate risks, soil and environmental degradation.
	Inadequate incentive policies to adopt HQL	Inadequate incentive policies and regulations for people to apply HQL including herders, animals in disease control and animal health from the emerging market economy (i.e. no demand from abattoirs, meat processors, consumers).

	Inefficient enforcement of the Mongolian Law of Livestock Gene Pool and Animal Health	The National Mongolian Livestock Program and the Mongolian Law on Gene Pool and Animal Health stress the importance of the animal registration database. However the implementation and enforcement of these legal documents have been impeded due to insufficient funding from the government.
	Unclear roles of state and private veterinary/ breeding workers and units	The Ministry of Industry and Agriculture assumes that local veterinary/breeding specialists at *soum* level should implement the government policies and plans and coordinate their implementation. Private veterinary/breeding units are expected to provide actual breeding and veterinary services to herders, however herders understanding of such services vary, and the expectations of roles and responsibilities from state and private services remain unclear.
Human skills	Insufficient numbers of animal breeding technicians and veterinarians at *soum* levels	The number of animal specialists is insufficient and current animal breeding technicians do not have adequate skills and techniques to provide qualified breeding services to herders. Techniques, facilities and breeding related medicines are not adequately provided to local veterinary and animal breeding units. The number of private veterinarians available to livestock producers, especially the extensively managed livestock production system, is declining. Young veterinarians are reluctant to work in isolated rural areas (Mongolia Livestock sector study, 2010). Current veterinarians need re-training to update knowledge and skills.
Institutional, organizational capacity	Inadequate technical and human capacity of local veterinary and breeding units	Provincial veterinary and breeding departments and local veterinary and breeding units have insufficient human and technical capacity to deliver necessary breeding and animal health service to herders.
Market failure	Low access to tested and proved breeds, qualified veterinary medicines and services	Research and development of local breeds are not sufficient in the country. Limited access to qualified veterinary medicines and services. Lack of facilities and medicines at veterinary and animal breeding units and laboratories at provincial level, inadequate research and development of veterinary products in the country are the main reasons of the limited access.
	Underdeveloped market and trade mechanism	Because of poor infrastructure, remoteness and underdeveloped markets at the local level, livestock productions have low value and experience high volatility and uncertainty. The government should invest in the establishment of an animal product market at provincial and *soum* levels and improve infrastructure facilities.
Social, cultural and behavioural	Reluctance of herders to breed high quality of livestock	Herders are reluctant to invest in breed improvement and prefer to increase animal numbers because the value of good animal breeds remains low due to remoteness from market and poor infrastructure, (including road and underdevelopment of provincial and local animal markets/trade networks.)
Information and awareness	Lack of understanding of the importance of the technology application	Herders do not fully understand the importance of veterinary services such as vaccines, anthelmintics and dipping and are reluctant to invest in veterinary services as long as high quality and healthy animals are under-valued in the production system. Herders are not lobbying for an improved service, hence there is little incentive to change or improve the system. Early warning or prevention system from animal disease does not exist and herders do not know their legal obligations or the government's legal obligations. Herders have limited knowledge and information about high quality breeds, animal disease prevention, diagnosis and treatment.
Network failure	Poor coordination between key actors	Poor coordination between key actors including national and provincial veterinary and animal breeding organizations, research institutions, private enterprises and international and national projects and programs.

2.3.4 Proposed action plan for HQL

Following barrier analysis, key experts and stakeholders analysed causes of barriers for HQL and potential solutions were articulated and ranked. As a result, thirteen measures were identified as key measures which support accelerating R&D, deployment and diffusion of HQL technology.

Table 47: Key measures identified for HQL, time span (short – 1-5 years, medium –up to 10 years and long up to 15-20 years) and roles in innovation stages

No	Key measure	Priority (1- high, 2- med, 3-low)	Accelerating RD&D	Accelerating deployment	Accelerating diffusion
	Financial incentives				
1	Allocate financial resources from the Government for livestock gene pool, animal registration and database set-up (Mongolian Law of Livestock Gene Pool and Animal Health)	1	Long	Long	
2	Tax exemption of veterinary products and breeding facilities	1	Medium	Medium	
3	Provision of soft loans to local manufacturing factories and intensified livestock farms	2		Long	Long
	Legislation and regulation				
4	Establish appropriate subsidy policy for herders to promote high quality livestock	1		Long	Long
	Skill training and education				
5	Develop capacity building programs for animal breeding specialists and veterinarians	2	Medium	Long	
	Mechanism and institutional arrangement				
6	Strengthen private veterinary and breeding units (capacity building and financial support)	1		Long	Long
7	Set up animal disease surveillance and prevention system based on veterinary and breeding network	2	Medium	Long	Long
8	Improve coordination between government organizations, private enterprises, research institutions and herder communities	2	Short	Medium	Medium
	Information and awareness raising				
9	Educate herders about high production breeds and scientific animal disease management	1		Medium	Medium
	Support R&D				
10	Support R&D of livestock breeds and animal disease management	1	Medium	Medium	
	Market system support				
11	Establish animal and its product trade markets and infrastructure at local level	2		Long	Long

12	Quality assurance by inspection organizations	2	Medium	Medium	
	International cooperation				
13	Improve international collaboration and coordination between similar organizations and research institutions	2	Short	Short	

The most essential measures for transfer and diffusion of HQL are: financial measures such as allocating sufficient funding from the government and tax exemption for importers and local manufacturers, and non-financial measures including establishing a subsidy policy, support animal health/veterinary units of *soums*, educating herders about the technology and support to R&D. Each measure has different characteristics in terms of time scale and accelerating different innovation stages such as R&D, deployment and diffusion. More detailed action plan for HQL is displayed in Table 48.

Table 48: Detailed action plan of for HQL

Sector : Animal husbandry / Agriculture							
Technology: Innovation Stage:	High quality livestock using selective breeding and animal disease management - large scale and long term Research and development - Deployment – Diffusion						
No	**Key measure/ category**	**Priority (1- high, 2- med, 3-low)**	**Why is it needed?**	**Who?**	**When (0-5 years, 5-10 years, 10-20 years)**	**How much will it cost?**	**Risks and indicators of success**
	Financial incentives						
1	Allocate financial resources from the government for livestock gene pool, animal registration and database set-up (Mongolian Law of Livestock Gene Pool and Animal Health)	1	The Mongolian Law on Gene Pool and Animal Health has articles about budget support from the Government, but implementation of the law has not been efficient.	Ministry of Finance; Ministry of Industry and Agriculture; Animal health and Breeding Agency; Private animal health/ breeding units; herders	10-15 years	It requires more than 30 billion *tugrugs* (23 million USD) from the Government and 50-60 billion *tugrigs* (40-48 million USD) from private enterprises.	Success: Increased funding from the Government
2	Tax exemption of veterinary products and breeding facilities	1	Tax exemption of veterinary products and breeding facilities would enable importers to bring more veterinary medicines and products until national manufacturing is developed.	Ministry of Finance; Ministry of Industry and Agriculture; Animal health and Breeding Agency; Private animal health/ breeding units; Private enterprises – importers and manufacturers	10-15 years	No additional funding is required.	Risk: government revenue will decrease. Success: increased availability of veterinary products and breeding facilities;

3	Provision of soft loans to local manufacturing factories and intensified livestock farms	2	Provision of soft loans to local manufacturing factories and intensified livestock farms is required to expand the gene bank of local breeds of high production. Soft loans to national manufacturer would allow the production of medicines and vaccines at reasonable price and increase their availability in the country.	Ministry of Finance; Ministry of Industry and Agriculture; Animal health and Breeding Agency; State and private financial institutions;	10-20 years	Local manufacturing factories need revolving fund of about 150 billion *tugrugs* (100 million US$) from government, banks and international donors.	Success: Increased animals with high quality
	Legislation and regulation						
4	Establish appropriate subsidy policy for herders to promote high quality livestock	1	Presently, there is no subsidy policy for high quality animals. Government subsidy can be used to encourage herders as well as intensified animal breeding farms.	Ministry of Finance; Ministry of Industry and Agriculture; Animal health and Breeding Agency; Private animal health/ breeding units; Herders organizations	10-20 years	Today Government used/ is using subsidy for goats and wool. At least 10-15 million US$ would be required every year from the government and international donors.	Risk: Good monitoring system is required. The total numbers of animals need to be controlled. Success: High quality animals would be increased.
	Skill training and education						
5	Develop capacity building programs for animal breeding specialists and veterinarians	2	Re-training and capacity building of veterinarians and breeding technicians of each *soums* is required to provide qualified veterinary and breeding service. In addition, climate change adaptation and related themes should be included in education curriculums of Agriculture colleges and universities, in order to ensure sustainability of adaptation measures and risk reduction in future.	Ministry of Education and Science; Ministry of Industry and Agriculture; Animal health and Breeding Agency; State and private animal health/ breeding units; Public and private colleges and universities;	5-6 years	Capacity building will cost at least 40,000 US$ per year for 5 years. Funding can be from the state budget and international sources.	Risk: Skilled veterinarians and breeding technicians should be supported through different incentives to work in local areas. Success: Increased number of skilled veterinarians and breeding specialists;
	Mechanism and institutional arrangement						
6	Strengthen private veterinary and breeding units (capacity building, technical and financial support)	1	Technical and facilities support is required from the government. Recurrent training should be done for staff.	Ministry of Industry and Agriculture; Animal health and Breeding Agency; State and private animal health/ breeding units;	8-10 years	It requires at least 300,000 US$ per year for 5 years from the government and international donors.	Risk: Responsibility mechanism should be considered. Success: *Soum* veterinary/ breeding units have capacity to provide primary and necessary services to all herders within a *soum*.
7	Set up animal disease surveillance and prevention system based on veterinary and breeding network	2	Improving early warning and disease prevention is an important measure to reduce risks related to climate as well as infectious diseases of animals.	Ministry of Industry and Agriculture; Animal health and Breeding Agency; National Emergency Management Agency; State and private animal health/ breeding units;	7-9 years	It would cost 150 000 US$ every year for 5 years from the government and international donors.	Risk: Climate related diseases should be considered within the system. Success: Operational surveillance and prevention system at all level;

8	Improve coordination between government organizations, private enterprises, research institutions and herder communities	2	Roles of government veterinary and breeding organizations at national, provincial and *soum* levels need to focus on increased public and private partnership and facilitate coordination meetings, forums, exhibition trades and exposure trips at all levels along with government institutions, national and international programs, private enterprises, research institutions, NGOs, herders communities.	Ministry of Environment and Green development; Ministry of Industry and Agriculture; Animal health and Breeding Agency; National Emergency Management Agency; State and private animal health/ breeding units; herders NGOs, groups etc.	4-5 years	No major cost would be required	Success: Improved partnership of the government and private organizations at local level; -Increased number of joint events such as forum, coordination meeting and others at all levels
	Information and awareness raising						
9	Educate herders about high production breeds and scientific animal disease management	1	Awareness raising and training of herders is essential in promoting animal breeding technologies and veterinary services and their positive impacts. Herders also need to understand their legal obligations regarding to laws such as animal health, and environmental laws etc.	Ministry of Environment and Green development; Ministry of Industry and Agriculture; Animal health and Breeding Agency; State and private training organizations; media and press	5-6 years	It requires about 35,000 – 40,000 US$ annually for 5 years including development of training packages and demonstration. Funding can be sources from the Government and international donors.	Success: Increased number of herding families who have adopted the technology;
	Support R&D						
10	Support R&D of livestock breeds and animal disease management	1	Support research and development of veterinary medicines and vaccines is required from the Government, international and national donors. It needs to be coordinated with national manufacturers of veterinary medicines.	Ministry of Environment and Green development; Ministry of Industry and Agriculture; Animal health and Breeding Agency; National Science Fund; State and private research institutes and organizations;	8-10 years	Expense will be about 70,000-80,000 US$ per year for 10 years for R&D of animal breeds and disease management. Government and international sources will be explored.	Success: -Increased number of animals with high quality; Number of tested and proved breeds of 5 types of animals;
	Market system support						
11	Establish animal and its product trade markets and infrastructure at local level	2	It enables herders to earn more income from their better breed animals and its production at provincial level at reasonable price without high volatility.	Ministry of Industry and Agriculture; other related agencies	5-6 years	The Government needs to allocate sufficient funding for the rural infrastructure and implementation of Law on Agriculture Auctions.	Success: Animal and its products markets will be intensified at local level. Animal products prices will be reasonable and stable level.

12	Quality assurance by inspection organizations	2	Quality assurance by inspection organizations would ensure the quality of imported and produced breeding facilities, semen, veterinary medicines and vaccines to increase herders' willingness to apply high quality livestock technology.	Ministry of Environment and Green development; Ministry of Industry and Agriculture; Animal health and Breeding Agency; State Inspection agency;	2-3 years	No additional cost is required.	Success: Service quality by veterinary/breeding units is sufficient at local level.
	International cooperation						
13	Improve international collaboration and coordination between similar organizations and research institutions	2	Experience sharing trips, forums, fair trade and exhibitions play important roles for learning from other countries. Research and study on the topic in educational or research institutions allow accelerating R& D and deployment of the technology.	Ministry of Environment and Green development; Ministry of Industry and Agriculture; Animal health and Breeding Agency; public and private research and educational institutions	4-5 years	The total expense will be about 120 000 USD for 4 years from donor agencies and the government.	Success: Increased number of professionals with improved skills and knowledge;

2.4 Action plan for Sustainable Pasture Management

2.4.1 About SPM

Sustainable Pasture Management is a climate change adaptation technology which aims to sustain healthy soils and restore degraded pasture in the countryside. This will have benefits for livestock raising, alleviating rural poverty and building resilience to major environmental challenges. Pasture degradation has already taken place to various degrees and the objective of SPM should consider restoring degraded land while preventing further degradation of any non-degraded land to ensure continued ecosystem health and functions.

Mongolia has an estimated 40 million livestock in an area of 1.1 million km^2 of rangeland. Pastureland is the backbone of Mongolian agriculture. Pasture degradation and desertification is among the most serious environmental problems in the country. In Mongolia, pasture degradation is widespread and occurs in all natural zones at different intensities. Pasture is the main source of livestock food and herders livelihood in Mongolia. Well managed pasture helps to protect natural resources and sustains ecological functions and services.

Pasture degradation in Mongolia has manifested in several ways: decreased biomass production, soil fertility decline, desertification, fewer and unpalatable plant species and physical damage by human activities. At present, about 70% of pastureland is in some form degraded. Overgrazing, off-road driving, mining, global warming, low precipitation and lack of land management skills are causing more and more problems for the ranges in Mongolia. Thus, it is becoming increasingly difficult for Mongolia to provide the necessary amount of fodder for the existing number of livestock that is the main source of income for more than one third of Mongolia's population.

There are different categories of pastures depending on usage:

- Otor pasture (Otoris reserved pasture where herders move in critical situations all or part of their herd and household in case of changing pasture, or weather conditions. They differ from seasonal moves in that they are not regular and repeated and usually do not include the entire herd and household. This type of pasture also can be classified into smaller types.)
- Transit pasture which used temporarily

while animals are moving to other locations

- Per-urban pasture
- Pasture for intensified livestock which is settled down in same location
- Pasture for nomadic livestock.

Each type of pasture requires different methodologies of pasture management depending on different factors related to local environment, geography and socio-economic context. Therefore, comprehensive SPM will assure conservation of natural resources and thereby increase livestock productivity. All of these directly increase the nation's resilience to withstanding the negative impacts of climate change and benefits will be widespread with producers as well as consumers. Socio-economic benefits and environmental benefits of SPM are shown in Table 49.

Table 49: Benefits of Sustainable Pasture Management

Socio-economic benefits	Environmental benefits
• Increased income of herders • Increased food security • Alleviate rural poverty • Improved livelihoods • Sustaining traditional lifestyles • Improved social sustainability and cooperation of different stakeholders	• Increased biomass and vegetation • Restored biological diversity including plant species • Sustained water sources (open and ground) • Increased soil fertility • Reduced GHG emissions • Reduced risks of natural disasters • Ensured ecological sustainability and ecosystem functions and services

Despite continuing efforts, pasture degradation remains a critical constraint for sustainable development of animal husbandry of the country. This is an indicator that SPM has not been adopted effectively. The reason is the existence of barriers that prevent effective technology transfer and diffusion mechanism for implementing SPM. Therefore, appropriate corrective action should be taken to address issues pertaining to technology transfer and diffusion for SPM. These barriers are often considered complex, and solutions require a systemic approach.

2.4.2 Target for SPM

The technology is expected to target all 320 *soums* of Mongolia and at least 90% of herding families can benefit from it. The diffusion of the technology would enable the herders to manage pasture in better ways and reduce pasture degradation and desertification. The technology transfer and diffusion is intended to be done within 8-10 years and completed by 2022.

2.4.3 Barriers to SPM

In order to identify the barriers, several research methodologies including desk studies through literature surveys, questionnaires, direct interviews with different levels of stakeholders were carried out prior to stakeholder consultations workshop held in September 2012. Through an extensive consultative process, a list of all potential barriers to be faced for technology transfer and diffusion process on SPM technology was prepared and discussed as given in Table 50.

Table 50: Key barriers to technology SPM

Barrier sub/ category	Key barrier	Brief description of barrier
Economic and financial	Lack of financial resources to adopt SPM	Pasture and land management measures and law implementation actions are under-funded from the government. Investment to construct water wells, building winter and spring shelters and other facilities are very limited from government and individual herders. Sufficient funding for training and educating herders and government officials is not allocated into local administration budget.
	Lack of taxation mechanism for pasture usage and management	Animals of herders are private, but pasture and water are common-pool resources. Common-pool resources are often overused - this is true for pasture in Mongolia which is often overgrazed due to lack of regulation and control (Chantsallkham J. and others, 2009).
Non-financial		
Policy, legal, regulatory	Lack of land tenure rights	Whilst full privatisation of the land has proven a successful countermeasure in some countries, it is not feasible in Mongolia, where livestock requires mobility in order to balance the variability of the available fodder. Pasture is common-pool resource in Mongolia and became 'tragedy of the common[31]'. Presently, Pasture Law has been under discussion for many years through frequent meeting of stakeholder. The issue is that there are different views on legality and right holder organizing process.
Institutional, organizational capacity	Lack of regulation authority and mechanism for pasture usage	According to the Land Law, *soum* governments have the power to control and regulate *soum* land, to allocate possession and user rights to citizens and to impose land fees on land possessors and users. But implementation of the Land Law is very weak at local level. The ability of the local governments to fulfill their obligations is limited by lack of manpower and budgetary constraints.
Social, cultural and behavioural	Complexity of pasture system in Mongolia	Socio economic and natural condition in Mongolia is quite unique and complex which makes solutions difficult to find.
	Mobile herding system	When pasture resources become limited and insufficient, social conflicts come up between herders and *soum* governments. In some cases, herders are not able to use traditional seasonal rotations of pasture. Today the total animal number is excessive in comparison with pasture carrying capacity. Therefore, when drought and *zud* happens, overgrazing exacerbate vulnerable herders and increases animal deaths.
	Uncontrolled animal numbers	Pasture land management within mobile herding system is not easy to regulate, and it is difficult to legalize ownership of common–pool resources.

31. The tragedy of the commons is the depletion of a shared resource by individuals, acting independently and rationally according to each one's self-interest, despite their understanding that depleting the common resource is contrary to the group's long-term best interests (Garret Hardin).

Information and awareness	Lack of awareness and knowledge of herders	There is no extension organization to increase herders' knowledge and or make new technological improvements available to them. Only private units of veterinary breeding services at the *soum* level provide some services through state subsidies.
Network failure	Poor collaboration between key actors including local governments, research organizations, civil society institutions and herder groups	Because of incomplete policies, and almost no financial resource, combined with lack of manpower, skills and sharing of some responsibilities with civil society institutions, the implementation of the Land Law is very weak at the local government level.
Other barrier	Frequent drought and harsh winter disasters	Livestock is very vulnerable to natural disasters because individual herders cannot overcome excessive consequences of drought and *zud*. Herders groups are weak in term of finance and human capacity.

According to the stakeholders' final results, ten key barriers to technology transfer and diffusion of SPM in the context of climate change were identified and ranked. Among key barriers, economic and financial barriers and policy, legal and regulatory barriers were the most essential.

2.4.4 Proposed action plans for SPM

Stakeholder consultations were carried out to identify measures to overcome barriers (in September 2012). Measures identified in these consultations were validated using results of analysis reported from national and international projects experiences in managing pasture degradation and promoting SPM (Table 51).

Table 51: Key measures identified for SPM, their time scale and roles in innovation stages

No	Key measure	Priority (1- high, 2- med, 3-low)	Accelerating RD&D	Accelerating deployment	Accelerating diffusion
	Financial incentives				
1	Allocate funding for SPM and Pasture Law implementation when it is enforced.	1		Medium	Long
2	Develop subsidy program for pasture usage and management	2	Medium	Medium	Long
	Legislation and regulation				
3	Establish appropriate legal framework for SPM	1	Short	Short	
	Mechanism and institutional arrangement				
4	Strengthen herders groups and organizations	2	Short	Short	
5	Increase capacity of research institutions	2	Medium	Medium	Medium
	Information and awareness raising				

6	Intensify training and education programs for herders and related government officials	3	Short	Short	Short
7	Develop communication strategy for herders	3	Short	Short	
	Support R&D				
8	Support R&D of SPM and pasture monitoring system	1	Medium	Medium	
	International cooperation				
9	Facilitate learning and experience sharing projects and events in countries with similar context	2	Short	Short	

Nine key measures were identified and ranked based on importance in the technology transfer and diffusion. The most important measures were: allocating sufficient fund for enforcement of the Pasture Law, establishment of legal framework for pasture appropriate usage and supporting research and development. Each measure has different roles in the technology innovation stages and time scales to implement (short- 1 to 5 years; medium -up to 10 years; and long – up to 15 to 20 years). Detailed characteristics of measures are provided in Table 52.

Table 52: Detailed action plan of for technology Sustainable Pasture Management

Sector : Animal husbandry / Agriculture							
Technology: Sustainable Pasture Management - large scale and long term Innovation Stage: Deployment – Diffusion							
No	**Key measure/ category**	**Priority (1- high, 2- med, 3-low)**	**Why is it needed?**	**Who?**	**When (0-5 years, 5-10 years, 10-20 years)**	**How much will it cost?**	**Risks and indicators of success**
	Financial incentives						
1	Allocate funding for SPM and Pasture Law implementation when it is enforced.	1	SPM practices including water resource management and establishment of wells and basins, restoration of degraded pasture, pasture and its ecosystems conservation activities, defining boundaries of common properties, animal forage production are generally more expensive. Also, benefits of adopting SPM practices are not immediate and usually spread over several years.	Ministry of Finance; Ministry of Industry and Agriculture; Ministry of Environment and Green Development; Local governments	10-20 years	It will require about 10 million US$ per year from the government and international donors.	Success: Increased funding for pasture management;
2	Develop subsidy program for pasture usage and management	2	Subsidy will support to change unsustainable practices into more managed pasture and other resources. Also animal forage growers and producers should be encouraged with subsidy program. Initiatives and projects for alternative income sources for herders should be supported and funding can be explored from national and international resources.	Ministry of Finance; Ministry of Industry and Agriculture; Ministry of Environment and Green Development; Local governments; Pasture management NGOs; herders organizations	5-7 years	Cost is estimated about 5 million US$ per year from the government and international donors.	Success: Pasture degradation will decrease.

	Legislation and regulation						
3	Establish appropriate legal framework for SPM	1	Whilst full privatisation of the land has proven a successful countermeasure in some countries, it is not feasible in Mongolia, where livestock requires mobility in order to balance the variability of the available fodder. In the Pasture law, Mongolia needs to define the appropriate mechanism, clear rights holders, roles and responsibilities of entities. Experience and lessons learnt from other countries with similar situation, national and international projects and pilots are essential in policy formulation. Results of public survey should be analysed and considered in the law improvements. Mechanism to review and change legal documents based on feedbacks and recommendations need to be considered.	Ministry of Industry and Agriculture; Ministry of Environment and Green Development; Local governments; Pasture management NGOs; herders organizations; research institutions;	2-4 years	No additional cost is required.	Success: Approved Pasture Law and efficient enforcement at all level
	Mechanism and institutional arrangement						
4	Strengthen herders groups and organizations	2	Training package for group formulation and development should be developed and make them available at *soum* level through local government and training centres. Package can include comprehensive guidance for herders about legal framework, business regulations, environmental issues and potential options for income diversification such as ecotourism, and small and medium enterprises using animals raw products etc. Exposure trips and experience sharing forums should be facilitated at provincial, national and international levels.	Ministry of Industry and Agriculture; Ministry of Environment and Green Development; Local governments; Pasture management NGOs; herders organizations; training organizations;	4-5 years	It requires about 50,000 US$ per year for 4 years from the government and international organizations	Risk: Sustainability of herder organizations and groups should be considered. Success: Increased number of herders informal and formal organizations with good capacity;

5	Increase capacity of research institutions	2	Government and non-government research institutions need to be supported to conduct research on pasture, ecosystems, pasture mapping and other related emerging themes and pilot promising practices in small scale. Win –win solutions with social and ecological sustainability should be developed through research and development and successful outcomes of research, tests and demonstration need to be scaled up higher level.	Ministry of Industry and Agriculture; Ministry of Environment and Green Development; Local governments; public and private research institutions;	5-6 years	It requires about 35,000 US$ per year for 5 years from the government and international funding	Risk: Practical application of research results should be ensured. Success: Increased number of research projects and initiatives on Pasture management;
	Information and awareness raising						
6	Intensify training and education programs for herders and related government officials	3	Involvement of related organizations which could provide qualified training, education programs on terms of pasture management and improvement.	Ministry of Industry and Agriculture; Ministry of Environment and Green Development; Local governments; public and private training organizations and national and local media and press;	3-4 years	It will require about 15,000 US$ per year for 3 years from the government and international agencies.	Success: Improved knowledge and skills on sustainable pasture management practices;
7	Develop communication strategy for herders	3	The government needs to develop a communication strategy with key messages along with media and press in order to convince herders and impact their behaviour on about SPM and positive practices.	Ministry of Industry and Agriculture; Ministry of Environment and Green Development; Local governments; public and private training organizations; media and press;	2-3 years	It will require 25,000 US$ to develop and pilot from the government.	Success: Efficient communication strategy about SPM for herders
	Support R&D						

8	Support R&D of SPM and pasture monitoring system	1	SPM Research and Development (R&D) require adequate funding from the government and other donor agencies to study and recommend local context specific solutions to diverse situations. The use of modern technology such as GIS mapping, satellite imaging, mobile communication system, and modeling etc. can be used in pasture monitoring system to provide precise solutions to herders and government officials. As the availability of budgetary resources from the government funding is not sufficient, harnessing donor support should be explored.	Ministry of Industry and Agriculture; Ministry of Environment and Green Development; public and private research organizations herders organizations;	5-6 years	It will cost about 80,000 US$ per year for 5 years from the government and international funding.	Success: Improved pasture monitoring and research on pasture; -decreased pasture degradation
	International cooperation						
9	Facilitate learning and experience sharing projects and events in countries with similar context	2	Learning from other countries will help Mongolia foresee potential issues in future and ensure the technology deployment and diffusion within expected time frame.	Ministry of Industry and Agriculture; Ministry of Environment and Green Development; public and private training organizations and international educational and research institutions;	4-5 years	It will cost about 100,000 USD for 4 years from the government and international funds	Success: Increased number of skilled professionals and specialists;

3. Cross-cutting Issues

Common barriers and required measures have been written in each chapter for the arable farming and the animal husbandry sector which were prioritized in the TNA process. For Mongolia, these two sectors play important roles in the economy. Barriers for the six technologies in the two sectors are displayed in Table 53.

Table 53: Key barriers for prioritized six technologies of arable farming and animal husbandry

Common barriers	Arable farming sector technologies			Animal husbandry sector technologies		
	System of wheat intensification	Vegetable production system	Potato seed production system	Seasonal prediction and early warning system	High quality livestock	Sustainable Pasture Management
Inadequate finance and loan access	X	X	X	X	X	X
High cost of equipment and supplies	X	X	X		X	
Poor policy, legal & regulatory framework	X	X	X		X	X
Inadequate human skills	X	X	X		X	
Inadequate institutional/ organizational capacity	X	X	X	X	X	X
Market failure	X	X	X		X	
Social cultural behavioural barrier	X	X			X	X
Lack of information and awareness	X			X	X	X
Poor research and development	X	X		X	X	X
Lack of partnership	X	X	X	X	X	X
Technical barriers	X	X				

According to Table 53, the most common barriers are:

- Inadequate finances: In all six technologies this barrier was identified as a key barrier. The government struggles to allocate sufficient funding for prioritized technologies adoption. Private enterprises of Mongolia have limited financial and human capacity to locally produce agriculture machineries, equipment and supplies, so they are mainly imported from other countries. Farmers, herders and small private enterprises face challenges to access loan services from banks and micro-finance organizations due to high interest rates, required collateral and repayment in short term. Lack of funding for R&D is a barrier to transfer and diffusion of five technologies.

- Poor policy, legal and regulatory framework: Policies affect implementation of measures in all six technologies. Inefficient law enforcement, amendments in legal frameworks, lack of business regulations and emerging need for Pasture Law were identified as a major barrier to adopt the six technologies.
- Inadequate human skills, institutional and organizational capacity: College and university curriculums in both public and private educational institutions do not sufficiently focus on climate change and adaptation technologies. Systematic development of professionals through education system is important for R&D in the promotion of all six technologies.
- Lack of partnership: This barrier exists and affects all six technologies. There is poor coordination between key actors including government organizations, private and public entities, research organizations, farmers and herders which prevent efficient deployment of all six technologies.

Key measures to overcome barriers have been compiled and listed in Table 54.

Table 54: Common measures for prioritized technologies

Common measures	Arable farming sector technologies			Animal husbandry sector technologies		
	System of wheat intensification	Vegetable production system	Potato seed production system	Seasonal prediction and early warning system	High quality livestock	Sustainable Pasture Management
Secure the Government funding	√√√		√√	√√√	√√√	√√√
Tax exemption and provision of soft loans	√√√	√√√	√√√		√√√	
Setting up subsidy policy	√√√	√√√	√√√		√√√	√√
Amendment of law or enforcement of new law	√√					√√√
Enforcement of quality assurance standards	√√	√√	√√√			
Systematic capacity building of professionals/ specialists	√√√	√√√		√√	√√	√√
Create stakeholder networks and partnership	√√√	√√		√√		
Increase awareness raising	√√	√√√			√√√	√
Support R&D	√√√	√√√	√√√	√√√	√√√	√√√

Market system support	√	√√	√√		√√	
Strengthen international cooperation and links	√√	√√	√√	√√	√√	√√

The most common measures are:

- Secure government funding: First of all, funding from the government would support these six technology transfer and diffusion. These can be done through national programs implementation, efficient law enforcement and local government budgeting process.

- Tax exemption and soft loans: For four technologies which in the consumer goods category (import tax exemption, tax deduction for local manufacturing and access to long term soft loans) would enable efficient transfer and diffusion of technologies of SWI, VPS, PSPS and HQL.

- Subsidy policy for sound environmental and climate technologies: The government of Mongolia should develop a comprehensive subsidy policy which supports sound environmental and climate technologies. The policy will enable the accomplishment of action plans of all six technologies within expected timeframes.

- Systematic capacity building: Systematic capacity building of agriculture and climate specialists and professionals is essential for all six technologies. Climate change adaptation concepts and practices need to be focused sufficiently in curriculums of public and private educational institutions.

- Support R&D: Research and development is required in all technologies. Sufficient funding and human resources will enable good scientific research to adopt all technologies transfer and diffusion.

- Strengthen international cooperation and networks: Learning from experiences and practical applications of technologies in similar context is important to accelerate R&D and deployment of all six technologies in the country. Many types of learning events such as forums, exposure trips, short and long term studies, exhibitions, fair trade and others can be facilitated to ensure efficient deployment and diffusion of these technologies.

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ANNEX 7: LIST OF STAKEHOLDERS INVOLVED IN THEIR CONTACTS

Sector/ Technology	Expert/ Stakeholder Name	Organization	Approach of consultation	Time	Topic
Key experts:					
Leader	Dr. P.Gomboluudev	Institute of Meteorology Hydrology and environment; p_gombo@hotmail.com	Leading and supervising all activities	daily	Barrier analysis and enabling environment, TAP
Agriculture/ Arable Farming	B.Bolortsetseg	Climate Change, Nature and Society NGO; ccnsMongolia@gmail.com	Leading Agriculture Working Group	daily	Barrier analysis and enabling environment TAP
Arable Farming	Dr. G.Davaadorj	Project of Desertification and Mitigation, Swiss Development Agency; G.Davaadorj2001@yahoo.com	Key consultant	Every week	Barrier analysis, enabling environment & TAP for Arable farming 3 technologies
Water	Dr. G.Davaa	Hydrology sector, Institute of Meteorology Hydrology and environment; watersect@yahoo.com	Key consultant	Every week	Barrier analysis, enabling environment and TAP for Drip irrigation
Pasture	B.Erdenetsetseg	Agrometeorology sector, Institute of Meteorology Hydrology and environment; erdtsetseg@yahoo.com	Key consultant	Every week	Barrier analysis, enabling environment & TAP for Animal husbandry 2 technologies
Natural disaster	Dr. L.Natsagdorj	Consultant, Institute of Meteorology Hydrology and Environment; natsag03@yahoo.com	Key consultant	Every week	Barrier analysis, enabling environment & TAP for Early warning & policy fact sheets
Policy analyst	L Oyunjargal	Head of division IMH	Meeting	Monthly	Analysis of related policies and fact sheets
Environment	Nicholas Harris	Environment specialist, harris.nicholas@gmail.com	meeting	Monthly	Review of the report
Arable Farming	Dr. G.Bayarsukh	Research Institute of Planting and Arable Farming, National University of Agriculture; bayar67@yahoo.com	Workshop and meeting	Monthly	Barrier analysis, market map & TAP for agriculture technologies
Animal husbandry	Dr. Togtokhbayar	Director of Research Institute of Animal Husbandry	Workshop and meeting	monthly	Barrier analysis, market map & TAP for livestock technologies
Animal husbandry	B.Binye	Ministry of Industry and Agriculture	Workshop and meeting	monthly	Barrier analysis, market map & TAP for livestock technologies
Animal husbandry	Dr. P.Gankhuyag	Head of Livestock Policy Sector, Ministry of Food, Agriculture and Industry,	Workshop and meeting		Barrier analysis, market map & TAP for livestock technology

Water	Dr. T.Oyunbaatar	Water sector, IMH,	Meeting	Once a month	Barrier analysis, market map, enabling environment & TAP for water related technology
Water	Dr. Sh.Baranchuluun	Head of Water Department, Ministry of Food, Agriculture and Industry	Meeting	Once a month	Barrier analysis, market map & TAP for drip irrigation technology
Deserti-fication	B.Bayarbat	Coordinator, National Committee for Combating Desertification	Workshop and meeting	Every month	Barrier analysis, market map & TAP for livestock technologies
Pasture management	D.Bulgamaa	Researcher, Green Gold project; bulgamaa@greengold.mn	Workshop and meeting	Every month	Barrier analysis, market map & TAP for livestock technologies
Land	J.Davaabaatar	ALACGAC, Head of the Land Issues Department; jdavaabaatar@yahoo.com	Workshop discussion	1 time	Barrier analysis, market map & TAP for agriculture technologies
Pasture management	B.Enhmaa	ALACGAC, specialist; Enkh1106@yahoo.com	Workshop and meeting	2 times	Barrier analysis, market map & TAP for agriculture technologies
Pasture management	S.Enhbold	Project of Desertification and Mitigation, Swiss Development Agency	Workshop and meeting	2 times	Barrier analysis, market map & TAP for livestock technologies
Pasture	Dr. D.Ariungerel	LEWS project, MercyCorps; ariunregel@yahoo.com	Workshop and meeting	2 times	Barrier analysis, market map & TAP for livestock technologies
Pasture/remote sensing	Dr. M.Erdenetuya	Specialist, №Information Center ; m_erdenetuya@yahoo.com	Workshop and meeting	Every month	Barrier analysis, market map, enabling environment & TAP

SECTION IV

Project Ideas

EXECUTIVE SUMMARY

Mongolia is a developing country with small population and vast territory where traditional nomadic livelihoods coexist with modern urban lifestyles. In recent years, climate change related challenges have become a major risk for the country's development. Ecosystems of the country are fragile to climate changes and livelihoods of people are dependent on the weather and environment. The assessment has showed that climate change would impact on the well being of people and the country's socio and economic development.

The following major steps have been followed in the assessment:

- ✓ Established an organizational structure and facilitated stakeholders engagements
- ✓ Selection of sectors and technologies considering implications of climate change for the country's development priorities and strategies
- ✓ Identifying of barriers and enabling frameworks
- ✓ Developing of Technology Action Plans for identified technologies
- ✓ Preparing project ideas

The TNA process was participatory which ensured the involvement of cross sectoral experts and stakeholders in each step of the assessment. Consequently stakeholder engagement was one of the key aspects of the project. Different entities including ministries, research and educational institutions, international and national NGOs, private enterprises, representative of farmers and herders were involved in the process in different ways.

Based on the research, analysis and discussions, arable farming and animal husbandry sub sectors were identified as the sectors most vulnerable to climate change and their social, economic and environmental losses due to climate change impacts are expected to be higher than those of other sectors. Prioritization of adaptation technologies was completed and the following six technologies which contribute to reduced agriculture sector vulnerabilities, have been prioritized:

Arable farming:

- ➢ System of wheat intensification
- ➢ Vegetable production system with drip irrigation and mulches
- ➢ Potato seed production system

Animal husbandry:

- ➢ Seasonal Prediction and Livestock Early Warning System
- ➢ High quality livestock through selective breeding and animal disease management
- ➢ Sustainable Pasture Management

Barriers to each technology were identified and necessary measures were defined. The most common key measures for the two sectors are: allocation of the government funding, tax exemption and soft loans, subsidy policy for environmentally sound and climate technologies, systematic capacity building, supporting research and development, and strengthening of international cooperation and networks. Technology Action Plans were developed and each action was described along with time frame, responsible owners, and required financial resources.

Based on sector and technology prioritization, barrier analysis and Technology Action Plans, five project ideas were developed by key experts and stakeholders from different entities. Key stakeholders from the Ministry of Industry and Agriculture, the Ministry of Environment and Green Development, research institutions, private enterprises, representative of farmers and herders were consulted during the project idea preparation process. In each project ideas, key stakeholders and their roles were described.

1. Project Ideas for the arable farming sector

1.1 Brief summary of the project ideas for the arable farming sector

In the TNA process, the arable farming and the animal husbandry sectors were identified as the most important sectors for climate change adaptation in Mongolia. Then potential technologies of two prioritized sectors were identified and three technologies for each sector were selected through stakeholder consultative process. For each technology, key barriers and enabling measures to overcome barriers were defined and technology action plans and project ideas were finalized through discussions with the stakeholders. Project ideas were written based on the previous three TNA reports for climate change adaptation. During the final workshop (conducted on 20 February 2013) of TNA project, final feedbacks and review were done. In the arable farming sector, two project ideas (Table 55) have been developed by key experts in discussion with stakeholders.

Table 55: Project ideas in the arable farming sector

Technology	Project name	Implementation period	Estimated budget, US$
System of wheat intensification	Pilot project of SWI in Mongolia – Phase 1	2 years	800,000
	Scaling up SWI technology in Mongolia– Phase 2	4 years	1,350,000
Vegetable production system with drip irrigation and mulches	Drip irrigation project	6 years	2,250,000

Detailed information of project ideas are given in the following sections.

1.2 Project idea 1 – Pilot project of System of wheat intensification in Mongolia

Sector: Arable Farming /Water	**How this technology contributes to adaptation:** • Provide better coping mechanism for increased wheat production by imparting better soil-plant relationship; • Increase soil fertility and moisture retention; • Reduce soil erosion
Technology: System of wheat intensification (SWI)	

1.2.1 Brief introduction to SWI

Wheat is the most important crop in Mongolia. After sharp decline of cereal production during the transition period between 1990 and 2007, there are some signs of revitalisation of wheat production alongside economic growth in the country. However, there is an imperative need for adaptation technologies to minimize the potential losses, because future climate change impacts and environment degradation can hinder development of sustainable and resilient wheat production system.

System of Wheat Intensification (SWI) technology has been selected as of the highest priority among identified technologies in the arable farming sector. The System of Wheat Intensification technology consists of conservation tillage and holistic plant management, with an emphasis on wheat root management to achieve economically, ecologically and socially sustainable agricultural production.

Conservation tillage practices ensure permanent soil cover and minimal soil disturbance, slow water flow, and reduce the amount of soil erosion. In the pilot project of conservation tillage in Mongolia, tillage operations were significantly reduced for cropping (Silke H., 2006).Holistic plant management consists of nutrient and water management, root treatments and crop rotation. Crop rotation is the practice of growing a series of dissimilar types of crops on the same piece of land in sequential seasons. Crop rotation confers various benefits to the soil and mitigates the build-up of pathogens and pests that often occurs when one species is continuously planted on the same piece of land. It can also improve soil structure and fertility by alternatively planting deep-rooted and shallow-rooted plants. Presently, crop farms have neither the appropriate technology for rotation including seeds of legume varieties which can grow well and produce high yield under the Mongolian soil and climate conditions. Some research on rotation systems in irrigated planting has only restarted recently in Mongolia after more than 30 years of pause.

System of wheat intensification through conservation tillage and holistic plant management is a technically viable alternative to the current crop production practices in Mongolia and provides prospects for future sustainability.

1.2.2 Introduction to the project

This project proposal was developed through consultation with stakeholders and key experts. Information was gathered through research into past studies, implemented projects and programs and other sources of publications. Interviews and discussions with stakeholders were facilitated by key experts. Research and development is a very important step, which can pave the way for SWI technology deployment and diffusion in Mongolia.

The main goal of this proposed project is to increase wheat production through SWI in Mongolia. Objectives of the pilot projects are:

- Identify appropriate models and practices of holistic plant management including conservation tillage, root treatment, fertilizer and herbicide application and legumes varieties for rotation through pilot scale research and adaptation using participatory research involving farmers, extension workers and researchers

- Pilot identified models and practices at research sites and farmers' fields representing the western, central, and eastern crop zones

- Build capacity of grain producers with knowledge and skills of SWI technology and practices.

The project is proposed to be implemented in two phases for overall six years to achieve the above three objectives.

In the first phase, research and initial testing of some ideas of the technology will be done in order to gain confidence researchers and some early adopters-farmers. Second phase of SWI project is designed for more comprehensive testing and demonstration of components of the technology.

1.2.3 Methodology

There are three outcomes to the project.

1. Research and development of appropriate models of SWI: It will be based on research institutions in *Ulaanbaatar* (UB) and *Darkhan*. The research will cover topics including: wheat and legumes varieties, minimum soil tillage alternatives, root treatments, fertilizer and herbicide application; rotation options; and other related agriculture practices.

2. Pilot and demonstration of the SWI technology: Piloting and testing will be done at research and farmers' fields located in provinces. Piloting and demonstration at farmers' fields and feedback analysis process will ensure participation of as many as possible stakeholders of different interest groups. Technical support and regular

monitoring will be provided by the research institutes.

3. Education and awareness-raising: Extensive awareness-raising for grain producers and the general public will be conducted through national and local media and press. Training packages for farmers will be developed and conducted by public and private training organizations.

1.2.4 Log frame of the project

Objective	Outputs	Key activities	Timeline	Possible complications/ challenges
Phase 1.				
Identify appropriate models and practices of holistic plant management	-Conservation tillage and holistic plant management practices and options studied and developed - Tested at small scale research sites	-Identify initial components (water nutrient & holistic plant management) of SWI for the Phase 1 -Conduct research on conservation tillage and holistic plant management -Facilitate discussion on research results and improvements with stakeholders and end users -Experience sharing and learning from other countries including field visits to communities in other countries -Conduct analysis of SWI & develop recommendation for the next phase	2 years	Sufficient funding for the research is required from the government and donors.
Phase 2.				
Pilot identified models/practices at research sites and farmers' fields	-Comprehensive research on SWI technology components -Proved positive results of SWI models -Guidelines and instructions of options/models of SWI developed -Increased demonstration of R&D -Crop land area (at least 10,000 ha) where SWI is applied	-Conduct more detailed research on SWI technology components -Pilot identified models/ practices at provincial research sites -provide technical support and monitoring -facilitate demonstration of pilots	2 years	Financial measures (TAP report) should be taken place
Build capacity of grain producers with knowledge and skills	-Established national program of SWI including legumes -Number of farmers who use SWI technology -Increased legumes demand at markets	-Develop national program through consultative process of stakeholders and endorsement by the government; -Develop training packages -Conduct trainings for grain producers -Public awareness raising	3 years	Legal environment should be established;

1.2.5 Partnering

Stakeholder	Role
Ministry of Industry and Agriculture	-Main coordinator for implementation -Ensure legal framework
Ministry of Environment and Green Development	-Recommendation of adaptation technology -Ensure alignment with climate change environmental programs
Public and private research institutions	-Implementing actor -Conduct research and development -Establish technical framework
Provincial agriculture extension centres	-Implementing actor -Piloting technology, bridge between research and practical application -Demonstration to farmers
Grain producers: farmers and companies	- Implementing actor -Learning and knowledge sharing
NGOs of grain producers	-Project monitoring and evaluation -Feedback to project implementation
Public and private training institutions	-Develop training packages -Conduct training
Media and press organizations	-Public awareness raising -Support knowledge and experience sharing

1.2.6 Costs and Benefit Analysis

In addition to environmental benefits, the technology has several financial benefits:

- Overall, the technology would increase wheat harvest by at least 25-40% due to increased soil fertility, soil moisture retention and proper application of fertilizers and herbicides.

- Conservation technology would reduce labour and cost of soil tillage operations.

- Planting legumes as rotated crop will increase not only soil organic matter, but also provide economic benefit of legume harvest instead of using bare fallow practices.

Table 56: Budget of project implementation

Year	Major activities	Estimated Cost
Phase 1		
Year 1	-Learn from other countries about available practices and experiences -Conduct field visit to communities in other countries -Start initial research and test and develop models and practices; -Identify small scale pilot sites for the Phase 1.	350,000 US$
Year 2	-Continue research and test and develop models/practices; -Pilot initial SWI ideas and components -Develop recommendations for the Phase 2 of the project	450,000 US$
Phase 2.		
Year 3	-Conduct detailed research and improve models/practices -Continue piloting of SWI practices and models at provincial level -Develop instructions and guidelines for SWI applications -Develop training packages and awareness strategy for public	450,000 US$
Year 4	-Continue piloting of SWI -Conduct trainings and awareness raising about the technology	450,000 US$
Year 5	-Complete piloting of SWI -Conduct trainings and awareness raising about the technology -Ensure legal, financial and other enabling environment through national programs, legal frameworks and others	200,000 US$
Year 6	-Ensure sustainability through legal and other enabling environment, handing over to the government; -Evaluate performance of the project	250,000 US$
Total: 6 years		**2,150,000 US$**

1.2.7 Impact Statements

Country social development priorities	Wheat is the main crop which ensures national food security in Mongolia. The National Programme for Food Security (2009-2016) has an objective to make the country self-sufficient in wheat flour production. Also, increasing application of soil protection technologies in agriculture is one of priorities in the National Programme on Climate Change. The goals of this project are fully aligned to achieve the related national programs objectives. The grain producers and farmers will see their livelihood improved because their income will increase and the productivity of their land will be improved.
Country economic development priorities – economic benefits	The project will have several benefits: • Increases in production of wheat and legumes • Decreases in labour and expense through application of conservation tillage • Provides avenues for more holistic plant management learning opportunity to the farmers and better connect between research and extension; • Grain producers will have more income and will gain better financial status. • Price of wheat flour and its products will become more stable.
Country environmental development priorities– Environmental benefits	The technology aims to introduce environmentally sound practices in wheat production system. The environmental benefits are: • conservation of soil fertility • retention of soil moisture • proper application of fertilizers and herbicides and less long term impacts
Social benefits	• Knowledge and skills of grain producers and farmers will be extended and their confidence using environmentally sound and climate technologies will be increased. • Legal environment will be more favorable and supportive climate change adaptation technologies.

1.2.8 Other considerations and priorities

This project intends to support R&D and deployment of SWI technology. Within the project framework, access to tested and proved practices will be ensured and at least 50% of farms will use the technology after six years. Legal and business environment is in the diffusion stage. However, enabling framework (which is defined in the TAP) should be established within the given timeframe. If policy and regulations are supportive and financial and economic measures are taken, the diffusion of the technology up to 80% of farms by 2022 can be assured.

Up scaling potential- The project is intended to develop technology which will be scaled up as the technology targets.

1.3 Project idea 2 – Pilot project of Vegetable Production System

<table>
<tr><td>Sector: Vegetable production farming / water</td><td rowspan="2">How this technology contributes to adaptation:
• Increases water use efficiency in irrigated land and vegetable production;
• Saves water resources through reducing evaporation from irrigated land.</td></tr>
<tr><td>Technology: Vegetable production system with drip irrigation and mulches (VPS)</td></tr>
</table>

1.3.1 Brief introduction to VPS:

Crop production in arid and semi-arid land of Mongolia is dependent on climate conditions in the warm seasons. Potential evaporation sometimes exceeds precipitation. Currently, 33.5% of all potato fields are irrigated. In the future, water shortages due to climate change, will pose a significant challenge for the farming sector. Wide application of drip irrigation can play a vital role in sustaining agricultural production amid water shortage constraints. There are 244 irrigation systems registered in Mongolia. However, 102 of them are currently in use, mostly for vegetable and potato production, and only 22 of the currently operating irrigation systems have capacity to irrigate over 500 ha of agricultural land.

Mongolia first introduced drip irrigation systems in 1997 and its applicability has been proven. Currently, drip irrigation systems have been applied to about 100ha of agriculture land. The aim of developing drip irrigation systems is to help farmers reduce water consumption for vegetable production. However, current application of drip irrigation system wasn't as efficient as expected, because farmers main interest is developing crop production and regard water saving as a secondary priority. Availability of the technology is low due to limited import and high cost of equipments. Current practices show that the initial cost to purchase and install drip irrigation is 17 million *tugrigs* (12000 US$) per hectare including infrastructure such as water well and electricity supply.

The Government of Mongolia endorsed the "Third development of crop production" program in 2008, and a program on "Food security" in 2009. Mongolia's total crop production in 2012 was 460 700 metric tones of cereals, 232 000 tones of potatoes, 97 000 tones of vegetables (carrots, cucumbers, tomatoes etc.), and 44 400 tones of forage plants. The country's production of cereals and potatoes are able to meet the country's demand, however, the country still needs to import a large amount of vegetables and fruits to meet their needs.

A lack of vegetables and fruits contributes to insufficiency of essential vitamins and minerals that may cause malnourishment and stunting. Governmental and non-governmental organizations are much concerned about the problems posed by the limited variety of diet.

The parliament of Mongolia endorsed the national "Water" Program and accordingly, the national government developed an action plan to implement the program in 2010.

However, there is still high need of adaptation technologies in VPS to meet national demand on vegetable production, minimize water losses through evaporation, and to save water consumption. Future climate change impacts and environment degradation can hinder the development of sustainable and resilient vegetable production system. Therefore, drip irrigation technology has the highest priority among identified technologies in the arable farming sector. VPS consist of the production line equipment, control unit, motion controller and water reservoirs, and aims to achieve economically, environment friendly and socially sustainable agricultural production. Production line is a key component -the production line should be monitored inline to ensure the quality of products. Research on VPS has not yet started in Mongolia.

1.3.2 Introduction to the project

This project proposal was developed through consultation with stakeholders and key experts. Information was gathered through a desk review of past studies, implemented projects and programs and publications. Interviews and discussions with stakeholders were facilitated by key experts. There are three important phases of the technology transfer: research and development; deployment, and diffusion (Handbook for Conducting TNA, 2010). Research and development is a very important phase, which lays the foundation for drip irrigation technology diffusion in Mongolia.

The main goal of the project is to increase vegetable production by introducing water savings with drip irrigation and mulches in various climate zones in Mongolia.

Objectives of the pilot projects are:

- To introduce an integrated vegetable production system with drip irrigation and mulches and conduct research vegetable crop water requirements and how to meet them in small farming experimental fields in desert (*Gobi*), arid (Eastern steppe), semi-arid (Central) and cold arid (Western-mountainous) regions of Mongolia.

- To establish incentive mechanisms and enabling environment for farmers to apply environmentally sound irrigation and upscaling the best practice in these regions to meet national vegetable demand.

- Build capacity of vegetable and drip irrigation equipment producers and improve their knowledge and skills of the technology and practices.

The project is proposed to be implemented for six years to accomplish all three objectives.

1.3.3 Methodology

There are three expected outcomes for this project.

- Optimized water requirements for potato, cucumber, tomato, cabbage and two types of berries in different geographical zones.

- Development of capacity in VPS as well as providing soft loans, tax exemption for producing irrigation equipment in the country, which include heavy duty (soft) pipes, closed or open reservoir materials, water tanks and others.

- Education and awareness: Extensive awareness rising for vegetable producers and general public will be done through national and local media and press. Training packages for farmers will be developed and conducted by public and private training organizations.

1.3.4 Log frame of the project

Objective	Outputs	Key activities	Timeline	Possible complications/ challenges
To introduce drip irrigation system and mulches and conduct research to understand and find out how to meet vegetable crop water requirements	-Regional specific optimized crop water requirements, tested at small farming scale - Increased demonstration of R&D - Guidelines and instructions of drip irrigation	-Conduct complex research introducing the system and establishes irrigation norms and regimes, correlated with regional climate conditions -Facilitate diffusion introducing the system in these regions with involvement of stakeholders and end users -Experience sharing and learning from other countries	3 years	Sufficient funding for the demonstration and research is required from the Government and donors.
To establish incentive mechanism and enabling environment for farmers to apply environmentally sound irrigation and up scale the best practice in these regions to meet national vegetable demand	-Provided soft loans, tax exemption for introducing drip irrigation for vegetable crop and producing irrigation equipments as heavy duty (soft) pipes, closed or open reservoir materials, water tanks and others. -Increased vegetable crop production with drip irrigation in land area (at least 2000 ha)	- Develop regulations and endorsement for provision of soft loans and tax exemption for efficient agriculture -Provide technical support and monitoring efficiency of the system (crop production and water saving) -Facilitate demonstration of pilot site farming achievements	3 years	Financial measures (TAP report) should be taken place Legal environment should be established.
Build capacity of vegetable and drip irrigation equipment producers and improve their knowledge and skills of the technology and practices	-Established capacity for producing drip irrigation equipment (heavy duty (soft) pipes, closed or open reservoir materials, water tanks and others) -Increased vegetable production with drip irrigation and accordantly number of farmers who use the technology -Vegetable production will meet demand at markets	-Increase market demand for vegetable production and drip irrigation equipments through consultative process of stakeholders and endorsement by the government; -Develop training packages -Conduct trainings for sustainable vegetable producers -Facilitate public awareness raising	3 years	Regulations and financing

1.3.5 Partnering

Stakeholder	Role
Ministry of Industry and Agriculture	-Be main coordinator for the implementation -Ensure legal framework
Ministry of Environment and Green development	-Recommendation of adaptation technology and monitoring environmental flow requirements -Ensure alignment with climate change environmental programs
Public and private research institutions	-Implementing actor -Conduct research and development -Establish technical framework
Provincial agriculture extension centers	-Implementing actor -Piloting technology, bridge between research and practical application -Demonstration to farmers
Vegetable producers: farmers and companies	- Implementing actor -Learning and knowledge sharing
NGOs of drip irrigated vegetable producers	-Project monitoring and evaluation -Feedback to project implementation
Public and private training institutions	-Develop training packages -Conduct training
Media and press organizations	-Public awareness raising -Support knowledge and experience sharing

1.3.6 Cost and Benefit Analysis

Beside environmental benefits, the technology has several financial benefits-

- Overall, the technology would increase vegetable production by at least three times due to water saving and prevention of vast amount of evaporation loss, soil moisture retention and proper application of the system.

- Automated technology would reduce labour and costs of irrigation operations.

- An increase in vegetables and fruits contributes to an adequate amount of essential vitamins and can help solve the problems posed by the limited diet. Vegetable production could meet the national demand

Table 57: Budget of project implementation

Implementation year	Major activities	Estimated Cost
Year 1	-Build small farming test sites with drip irrigation and mulches and conduct research on crop water requirements; -Learning from other countries;	450,000 US$
Year 2	-Continue research and test and develop model sites; -Start piloting of drip irrigation farming sites; -Technical support for producing irrigation equipments	650,000 US$
Year 3	-Continue research and improve model sites/ practices; -Continue piloting of drip irrigation research and practices and models at regional level; -Develop legal framework for supporting vegetable and equipment producers; -Develop instructions and guidelines for the technology applications -Develop training packages and public awareness raising strategy	350,000 US$
Year 4	-Finalise research and develop recommendations -Continue piloting of the technology for 3rd year -conduct trainings and awareness raising about the technology	350,000 US$
Year 5	-Complete piloting of farming -Conduct trainings and awareness raising about the technology -Ensure legal, financial and other enabling environment through National programs, legal frameworks and others	200,000 US$
Year 6	-Ensure sustainability through legal and other enabling environment, handing over to the government; -Evaluate performance and results of the project	250,000 US$
Total:	**6 years**	**2,250,000 US$**

1.3.7 Impact Statements

Country social development priorities	Vegetables are the crop with the highest priority for national food security in Mongolia. The National Programme for Food Security (2009-2016) has an objective to make the country self-sufficient in vegetable production. Also, increasing application of water saving technologies in agriculture is one of the priorities in the National Programme on Climate Change. The goals of this project are aligned to achieve the related national programs objectives. Vegetable producers and farmers will see their livelihood improved because of increases in their income and improvements in the productivity of their water and land.
Country economic development priorities – economic benefits	The project will enable several advantages: • Increased vegetable production with efficient use of water resources; • Decreased labour and expense through application of the technology; • Vegetable producers will have more income and will gain financial stability. • Price of vegetable products will become more stable.
Country environmental development priorities - Environmental benefits	The technology fully aims to introduce environmentally sound practices in vegetable production system. These practices are: • Water savings and rational use • Retention of soil moisture • Proper application of the technology and minimized long term impact and adaptive to climate change
Social benefits	• Vegetable production will increase and be able to meet the demand that is basic welfare requirement. Knowledge and skills of the vegetable producers and farmers will be extended and their confidence in using environmentally sound and adaptive to climate technologies will be increased. • The legal environment will be more favorable and supportive to the transfer and application of climate technologies

1.3.8 Other considerations and priorities

This project intends to support R&D and deployment of drip irrigation technology. Within the project framework, access to proved practices will be improved and majority of small farms will use the technology after 6 years. Legal and business environment is in the diffusion stage. However, the enabling framework which is defined in the TAP, should be established within given time. If policy and regulations are supportive and financial and economic measures are taken, the diffusion of the technology up to 80 % of farms by 2023 can be assured.

Up scaling potential -The project is fully up scalable in regional and national levels to ensure VPS technology diffusion.

2. Project Ideas for the animal husbandry sector

2.1 Brief summary of the project ideas for the animal husbandry sector

Project ideas in the animal husbandry sector were identified with stakeholder participatory process based on the technology needs assessment, barrier analysis, enabling framework and the technology action plans. Three project ideas, one for each prioritized technology, have been developed and are listed in Table 58.

Table 58: Project ideas in the animal husbandry sector

Technology	Project name	Implementation period	Estimated budget, US$
Seasonal prediction and livestock early warning system (SPLEWS)	Improving seasonal prediction and livestock early warning system	4 years	1, 200 000
High quality livestock through selective breeding and animal health (HQL)	Strengthening animal health	7 years	2,400,000
Sustainable Pasture Management (SPM)	Improving pasture monitoring system	5 years	2,220,000

Detailed project proposals are defined in the below sections.

2.2 Project idea 1– Improving SPLEWS

<table>
<tr><td>Sector: Animal husbandry</td><td rowspan="2">How this technology contributes to adaptation:
Reducing vulnerability of livestock and herders family as managing weather and climate disaster risk
Improving herders community livelihoods and food security through seasonal prediction</td></tr>
<tr><td>Technology: Improving seasonal prediction and livestock early warning system</td></tr>
</table>

2.2.1 Brief introduction to SPLEWS

Seasonal prediction and livestock early warning system provides precise and timely information through identified institutions that allows herders and government officials to prepare for effective response to slow onset disasters including drought and *zud* and avoid or reduce. Due to the magnitude of economic loss, the primary focus of SPLEWS is mitigating disaster risk from drought and *zud* which are slow onset disasters (extreme climate). However, rapid onset disasters such as flood, storms and others (extreme weather) are considered in the technology too.

The current livestock sector is based on the traditional nomadic pasture system and herder families' livelihood is highly dependent on (and influenced by) weather and climate. Herder families need to make preparations for winter and spring and reduce their livestock losses during these seasons. When preparing for winter, the conditions of the previous summer in terms of vegetation growth and climate outlook are essential information for planning. Herders need to plan for migration, stockpile hay and fodder as well as other measures by decision makers at *soum*, *aimag* (province) and country levels. Annual economic losses caused by extreme weather and climate related natural disasters have increased in Mongolia. The tendency for increased frequency of climate extremes is expected to continue in the future. As a result, dry and harsh winter (*zud*) is highly likely to occur more frequently, causing risks for agriculture and nomadic livestock. Also, there is clear evidence of drought intensification in Mongolia under global climate change (MARCC, 2009).

SPLEWS has four main components- risk knowledge, monitoring and predicting, disseminating information and response. The main purpose of SPLEWS is that the earlier and more accurately we are able to predict short and long-term potential risks associated with natural and human-induced hazards, the more likely we will be able to manage and mitigate the disasters' impact on society, economies, and environment.

2.2.2 Introduction to the project

This project will develop comprehensive local seasonal dynamic-statistical prediction system in Mongolia. The final products of the project would be applicable for not only herders but also other social groups in the country. Therefore, the overall project goal is to strengthen SPLEWS based on improving seasonal prediction skill.

The specific objectives are:

- Develop localized multi- model ensemble prediction system as evaluating models in regard to their forecast capacity for Mongolia
- Forecast *zud* combining with pasture monitoring and seasonal forecast in Mongolia, and evaluating outputs against observation
- Organize web based training for herders community, especially for information application

The project is proposed to be implemented for three years to accomplish all three objectives.

2.2.3 Methodology

There are three outcomes in the project.

1. Develop multi- model ensemble prediction system: Modern statistical downscaling technique will be used in the development of seasonal prediction system based on outputs of multi model ensemble forecast system from international centres (global scale). Seasonal temperature and precipitation observation and forecast will be carried out at about 70 meteorological stations over the country in terms of regional scale.

2. Forecast *zud* disaster: Past summer pasture monitoring data including ground biomass measurement at 1550 points and MODIS satellite image production such as NDVI and snow cover etc., will be synthesized with seasonal forecast using Geographical Information System, to give early warning about zud as timely and effectively as possible.

3. Organize web based training for herder's community: Develop web pages of livestock early warning system and organize training for herders community and decision makers.

2.2.4 Log frame of the project

Objective	Outputs	Key activities	Timeline	Possible complications/ challenges
Develop multi model ensemble prediction system	-Hind cast assessment and analysis of multi models from 1981 to present -Human capacity building	-Drought and *zud* events analysis and large scale prediction test -Statistical downscaling scheme development and evaluation -Equip with high performance computer peripherals and software -Conduct trainings for specialists.	2 years;	Collaboration among research institutions and their roles are clearly defined in the activities.
Forecast *zud* disaster and improve preparedness plan for livestock	-Introduce IT technology into ground biomass measurement at 1550 points - Calibrate of MODIS satellite image production with ground measurement. -Human capacity building on image processing and GIS application	-Facilitate agro-meteorological post with camera and IT technology into ground pasture monitoring system -Conduct research satellite image processing and comparison with ground measurement -Share experiences and learn from other international centres;	2 years	Especially, systematic training on field for agro-meteorological observer is much more needed.
Organize web based training for herder's community	-Drought/*zud* vulnerability-risk maps composition -Web page building and training for application of SPLEWS output	-Develop web based operational system and composite maps -Provide technical support and monitoring -Facilitate demonstration of training for application of SPLEWS output among the herder's community -Application of user manual	1 year	Lack of communication infrastructure from province centre to *soum* and herder communities

2.2.5 Partnering

Stakeholder	Role
Ministry of Industry and Agriculture	-Livestock and risk management
Ministry of Environment and Green development	-Recommendation of adaptation technology -Ensure alignment with climate change environmental programs
National Agency for Meteorology and Environment Monitoring	-Main coordination of implementation -Future role in scaling up the technology nationally
Research institutions	-Implementing actor -Conducting research and development -Establishing technical framework
National Emergency Management Agency	-Implementing actor -Piloting technology, bridge between research and practical application -Demonstration to herders

Herders and herders' groups	- Implementing actor -Learning and knowledge sharing
NGOs of herders	-Project monitoring and evaluation -Feedback to project implementation
Public and private training institutions	-Develop training packages -Conduct training
Media and press organizations	-Public awareness raising -Support knowledge and experience sharing

2.2.6 Cost and Benefit Analysis

Relatively, precise seasonal prediction and proper preparation for *zud* would result in saving about 80% of animals which die every winter. This technology is targeted beneficiary groups are the whole society, including herding and farming communities and other citizens.

Table 59: Budget of project implementation

Implementation year	Major activities	Estimated Cost
Year 1	- Drought and *zud* events analysis and large scale prediction test and validation - Statistical downscaling scheme development and evaluation - Equip with high performance computer peripherals and software - Conduct trainings for specialists;	450,000 US$
Year 2	- Facilitate agro-meteorological post with camera and IT technology into ground pasture monitoring system - Conduct research satellite image processing and comparison with ground measurement - Conduct trainings for specialists; - experience sharing and learning from other international centres.	350,000 US$
Year 3	- Review and improvement of system and tools - Develop training curricula and handouts - Application of user manual - Conduct trainings for specialists; - Experience sharing and learning from other international centres.	200,000 US$
Year 4	- Develop web based operational system and composite maps - Provide technical support and monitoring - Facilitate demonstration of training for application of SPLEWS output among the herder's community	200,000 US$
Total:	**4 years**	**1,200,000 US$**

2.2.7 Impact statements

Country social development priorities	Currently the livestock sector is based on traditional nomadic pasture system and herder families' livelihood is highly dependent on and influenced by the weather and climate conditions. Herder families need to make preparations for winter and spring and reduce their livestock loss during these seasons. Practically, seasonal prediction and proper preparation for *zud* could result in saving about 80% of animals which die every winter. This technology belongs to non-market goods and its targeted beneficiary groups are the whole society, including herding and farming communities and other citizens.
Country economic development priorities – economic benefits	The technology reduces vulnerability of the livestock sector to extreme weather climate disasters through more effective climate risk management. Seasonal prediction and livestock early warning system would improve herder communities' resilience to climate change, improving the country's food security and safety, and improve their livelihoods and income diversification.
Country environmental development priorities - - Environmental benefits	There is no significant direct benefit to environment. However, the technology has the indirect benefit which would help to decision makers in water resource, arable farming and livestock sectors management –this has benefits natural resources and ecosystem service.
Social benefits	Knowledge and skills of herders and their experience and resilience will be improved and their disaster preparedness would be strengthened. Traditional lifestyle and nomadic animal husbandry can be conserved in more sustainable ways.

2.2.8 Other considerations and priorities

Some market support measures are important for the successes of the technology diffusion. Intensifying local market of animal products will play crucial role because herders can benefit from the technology and gain more income with reducing risk.

Up scaling potential- The project outcomes will be fully scalable up from *soum* to province, province to national level supportive to achieve targets of SPLEWS technology which is 80 % of herding families by 2018.

2.3 Project idea 2 – Strengthening High Quality Livestock systems

Sector: Animal husbandry	**How this technology contributes to adaptation:** • Improved livestock quality and resilience to climate change; • Control of animal disease including vector borne diseases; • Opportunity to control animal numbers and reduce pasture degradation
Technology: High quality livestock through selective breeding and animal disease management	

2.3.1 Brief introduction to the HQL

In 2012, Mongolia has an estimated 40 million livestock, including horses, cattle, camels, sheep and goats. High quality livestock (HQL) technology aims to improve the quality of all animals in *aimags* and *soums* based on selective breeding using core herds and improved animal health services. Diffusion of the technology would enable Mongolia to control livestock number within its pasture carrying capacity and reduce overgrazing and desertification.

The technology includes two big components, which are selective breeding and animal disease management. Genetic make-up influences livestock' health conditions and adaptation capacity and determines an animal's tolerance to shocks such as temperature extremes, droughts, flooding, pests and diseases. Adaptation capacity to harsh environments includes heat tolerance and an animal's ability to survive, grow and reproduce in the presence of poor seasonal nutrition as well as parasites and diseases. Using advanced breeding techniques such as artificial insemination combined with traditional methods would allow for the breeding of high quality animals which are resistant to drought, thermal stress, harsh winter and parasites and diseases.

The selective breeding technology is a kind of 'consumer good' because it targets at animals for commercial and household use by herders and animal breeding farms.

The livestock disease management component itself consists of prevention and control which help to achieve higher production, lower morbidity and mortality, and less loss of animal production. The major impacts of climate change on livestock diseases have been the expansion of vector-borne diseases. Climate changes could also influence disease distribution indirectly through changes in the distribution of livestock. A comprehensive disease management system has been identified as essential for Mongolian livestock for climate change adaptation.

National level surveillance of infectious diseases among animals and management of appropriate preventive measures are urgently needed in Mongolia.

2.3.2 Introduction to the project

This project proposal was developed by stakeholders and key experts based on technology prioritization, enabling framework analysis and the technology action plan.

The main goal of the project is to improve livestock quality in Mongolia. There are three main objectives of the pilot project, which are:

- To build capacity of the animal health and breeding units and specialists at local level;
- To support R& D of HQL technology in Mongolia; and
- To pilot selective breeding and animal health practices at local level.

The project is proposed to be implemented for seven years to accomplish all three objectives.

2.3.3 Methodology

There are three outcomes in the project.

1. Capacity building for animal health and breeding specialists: Capacity building for specialists will be done through several steps like present capacity assessment, development of capacity building plan and implementing capacity building activities.

2. Research and development of HQL: Public and private research institutions will work on research and development of selective breeding techniques and veterinary practices. Training and demonstration of the technology will be carried out.

3. Piloting of selective breeding and veterinary practices: Tested selective breeding and veterinary practices will be piloted in at least 30 *soums* in Mongolia. Successes and lessons learnt will be shared with the herders and public and awareness raising about the technology benefits will be conducted.

2.3.4 Logframe of the project

Objective	Outputs	Key activities	Timeline	Possible complications/ challenges
Research and development of HQL	-Studied and tested selective breeding techniques and veterinary practices -Laboratory test guidelines and instructions of practices and techniques developed	-Review current and desired status HQL and related technical and human capacity -Conduct research and test in laboratory or at small scale -Facilitate discussion on research results and improvements with stakeholders and end users; -Develop guidelines instructions of technology to apply in practices of herders and specialists -Experience sharing and learning from other countries.	3 years	Selective breeding usually takes longer period. But intensifying promising research can shorten time.
Build capacity of the animal health and breeding units and specialists	-Assessment of present capacity of local animal health and breeding units and gap analysis -Developed capacity building plan for long and short term scales	-Assess present and required capacity and identify gaps -Develop HR capacity building plan for short and long term; -Develop training packages -Support local animal health and breeding units with facilities; -Conduct trainings for specialists; -Develop communication and awareness raising strategy for the technology diffusion -Conduct public awareness raising;	2 years;	Roles and responsibilities of public and private services should be clear to develop capacity building plan.
Piloting of selective breeding and veterinary practices	-Increased demonstration of R&D -30 *soums* will pilot the proposed techniques and practices of HQL -Increased number of high quality livestock -Established comprehensive surveillance system of animal diseases	-Pilot identified models and practices at local sites -Provide technical support and monitoring -Facilitate demonstration of pilots -Establish animal disease surveillance system	3 years	Legal and financial (subsidy policy) environment should be established;

2.3.5 Partnering

Stakeholder	Role
Ministry of Industry and Agriculture	-Ensure legal framework
Ministry of Environment and Green Development	-Recommendation of adaptation technology -Ensure alignment with climate change environmental programs
National Animal Health and Breeding Agency	-Main coordination of implementation -future role in scaling up the technology nationally
Public and private research institutions	-Implementing actor -Conduct research and development -Establish technical framework
Local animal health and breeding units	-Implementing actor -Piloting technology, bridge between research and practical application -Demonstration to herders
Herders and herders' groups	- Implementing actor -Learning and knowledge sharing
NGOs of herders	-Project monitoring and evaluation -Feedback to project implementation
Public and private training institutions	-Develop training packages -Conduct training
Media and press organizations	-Public awareness raising -Support knowledge and experience sharing

2.3.6 Cost and Benefit Analysis

Beside environmental benefits, the technology has several financial benefits. Overall, the technology would increase animal production due to selective breeding and increase animal disease management. High production of livestock would give an opportunity to reduce the total number of livestock within current pasture carrying capacity.

Table 60: Budget of project implementation

Implementation year	Major activities	Required Cost
Year 1	-Review of current status of public and private service providers -Study current and traditional practices related to HQL -Start research and development	400,000 US$
Year 2	-Continue research, test and develop techniques/practices; -Support local animal health and breeding units -Conduct capacity assessment and gap analysis -Development of capacity building plan -Develop training packages and awareness strategy for public -Pilot training and communication plans	50,000 US$
Year 3	-Continue research and improve techniques/practices -Identify pilot *soums* for HQL technology -Conduct extensive training events	350,000 US$
Year 4	--Continue research and improve techniques/practices -Start pilot of HQL techniques -Conduct trainings and awareness raising about the technology -Study current status of surveillance system of animal disease and identify gaps	350,000 US$
Year 5	-Continue research and development -Continue piloting of HQL -Conduct trainings and awareness raising about the technology -Set up comprehensive surveillance system and test the system -Develop scale up plan for HQL technology	350,000 US$
Year 6	-Complete HQL technology piloting -Conduct trainings and awareness raising about the technology -complete establishment of animal diseases' surveillance system and make it operational	300,000
Year 7	-Complete piloting of HQL -Carry out evaluation of the project -Develop sustainability and scale up plan for HQL technology	200,000
Total:	**7 years**	**2,400,000 US$**

2.3.7 Impact statements

Country social development priorities	The National Livestock Program and the Mongolian Law of Gene Pool and Animal Health are the legal enabling frameworks for HOL technology. The current number of livestock (about 40 million), is posing an excessive pressure on pasture and environment. HQL technology will control animal numbers through increased productivity of livestock. The benefits of livestock breeding and disease management includes: higher production (as morbidity is lowered and mortality or early culling is reduced), and avoided future control costs. When herders mitigate disease through disease management, they benefit not only themselves but also other social groups at risk of adverse outcomes from the presence of disease. At-risk populations include herders, local residents, and consumers. The beneficiaries might also include at-risk wildlife populations surrounding the area that may have direct or indirect contact with livestock or livestock-related material.
Country economic development priorities – economic benefits	Outcomes of the technology are improved livestock health and resilience to climate change, increased food security and safety, more access to urban and international markets of animal products. - Profit from increased livestock can benefit herders. Training can be done in classes as well as through distance learning. - State policy of safe and clean food supply to population will be implemented. - Herders would have fewer animals and higher production and income. Pasture management would be improved
Country environmental development priorities – Environmental benefits	Herders would own the breeds which are resilient to climate change, adapted to local context and possess the highest production. Animal numbers and composition (ratio between sheep and goats play critical role in pasture degradation) can be controlled. Greenhouse gas emissions would be decreased and herders would have access to carbon market.
Social benefits	The knowledge and skills of herders and animal health and breeding specialists will be extended and their confidence in using environmentally sound and climate technologies will be increased. Traditional lifestyle and nomadic animal husbandry can be conserved in more sustainable ways.

2.3.8 Other considerations and priorities

Some market support measures are important for the successes of the technology diffusion. Intensifying local market of animal products will play a crucial role because herders can benefit from the technology and gain more income. Subsidy policy will provide confidence to herders to possess high quality healthy animals. Therefore, legal and business environment is important for the up scaling of the project and the diffusion of HQL technology.

Up scaling potential - The project outcomes can be fully scaled up throughout the country and supportive to achieve the target of increasing the HQL technology penetration rate to 60 % among herding families by 2020.

2.4 Project idea 3 – Improving pasture monitoring system in Mongolia

Sector: Animal husbandry	**How this technology contributes to adaptation:** • Reduce pasture degradation; • Improve pasture management; • Reduce risk of livestock to natural disasters of drought and severe winter/*zud*.
Technology: Sustainable Pasture Management	

2.4.1 Brief introduction to SPM

Sustainable Pasture Management (SPM) is identified as a climate change adaptation technology in the animal husbandry sector for the benefits of sustaining soil fertility and restoring degraded pasture in the country, supporting livestock raising, alleviating rural poverty and building resistance to major environmental challenges. Pasture degradation has already taken place to various degrees and the objective of sustainable pasture management needs to include restoring degraded land while preventing further degradation of any non-degraded land to ensure continued ecosystem health and functions.

Mongolia has an estimated 40 million[32] livestock in an area of 1.1 million km^2 of rangeland. Pastureland is the backbone of Mongolia's agriculture sector. Pasture degradation and desertification is among the most serious environmental problems facing the country. In Mongolia, pasture degradation is widespread and occurs in all natural zones at different intensities. Pasture is the main source of livestock food and herders' livelihood in Mongolia. Well managed pasture helps protect environment and natural resources and facilitate the provision of ecological functions and services in a sustainable manner.

Pasture degradation in the country are manifested in several ways: decreased biomass production, soil fertility declines, desertification, fewer and unpalatable plant species. These factors have been exacerbated by physical damage by human activities. At present, about 70% of the pastureland is degraded in some aspect. Overgrazing, off-road driving, mining, global warming, low precipitation and lack of land management skills are causing more and more problems for the ranges in Mongolia. Thus, it is becoming increasingly difficult for Mongolia to provide the necessary amount of fodder for the existing number of livestock that is the main source of income for more than one third of Mongolia's population.

There can be different categories of pastures depending on usage and each type of pasture requires different ways of pasture management, depending on different factors related to local environment, geography and socio-economic context.

Therefore, comprehensive sustainable pasture management (SPM) will contribute to conservation of land associated natural resources and increase livestock productivity. This can directly increase the nation's resilience to the negative impacts of climate change and generate widespread benefits for producers as well as consumers.

32. National Statistical Yearbook Mongolia, 2011

2.4.2 Introduction to the project

Pasture experts have developed the project proposal along with stakeholders who are involved in pasture related projects, government organizations and community relations. Studies of publications about scientific research and pilot projects, discussion and interviews with stakeholders were carried out. SPM has several components such as pasture monitoring, appropriate grazing schemes based on pasture, water and other resources; supplement forage production and ecosystem conservation actions. The backbone of SPM is good pasture monitoring for Mongolia. Therefore the projects intends to improve the pasture monitoring system which is background of pasture and other resource management, developing grazing scheme, and other animal management planning.

The main objectives of the projects are:

- To improve pasture monitoring system through using advanced communication technology
- To develop grazing schemes and restoration plan of degraded pastures
- To pilot developed grazing schemes and pasture restoration practices at *soum* levels

The project is proposed to be implemented for 4 years to accomplish all three objectives.

2.4.3 Methodology

Under the main objectives, the following main activities will be carried out:

- Improving pasture monitoring system: Presently, pasture monitoring is done based on national meteorology and environment observation networks. Observers and technicians of weather stations and posts conduct pasture plant observation every ten days. The observations are done manually, recorded on paper and sent to province centers and then to the national center. This work is very labor intensive and the results often contain human biased errors. One objective is to help automate this procedure through using mobile communication devices and real time data transmission. Using the advanced devices and communication technology would allow for involving volunteers and herders in the monitoring of pasture.

- Develop grazing schemes and restoration plan for degraded pastures: When pasture monitoring is done at fine level (*soum* level), mapping of pasture will be done using other techniques such as GIS, modeling and some software. Based on mapping, detailed grazing schemes can be developed. Pasture restoration methods will be developed and tested at research fields in different natural zones. Education and awareness raising will be done extensively for herders and pasture and livestock specialists.

- Pilot developed grazing schemes and pasture restoration practices at *soum* levels. *Soum* government along with herders and animal and pasture specialists make grazing plan for different seasons based on pasture monitoring information and mapping. This process will be participatory because it affects all herders in a *soum*. This activity will help ensure efficient enforcement of the Law of Pasture which is under discussion presently.

2.4.4 Log frame of the project

Objective	Outputs	Key activities	Timeline	Possible complications/ challenges
Improving pasture monitoring system	-Developed and tested pasture monitoring methodology - Guidelines and instructions pasture monitoring and mapping	-Develop hardware and software programs using advanced mapping and communication devices -Test of equipments for pasture monitoring and communication channels -Develop guidelines and instruction for pasture monitoring and mapping -Conduct trainings about the new techniques	2 years;	Transmission of data can cost more. However other affordable channel can be explored.
Develop grazing schemes and restoration plan of degraded pastures	-Guideline and instruction to develop grazing schemes -Tested and proved restoration methods for degraded pasture	-Identify methodology for developing preparing grazing schemes at *soum* level -Conduct research and test pasture restoration methodologies -Develop training programs and conduct training for different audiences -Ensure participation of herders and agriculture specialists in the process at *soum* and *aimag* level	2 years	Procedure to reach consensus of *soum* herders should be in place.
Pilot developed grazing schemes and pasture restoration practices	-Demonstration of grazing scheme and restoration methods -At least 20 *soums* will pilot the technology.	-Implement identified grazing schemes and restoration activities at *soum* level. -Evaluate and if necessary, improve pasture monitoring grazing schemes	2 years	Law of Pasture should be supportive to implement grazing schemes and restoration measures.

2.4.5 Partnering

Stakeholder	Role
Ministry of Industry and Agriculture	-Ensure legal framework -Evaluation of the project
Ministry of Environment and Green Development	-Recommendation of adaptation technology -Ensure alignment with climate change environmental programs
Public and private research institutions	-Develop methodology of pasture monitoring and mapping -Conduct research and development -Establish technical framework -Develop guidelines and instructions for users -Provide technical support to users
Provincial and *soum* governments	-Implementing actor -Facilitate process of identifying grazing schemes -Ensure implementation of grazing schemes and pasture restoration measures
Herders and herders groups	- Implementing actor -Learning and knowledge sharing

Pasture and herder NGOs	-Project monitoring and evaluation -Feedback and recommendations to project implementation
Public and private training institutions	-Develop training packages -Conduct training
Media and press organizations	-Public awareness raising -Support knowledge and experience sharing

2.4.6 Budget of project implementation

Year	Main components	Estimated Cost
Year 1	-Equipments and software programs for pasture monitoring – 400,000 US$ -Analysis of endorsement process of Pasture Law - 20,000 US$-Research and development of pasture monitoring– 100,000 US$	520,000 US$
Year 2	-Research and development – 100,000 US$ -Software and equipments for mapping and modeling – 250,000 US$ -Support endorsement process of Pasture Law - 30,000 US$ -Development of training packages and testing curricula– 40,000 US$	420,000 US$
Year 3	-Capacity building at *soum* levels (herders as well as officials) – 100,000 US$ -Support endorsement process of Pasture Law - 30,000 US$ -Piloting of grazing schemes and restoration measures -400,000 US$	530,000 US$
Year 4	-Piloting of grazing schemes and restoration measures -400,000 US$ -Support implementation of Pasture Law - 100,000 US$	500,000 US$
Year 5	-Wrapping up grazing schemes and restoration measures -150,000 US$ -Evaluation, lessons learnt and recommendations for scaling up –100,000 US$	250,000 US$
Total:	**5 years**	**2,220,000 US$**

2.4.7 Impact statements

Country social development priorities	Definitely, pasture management is an emerging issue in Mongolia where traditional nomadic animal husbandry exists. Currently, the Mongolian Law of Pasture has been under discussion among specialists and public for several years. If the law is passed, the project could play an important role to establish promising practice through developing grazing scheme based on local context and pasture monitoring. The following social benefits characterizes the project: • Increased income of herders • Increased food security • Alleviate rural poverty • Improved livelihoods • Sustaining traditional lifestyles • Improved social sustainability and cooperation of different stakeholders
Country economic development priorities – economic benefits	Animal husbandry will continue to be one of the major economic sectors. The technology is aligned with objectives of National Livestock Program, and National Action Programme on Climate Change. The project will ensure several economic advantages: • Development of the animal husbandry sector • Increased economic status of herders;
Country environmental development priorities – Environmental benefits	Environmental benefits are followed: • Increased biomass and vegetation • Restored biological diversity including plant species • Sustained water sources (open and ground) • Increased soil fertility • Reduced risks of natural disasters • Ensured ecological sustainability and ecosystem functions and services
Social benefits	• Knowledge and skills of herders regarding to pasture management will be extended and applied in animal raising practices. Herders social active-ness and participation in planning, decision making and evaluation will be increased through the project implementation. Mongolian Law of Pasture will play an important role in legal enabling framework.

Up scaling potential– During the project, at least 40 *soums* will pilot updated pasture monitoring technique and identified grazing schemes. The promising practices can be scaled up and will reach the target of the technology.

LIST OF REFERENCES 4

Sources of the data and statements quoted in the reports, graphs, and tables should be indicated in their short form (such as: UNDP, 2010) in the context, and in their long form here (such as: UNDP, 2010, Handbook for Conducting Technology Needs Assessment for Climate Change, the United Nations Development Programme, New York, November 2010.)

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ANNEX 8. LIST OF STAKEHOLDERS INVOLVED AND THEIR CONTACTS

Sector/ Technology	Expert/ Stakeholder Name	Organization	Approach of consultation	Time	Topic
Key experts:					
Leader	Dr. P.Gomboluudev	Institute of Meteorology and Hydrology; p_gombo@hotmail.com	Leading and supervising all activities	Daily	Project ideas; Compiling report
Agriculture/ Arable Farming	B.Bolortsetseg	Climate Change, Nature and Society NGO; ccnsMongolia@gmail.com	Leading Agriculture Working Group	Daily	Project ideas; Compiling report
Arable Farming	Dr. G.Davaadorj	Project of Desertification and Mitigation, Swiss Development Agency; GDavaadorj2001@yahoo.com	Key consultant	Every week	Project- SWI and SPM
Water	Dr. G.Davaa	Water sector, Institute of Meteorology and Hydrology, watersect@yahoo.com	Key consultant	Every week	Project- Drip irrigation
Pasture	B.Erdenetsetseg	Agriculture sector, IMH, erdtsetseg@yahoo.com	Key consultant	Every week	Project- Sustainable pasture management
Animal husbandry	B.Binye	Livestock management Department, Ministry of Industry and Agriculture	Key consultant	Every week	Project- HQL and sustainable pasture management
Natural disaster	Dr. L.Natsagdorj	Consultant, IMH, natsag03@yahoo.com	Key consultant	Every week	Project- SPLEWS
Environment	Nicholas Harris	Environment specialist, harris.nicholas@gmail.com	Meeting	Monthly	Review of the report and project ideas
Arable Farming	Dr. G.Bayarsukh	Research Institute of Planting and Arable Farming, National University of Agriculture; bayar67@yahoo.com	Workshop and meeting	Monthly	Project- SWI
Animal husbandry	Dr. Togtokhbayar	Director of Research Institute of Animal Husbandry	Workshop and meeting	Monthly	Project- High quality livestock
Animal husbandry	Dr. P.Gankhuyag	Head of Livestock Policy Sector, Ministry of Food, Agriculture and Industry,	Workshop and meeting	Monthly	Project- Sustainable pasture management
Water	Dr. T.Oyunbaatar	Water sector, IMH,	Meeting	Once a month	Project- VPS

Water	Dr. Sh.Baranchuluun	Head of Water Department, Ministry of Industry and Agriculture	Meeting	Once a month	Project- VPS
Environment and Adaptation	D.Tsognamsrai	National desertification Committee, Ministry of Environment and Green development	Workshop	1 time	TAP and project ideas
Environment and Adaptation	P.Ongonsar	GIZ officer	Workshop	1 time	TAP and project ideas
Environment and Adaptation	Ts.Tuya	Ecosystem based Adaptation project, Ministry of Environment and green development	Workshop	1 time	TAP and project ideas
Environment and Adaptation	B.Sumiyasuren	Ecosystem based Adaptation project, Ministry of Environment and green development	Workshop and meeting	2 times	TAP and project ideas
Environment and Adaptation	N.Otgonjargal	Ecosystem based Adaptation project, Ministry of Environment and green development	Workshop and meeting	2 times	TAP and project ideas
Pasture management	P. Gereltuya	GIZ officer	Workshop	1 time	TAP and project ideas
Human health	Dr. B.Burmaajav	Institute of Nutrition, Ministry of Health	Workshop	1 time	TAP and project ideas;
Arable farming	T. Tuvshinzaya	*Bayantsogt* Company; wheat and vegetable farming, *Tuv aimag*	Interview and discussion	2 times	Project idea - SWI
Agriculture	S.Tsogoo	Greenhouse company, agriculture supplier	Interview	1 time	Project idea - VPS
Arable farming	R.Nyamsuren	Small scale farmer (vegetable and berry) in *Khan-Uul* district, UB	Interview and discussion	2 times	Project idea- VPS
Livestock	Z.Dorj	Herder, *Bayantsogt soum, Tuv aimag*	Interview	1 time	Project ideas- SPLEWS, HQL and SPM
Arable farming	Lopilmaa	Household gardening project coordinator, NGO	Interview and discussion	3 times	Project ideas – SWI and VPS

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