Republic of Moldova

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION

REPORT I

TECHNOLOGY PRIORITISATION

May, 2012

Supported by

PREFACE

The Republic of Moldova has signed the United Nations Framework Convention on Climate Change (UNFCCC) on June 12, 1992, ratified it on March 16, 1995 and for our country the Convention entered into force on September 7, 1995. On January 28, 2011 the Republic of Moldova has associated with the Copenhagen Agreement of the United Nations Framework on Climate Change. Under this Agreement, our country has set a new target aimed at Greenhouse Gas (GHG) emissions reduction, specifying " reduction of total national levels of GHG emissions by not less than 25% by 2020 compared to the reference year (1990). Hereby, it is determined that this target shall be achieved by implementing global economic mechanisms focused on mitigating climate change in accordance with UNFCCC principles and decisions."

The recent and underway policies of the Republic of Moldova on climate change mitigation are aimed at promoting energy efficiency and renewable energy sources in all sectors of the national economy, systematic afforestation activities and rational land management, promoting innovative approaches and environmentally friendly technologies and exploring carbon financing mechanisms.

In conformity with the general objective of the Convention, which sets as a target the maximum global average temperature growth until 2100 by no more than 2^0C, the Republic of Moldova has decided to undertake a transition to a low GHG emissions development path. The first step in this direction was made in 2011 when development of the Low-Emission Development Strategy and Climate Change Adaptation Strategy started. Approval of these strategies is planned for 2013, which will allow access to the long-term financing mechanisms under the Convention to implement the so-called Nationally Appropriate Mitigation Actions (NAMA) and adaptation measures. Technology needs assessment in the context of climate change mitigation and adaptation is a crucial first step in achieving the objectives of these strategies. Methodological aspects of evaluation and identification of appropriate technologies in climate change mitigation and adaptation revealed during the TNA will serve as a starting point in promoting them nationwide. In the future the Republic of Moldova will address climate change issues so, that they can be included in all national and sector development policies and strategies of the country. This status will allow our country to get integrated in the global process of climate change mitigation and adaptation to this phenomenon at the national level.

ACKNOWLEDGMENTS

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 Asian Institute for Technology (AIT), 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 is a product of the National TNA team, led by the Ministry of Environment of the Republic of Moldova.

ABBREVIATIONS

ACSA	Agency for Consultancy and Training in Agriculture
ASM	Academy of Sciences of Moldova
BG	Botanical Garden Research Institute
CDM	Clean Development Mechanism
CISRA	Centralized Irrigation System Rehabilitation Activity
GEF	Global Environment Facility
GRI	Genetic Research Institute
ICSR	Institute of Crop Sciences Research
ITFR	Institute of Fruits Trees Research
LEDS	Low Emission Development Strategy
MAFI	Ministry of Agriculture and Food Industry
MCC	Project funded by the Millennium Challenge Corporation
MCDA	Multi Criteria Decision Analysis
MDG	Millennium Development Goals
MFNC	Moldova's First National Communication under the UNFCCC
MoEN	Ministry of Environment
MSNC	Moldova's Second National Communication under the UNFCCC
NCCAS	National Climate Change Adaptation Strategy
NDS	National Development Strategy
NHDR	National Human Development Report
NIWVR	National Institute of Wine and Viticulture Research
NPEE	National Programme on Energy Efficiency
NSNHM	National Strategy of Natural Hazards Mitigation
RIMS	Institute for Maize and Sorghum Research
SHS	State Hydro meteorological Service
TAP	Technology Action Plan
TFS	Technology Fact Sheet
THVA	Transition to High Value Agriculture
UASM	State Agricultural University of Moldova
UNFCCC	United Nations Framework Convention on Climate Change

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

FOREWORD

I am proud to provide a foreword to this report, which is one of the outputs of the 'Technology Needs Assessment' (TNA) conducted in Moldova. The TNA process was coordinated by the Ministry of Environment through Climate Change Office (CCO), who, with the help of local experts, conducted a thorough stakeholder consultation and analysis of the technical and policy options for increasing the use of low-carbon and climate-resilient technologies in Moldova.

Following methodological and technical assistance provided by the UNEP Risø Centre, the CCO facilitated a stakeholder-led Multi Criteria Analysis for the prioritisation of both mitigation and adaptation-side technologies. This was followed by stakeholder consultations regarding the most important barriers to the uptake of these technologies, and what can be done to overcome them.

The TNA process has finalised with Technology Action Plans (TAPs) that provide a clear and realistic road map to reforming market incentives and attracting investment in specific technologies. As such, these documents allow us to facilitate the transfer of key climate technologies that also serve to drive economic growth and development. Above all, the TAPs offer practical solutions for the sustainable development of the country's agricultural sector, upon which we depend heavily for our income and livelihoods.

Gheorghe Șalaru

Minister of Environment of the Republic of Moldova

March 2013

Report I

Technology Needs Assessments

Executive Summary

Successive agreements made between Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have highlighted the need to accelerate the transfer of environmentally-sound technologies to developing countries. The TNA Project provides a great opportunity for the Republic of Moldova to perform country-driven technology assessment to identify contemporary, environmentally sound technologies that might be implemented with a significant contribution in addressing climate change adaptation needs of the country. Technology Needs Assessment Project is country driven and is done through a consultative process that engages relevant stakeholders.

The purpose of this TNA Project is to assist participant developing country Parties identify and analyse priority technology needs, which can form the basis for a portfolio of environmentally sound technology projects and programmes to facilitate the transfer of, and access to, the ESTs and know-how in the implementation of Article 4.5 of the UNFCC Convention.

The scope of TNA Project is to perform a country- specific evaluation of the current technological state in the most vulnerable to climate change sectors of the Republic of Moldova's economy for identifying and analysing priority technology needs for climate change mitigation and adaptation. The output of the TNA Project is the portfolio projects using high efficiency, environmentally sustainable technologies.

The overall objective of this Project comprises technology needs assessment, activities associated with sector and technology prioritization, with high involvement of experts and stakeholders, which encourage the creation of enabling environment for the transfer of environmentally sound technologies. The Project also aims to identify barriers hindering the acquisition, deployment, and diffusion of prioritized technologies and to develop Technology Action Plans (TAP) specifying activities and enabling frameworks to overcome the barriers and facilitate the transfer, adoption, and diffusion of selected technologies.

The working groups of both Mitigation and Adaption components have consulted a number of official documents (Republic of Moldova development strategies, sectorial strategies, sectorial plans, and other relevant materials) and have clustered the national development priorities with relevance to climate change. These priorities, which reflect national circumstances, have been considered in each step of technological evaluation.

The Institutional setup for TNA Project includes TNA Coordinator, National TNA Team, a National TNA Committee and National consultants/experts organized in workgroups. A National Steering Committee is envisaged as the top most decision making body of the TNA Project, comprising policy makers from relevant key ministries.

During inception workshop, the TNA Team and stakeholders agreed upon activities to be implemented during Project lifetime and budget allocated. A detailed draft of Work Plan was elaborated and discussed with stakeholders, the final version was endorsed by the stakeholders and experts.

The TNA activities involved stakeholders from key institutions (Ministry of Environment, Ministry of Agriculture and Food Industry, Ministry of Health of the Republic of Moldova), Ministry of Economy in all stages of technology prioritization to ensure relevance of appraised technologies and to engage stakeholders that will be central to implementation of prioritized technologies. They have been involved in the clustering of national priorities with relevance to climate change, in sector and technology prioritization.

In the implementing TNA Project the methodological guidance was provided during TNA workshop in Bangkok, Thailand (8-11 August, 2011) and the following methodological sources have been consulted: UNDP Handbook *Technology Needs Assessment for Climate Change*, Climate TechWiki website, *Multi-criteria analysis:* a *manual*, the TNA guide *Technologies for Climate Change Adaptation, Agriculture sector*, guidance provided by URC Country Coordinator, UNEP Risø Centre website information, Asian Institute of Technology.

According to the TNA Project Work Plan, during the meetings of sectoral working groups, the representatives from Ministry of Environment, Ministry of Agriculture and Food Industry and Ministry of Health of the Republic of Moldova, experts, specialists from the main sectors of economy (Agriculture, Energy, Human Health, Water resources, Tourism, Forestry) have applied Multi criteria Analysis to conduct sector's and technology's evaluations.

For Adaptation component, an overview of sectors profile in relation to climate change vulnerability, environmental impact and adaptation options has been prepared for Agriculture, Forestry, Energy, Tourism, Transport, Human Health, Biodiversity and Ecosystem sectors. The Short List of sectors in Adaptation component consists of (i) Agriculture and (ii) Human Health Sectors.

Republic of Moldova

For the purpose of getting informed on the current technological status, the experts have provided the information about the current status of most common practices, techniques and measures currently used in the Agriculture and Human Health sectors of the Republic of Moldova.

An overview of possible adaptation technology options in Agriculture sector and their adaptation benefits has been provided in the current Report. The Long List of technology options in the Agriculture sector consists of proposed 33 adaptation technologies in the areas of Crop production, Agriculture Soil Management, Livestock Production, Biotechnology, Agricultural Insurance and Irrigation Systems.

Overviews of possible adaptation technology options in Agriculture and adaptation measures in Human Health sectors and their adaptation benefits have been presented in the current Report. Technology options have been elaborated in Technological Fact Sheets format and annexed to the Report.

Objectives, criteria and indicators of technological evaluation were organized by clustering them under different levels of hierarchy and presented in the Hierarchy Value Tree of Agriculture and Human Health Sectors. The final Long List of adaptation technological options of the Agriculture sector consisted of proposed 28 adaptation technologies in the areas of Crop Production, Agriculture Soils Management, Livestock Production, Biotechnology, Crop Insurance, Irrigation system. The final Long List of adaptation measures in Human Health sector consisted of 7 adaptation measures.

Technology prioritization was done according to the guidance provided during Bangkok training workshops (8-11 August, 2011), using TNA Handbook and Multi-criteria analysis manual, applying Multi Criteria Decision Analysis. During technology appraisal, each sector working group led by team leader applied the main 8 steps of MCDA. Stakeholders from governmental institutions, NGOs and private sectors, national consultants participated in the development of national criteria and their components (set of indicators) used in technological appraising.

For Agriculture sector, the technologies were assessed separately, according to each category: a) small scale/short term; b) small scale/medium-long term, c) large scale/short term; d) large scale/medium -long term. For Human Health sector, the adaptation measures were classified under one category: Small Scale/Short Term, as they fit into this category by time and implementation scale.

Costs/benefits analysis was performed for each category of technologies, as in Moldova's economic constrains the implementation of new technologies are preferred to be done at the lowest costs. The ranking of technologies were plotted on graphs and criteria contribution chart bars. In Sensitivity Analysis exercise the working group members have adopted the model of reducing weight given to costs. The ranking graphs show a fairly consistent robustness under a large variation of given weights. For both sectors of Adaptation component were applied several "optimistic scenario" for some of ranked technologies and measures. These changes brought about differences in the adaptation technologies/measures ranking, yet the changes in the scores did not affect the ranking of the most prefered adaption tchnologies/measures. Sensitivity analysis helped us to identify robust performers for each category of technologies.

The outputs of technology prioritization (technologies winners) have been presented in the summarizing tables of prioritized technologies for Agriculture and Human Health sectors and represent the basis of sectorial portfolio of environmentally sound technologies. Implementation of these adaptation technologies/measures will have a significant contribution to enhancing sectorial adaptation to future climate change.

For further consideration in the next phases of TNA Project, the working groups have selected 3 technologies for Agriculture sector *(Conservation system of soil tillage without herbicides for winter wheat; Applying of 50 t/ha of manure with bedding to agricultural soils once per five years; Vetch field as green fertilizer into 5 year crop rotation)* and 2 measures for Human Health sector *(Supply of high guarantee quality water to rural population; Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves).*

The shortlisted technologies of Agriculture and Human Health sectors are in line with national sustainable development priorities of the Republic of Moldova and government plans and policies in agriculture and human health development.

Chapter 1 Introduction

1.1 About the TNA Project

In 2002 year, having the support of Global Environment Facility (GEF), the Republic of Moldova has undertaken the first technological needs assessment. The Report "Technology needs assessment and development priorities"[1] was elaborated within the Project "Climate Change: Enabling Activity (Phase II)" and implemented by the Ministry of Ecology, Constructions and Territorial Development in cooperation with UNDP Moldova under GEF financial assistance and published in 2002 year. The document provides the information about current status of the national sectors with highest GHG emissions and the state-of–the–art world technologies that could replace depreciated at that time technologies from Moldova.

The second country driven technological needs assessment of the Republic of Moldova has been launched in 2011 year within TNA Project Republic of Moldova "Technology Needs assessment and technology action plans for climate change", having financial and guidance support of UNEP Risø (URC). The current assessment, presented in this Report, aims to perform a country- specific evaluation of the current technological state in the most vulnerable to climate change sectors of the Republic of Moldova's economy for identifying and analysing priority technology needs for climate change mitigation and adaptation. The output of the TNA Project is the portfolio projects using high efficiency, **environmentally** sustainable technologies, that would ensure Republic of Moldova sustainable development. The TNA activities involve stakeholders in all stages of technology prioritization to ensure the relevance of evaluated technologies and to engage stakeholders that are central to implementation of prioritized technologies. A number of professionals from relevant institutions from strategically important sectors of Moldova's economy, possessing knowledge and experience in the area, have been engaged as TNA experts/national consultants. Most of them have participated in other climate change related projects, particularly in the First and Second National Communications. Both stakeholders and experts have performed the prioritization of technologies that further are subject to barrier analysis, technology plan implementation and, as a final step, submission of the projects ideas for effective implementation, having the investment support from international financing institutions.

1.2 Republic of Moldova development priorities with regard to adaptation component of climate change.

The adoption of the Cancun Adaptation Framework (CAF) during UN Conference on Climate Change, held in December 11, 2010, in Cancun – Mexico marks a milestone for international action on adaptation, since for the first time it provides an umbrella agreed under the UNFCCC which aims to provide guidance on various aspects of international cooperation on adaptation. The Cancun Agreements establishes and Adaptation Framework aiming at enhancing action on adaptation. The Adaptation Framework identifies a set of priority areas where the Parties are encouraged to undertake action, one of the most important being development and implementation of adaptation technology. Industrialized countries agreed to provide substantial funding to developing countries in order to support intensified action on mitigation, adaptation, capacity-building and technology development and transfer.

Republic of Moldova associated itself with the Copenhagen Accord and submitted an emission reduction target to be specified in its Appendix II: "*A reduction of no less than 25% of the base year (1990) level total national GHG emissions have to be achieved by 2020 through implementation of global economic mechanisms focused on the climate change mitigation, in accordance with the Convention's principles and provisions*." The target of the Republic of Moldova is provided without specific NAMAs identified and quantified or further clarification on the support needed. However it is recognized that significant financial, technological and capacity building support will be needed to achieve this target.

Moldova's goal to enhance socio-economic development may give rise to different level of GHG emissions, which imposes environmental and economic stress. For this reason adaptation steps are to be undertaken in order to have a long-term sustainable development. According to Republic of Moldova National Development Strategy (2008-2011), the country adopted sustainable development that will entail accelerated growth, targeted inventions and community mobilization to eradicate poverty and ensure the ecologically sustainable use of natural resources and ecosystem services.

[1] Technology needs assessment and development priorities, Chisinau 2002, 175 p.

In the above mentioned context, the TNA Project provides a great opportunity to the Republic of Moldova to perform country-driven technology assessment for identifying contemporary, environmentally sound technologies that might be implemented with a significant contribution in addressing climate change adaptation needs of the country.

The overall objective of this Project comprise technology need assessment, activities associated with sector and technology prioritization, with high involvement of experts and stakeholders, which encourage the creation of enabling environment for the transfer of environmentally sound technologies. Beside those mentioned above, the Republic of Moldova's National Priorities are articulated in a number of other relevant documents elaborated by the Government, and which address the sustainable development issues.

National Development Strategy (NDS) 2008-2011 [2]

Adopted in December 2007, this document formulates Moldova's key strategic objective "*to ensure a better quality of people's lives by strengthening the foundation for a robust, sustainable and inclusive economic growth*". The NDS explicitly recognizes that the incidence of poverty is higher in rural than areas in urban areas and that this is due to low agricultural productivity and limited non-agricultural employment opportunities. In terms of climate change, the document doesn't specify anything directly, but rather emphasizes issues related to agriculture, including soil conservation, scaling-up of afforestation on degraded farming lands and upgrading the national monitoring system for hydro meteorological conditions.

The Second Millennium Development Goals Report [3](2010) notes that today, the MDG 8 are included in the Government's medium-term agenda, which are set out in the National Development Strategy (NDS) for 2008-2011.
The National Report notes, that the main achievements of the country related to the eight Millennium Development Goals are aimed at eradicating poverty, reducing infant and maternal mortality, extending the areas protected by the state and the increasing role of information technology in the context of creating partnerships for development. Less successful were developments in the area of education, combating HIV/AIDS and tuberculosis and ensuring people had access to an adequate health infrastructure.

National Strategy for Sustainable Development of the Agricultural Complex of the Republic of Moldova for 2008-2015[4]

This document outlines a significant strategic step to prioritize the development of the organic agricultural sector by doubling organic production and tripling certified farmed areas by 2015. The strategy aims to integrate domestic legislation and practices for organic farming and products with EU requirements and to support the development of the organic sector through research, development and extension. The strategy is already having an impact and a rapid increase of the area of certified organic production has occurred over recent years. The major organic products are vegetables, wines, dried fruits and walnuts. To achieve the objectives of the strategy, it is clear that climate change and adaptation are key components that should to be analyzed, integrated and mainstreamed.

Health System Development Strategy for 2008-2017[5]

The objectives of this strategy are strengthening health system performance and continued improvement of health, financial risk protection of citizens of accession to health services. Reducing inequalities in the use and distribution of health services and satisfaction of recipients. Creation of optimal prerequisites for the maximum realization of the health potential of every individual throughout their entire life and attainment of adequate life quality standards of the population.

National Strategy of Natural Hazards Mitigation (NSNHM)[6]

This strategic document was developed by the World Bank within 2007-2008 periods. The NSNHM aimed at mainstreaming natural hazards mitigation into the national policy setting. The main objectives of the NSNHM was to: 1) increase the level of adaptation of natural resources, ecosystems and agriculture to climate change; 2) maintain low levels of greenhouse gas emissions; 3) consolidate the institutions involved in management and alleviation of extreme

[2] *National Development Strategy (NDS) 2008-2011*, http://www.gov.md/lib.php?l=en&idc=447
[3]*The Second Millennium Development Goals Report* http://www.un.md/key_doc_pub/
[4]*National Strategy for Sustainable Development of the Agricultural Complex of the Republic of Moldova for 2008-2015* http://www.maia.gov.md/doc.php?l=en&idc=48&id=13472
[5] *Health System Development Strategy for 2008-2017* http://www.ms.gov.md/_files/1281Strategia_2008_2017_eng.pdf
[6]*National Strategy of Natural Hazards Mitigation (NSNHM)* http://siteresources.worldbank.org/ECAEXT/Resources/258598-1277305872360/7190152-1303416376314/moldovacountrynote.pdf.

events; and 4) raise institutional and community awareness concerning natural risks and climate change. In order to accomplish the strategic vision, the NSNHM focuses on: (i) the development of infrastructure for disaster mitigation; (ii) the development and implementation of insurance instruments against natural disasters; (iii) the implementation of adaptation measures for anticipation and mitigation of natural disasters risks; and (iv) the strengthening of the institutional and legal framework for coordination of activities between national and international organizations in responding to natural hazards.

Based on these documents and other relevant information (sectoral strategies, as for instance: National Health Policy of the Republic of Moldova, Program of Water Supply and Sewerage in Communities of the Republic of Moldova until 2015, Sustainable Development Strategy for the Forestry Sector, Energy Strategy of the Republic of Moldova to the year 2020, Road Transport Infrastructure Strategy, other documents) the group of stakeholder and experts has clustered the national development priorities with relevance to climate change adaptation (table 1.1-1).
These development priorities have been considered in the context of climate change, its long term effect, country specific geography, environment, economic and social characteristics. The working groups have considered them during identification of the criteria and set of indicators used for adaptation technological assessment.

Table 1.1-1 Development priorities of the Republic of Moldova clustered under climate change.

Environmental Development Priorities	
Reduced soil degradation	Soil is continuing to degrade due to unsustainable harvesting.
Achieve environmental sustainability	Unsustainable consumption of natural resources, reduced capacity of ecosystems to deliver goods and services and support livelihoods.
Improved management of the water supply and sewerage sector.	The current management of the water supply and sewerage sector is not adequate to today’s requirements.
Economic development priorities	
Reduced absolute poverty rate.	Moldova is the poorest country in Europe[7]. 26.3% of population is below poverty line (2009) [8].
Increased energy security.	Lack of own natural fossil fuel reserves is obliging the country to import more than 96% of energy resources needed. 70% of electricity demand is covered by import. All natural gas is coming from GAZPROM Company (Russian Federation).
Improved urban and rural roads.	According to World Economic Forum[9] the quality of the Republic of Moldova roads accumulate 1.6 point from a maximum of 7.0.
Establishment of an integrated and stable agricultural system.	The vegetable crop production and animal breeding is not one integrated by each agricultural soil/climate zone.
Improved employment	This holds for both quantity of jobs and human capital transfer.
Social development priorities	
Access of rural child to well-equipped school.	During the last 10-15 years in the many of the villages the number of children has decreased significantly and that has led to both lack of tutors and necessary equipment for qualitative teaching.
Ensured medical assistance to rural population. Combat HIV/AIDS, tuberculosis and other diseases.	Lately many of the villages have lost the capacity to maintain the appropriate medical staff. The tuberculosis mortality rate continues to pose a threat to the population of Moldova, as the disease mainly affects socially vulnerable groups of people.

[7] http://www.ruralpovertyportal.org/web/guest/country/home/tags/moldova
[8] http://www.indexmundi.com/moldova/population_below_poverty_line.html
[9] http://www.constructor.md/News/3260/ro.html

Chapter 2. Institutional arrangement for the TNA and the stakeholders' involvement.

2.1 TNA team, national project coordinator, consultants, etc.

The National TNA team includes a TNA Coordinator, a wide range of stakeholders to constitute the National TNA Committee and National Consultants/experts organized in workgroups. A National Steering Committee is envisaged as the top most decision making body of the TNA Project, comprising policy makers from relevant key ministries. As presented in Figure 2.1-1, as well as in the detailed description provided next, each element of the in-country institutional structure is designed to play an important role.

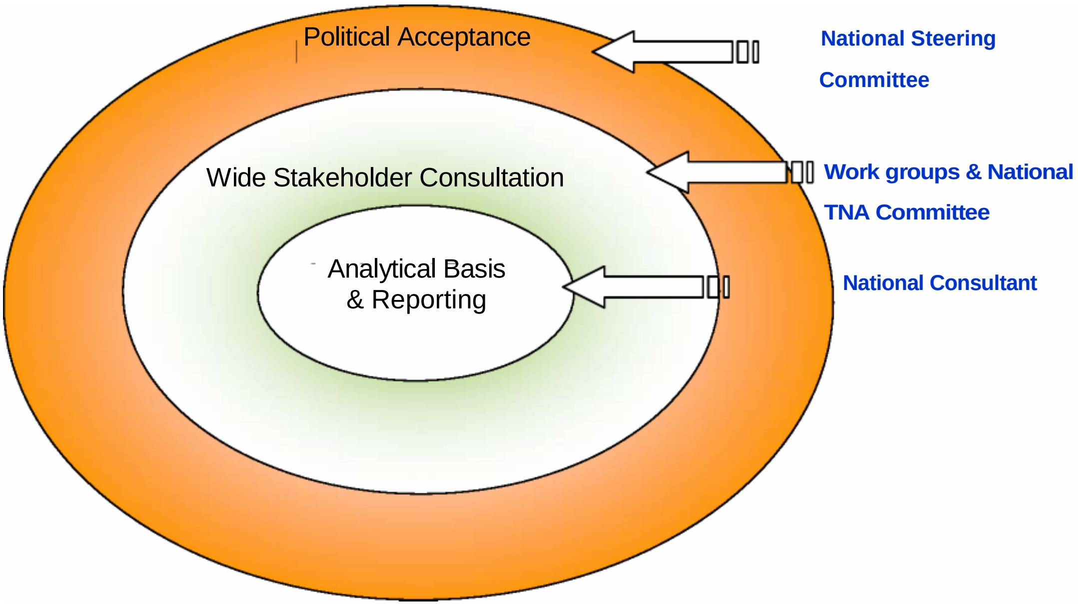

Fig. 2.1-1 Role of Institutional Elements for the TNA Project in the Republic of Moldova.

National Steering Committee

National Steering Committee is envisaged as the top most decision making body of the project. The National Steering Committee is comprised of members responsible for policy making from relevant ministries as well as key stakeholders from the academia sector and civil society. The National Steering Committee provides political acceptance to the TNA process and is also responsible for appointment the National TNA Committee, as well as for the political acceptance for the Technology Action Plan (TAP).

Republic of Moldova National Steering Committee.

1. **TNA Coordinator:**
   PhD Vasile SCORPAN
2. **Members of National Steering Committee:**
   1) H.E. Gheorghe SALARU, Minister, Ministry of Environment; UNFCCC and GEF Focal Point, Head of National Steering Committee;
   2) Mrs. Maria NAGORNII, Head of Direction, Direction Analysis, Monitoring and Policies Evaluation, Ministry of Environment, Steering Committee Member.
   3) Mr. Pintilie PIRVAN, Head of Direction, Food Industry Direction, Ministry of Agriculture and Food Industry, Steering Committee Member.
   4) PhD Vladimir BERZAN, Director, Institute of Power Engineering, Academy of Sciences of Moldova, Steering Committee Member.
   5) Prof., PhD Petru TODOS, first vice-rector, vice-president of the Council of Administration of the Technical University of Moldova; Technical University of Moldova, Steering Committee Member.

6) Mr. Stefan LOZINSCHII, Director, Association of Environment Radio Journalists "ECOTERA" (NGO), Steering Committee Member.

3. **Members of National TNA Committee:**
   1) Mrs. Galina PARSIAN, Deputy Head of Direction, Thermo Power Direction; Ministry of Economy,
   2) Mrs. Tamara ROZNERITA, Deputy Head, Direction Ecological Agriculture, Renewable Energy and Irrigation, Ministry of Agriculture and Food Industry,
   3) Mr. Sergiu BRUMA, Head of Direction, Direction of Technology Transfer, Agency of Innovation and Technology Transfer, Academy of Sciences of Moldova;
   4) PhD Mihai TIRSU, Deputy-Director, Institute of Power Engineering, Academy of Sciences of Moldova;
   5) Acad., PhD Ion HABASESCU, Director, Institute of Agriculture Technics "MECAGRO" of the Academy of Sciences of Moldova;
   6) Prof., PhD Dumitru UNGUREANU, vice-rector for practical instruction, social issues and relationships with technical colleges, Technical University of Moldova;
   7) Prof., PhD Grigore MARIAN, State Agrarian University of Moldova, Faculty of Agricultural Engineering and Auto Transportation, Department of Machines Maintenance and Materials Engineering;
   8) PhD. Andrei CHICIUC, Vice-director "Energie Plus" University Centre, Technical University of Moldova.
   9) Prof., PhD Aurel GUTU, Technical University of Moldova
   10) Prof., Grigore FRIPTULEAC, the State University of Medicine and Pharmaceuticals of Moldova "Nicolae Testimiteanu".

National TNA Team

The National TNA Team is the main decision making body for the project with the TNA Coordinator acting as a focal point. The National TNA team is comprised of a small core group as the National TNA Committee, and a broader group of stakeholders and experts, that are aid the core group. This broader group includes national consultants and sectoral / technological workgroups. The TNA coordinator will play a key role and coordinate amongst the different groups to ensure that they work together as a team.

TNA Coordinator

The appointment of the TNA Coordinator was done by the Ministry of Environment of the Republic of Moldova (the representing of MoEN performs the functions of UNFCCC Focal Point, as well as of GEF Political and Operational Focal Points). The TNA Coordinator is the focal point for the effort and manager of the overall TNA process. This involves providing vision and leadership for the overall effort, facilitating the tasks of communication with the National TNA Committee members, National Consultants and stakeholder groups, formation of networks, information acquisition, and coordination and communication of all work products.

The leadership of the TNA coordinator is critical for the success of the TNA, therefore it was ensured that the skill set of the TNA Coordinator include facilitation skills, project management, and some scientific background, as these are likely to be advantageous in terms of familiarity with technology specifications and performance requirements.

National TNA Committee

The National TNA Committee is the core group of decision makers and includes representatives responsible for implementing policies from concerned ministries, members familiar with national development objectives, sector policies, climate change science, potential climate change impacts for the country, and adaptation needs.

The role of the National TNA Committee is to provide leadership to the project in association with the TNA coordinator. Specific responsibilities will include also:

1. Identifying national development priorities, and priority sectors from thereon;
2. Deciding on the constitution of sectoral / technological workgroups;
3. Approving technologies and strategies for mitigation and adaptation which are recommended by sectoral workgroups;
4. Approving the Sectoral Technology Action Plan (a roadmap of policies that will be required for removing barriers and creating the enabling environment) and developing a cross cutting National Technology Action Plan for mitigation and adaptation.

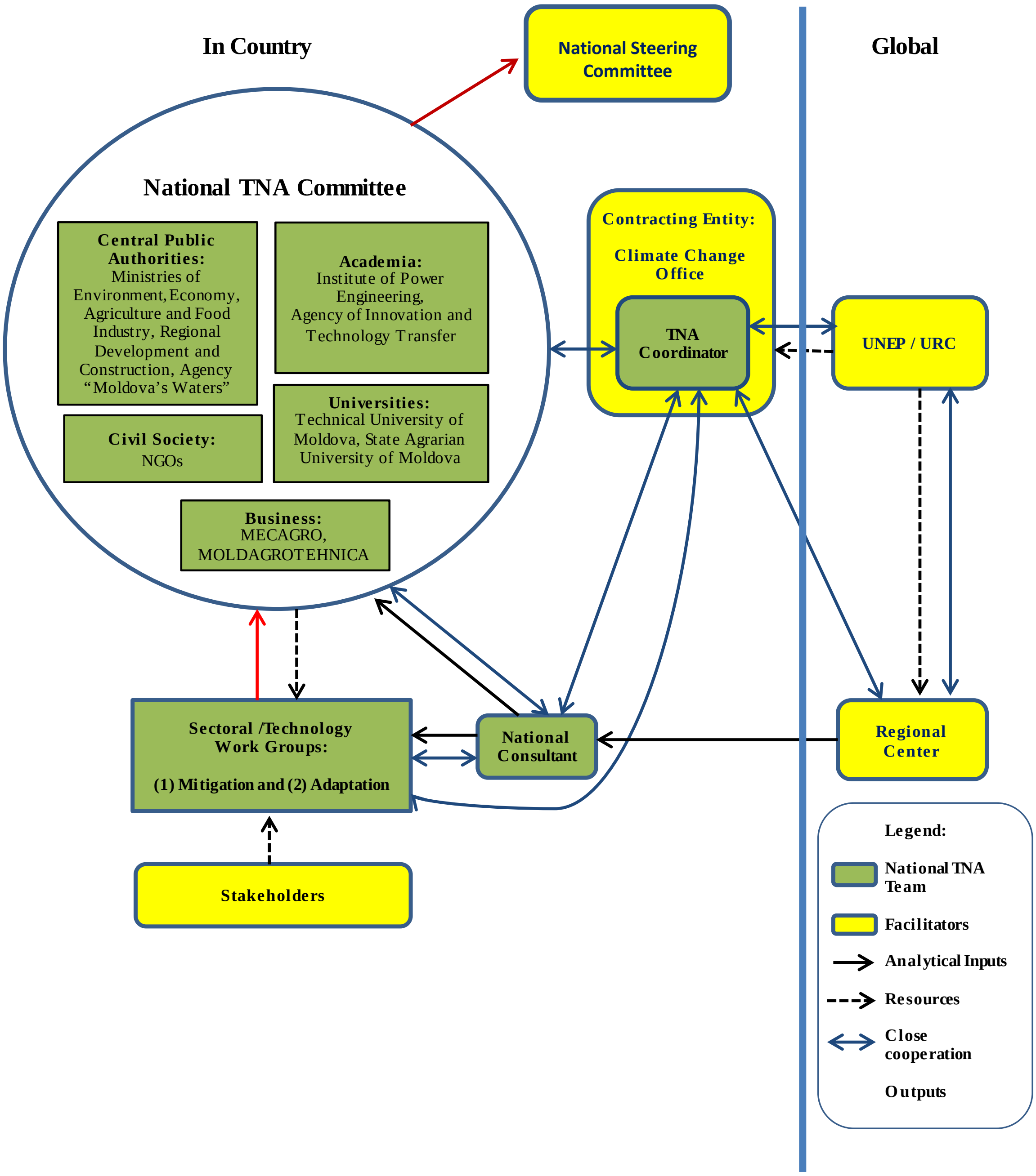

Fig.2.1-2 Institutional Structure for the TNA project in the Republic of Moldova.

National Consultants

The National TNA Committee has engaged a number of professionals and relevant institutions from strategically important sectors of Moldova's economy, possessing deep knowledge and extended experience in the area, high scientific degrees (PhD and habilitate) and holding administrative institutional positions. Most of the experts have participated in other climate change Projects, particularly National Communications, which is of great benefit for TNA assessment. Involvement in the TNA assessment of high level professionals from different sectors, assured a multidisciplinary team, led by the National Coordinator, who has a rich administrative and technical background and extended experience in climate change. The role of the national consultants is to lead and undertake activities such as research, analysis and synthesis in support of the TNA exercise. The leadership of national consultants/experts working groups was assured by the team leader of Adaptation component PhD, Druta Ala. National consultants worked in close collaboration with the National TNA Committee and sectoral work groups, and are directly responsible to the TNA Coordinator.

The national consultants'/experts overall task is to support the entire TNA process. The national experts are an important component of the TNA Project and participated in the capacity building workshops organized by UNEP Risoe Centre in Chisinau[10].

The national consultants/experts assisted the TNA coordinator in applying a participatory approach to the TNA process by facilitating the tasks of communication within the national TNA team, outreach to stakeholders, formation of networks, and coordination and communication of work products.

The selection procedure of national consultants/experts under TNA Project included the announcement of positions with required qualifications on 3 web sites and 2 national newspapers. Within 10 days from the announcement made CVs and Letters of intent have been collected. The most relevant professionals have been selected and contracted. The specific tasks of each expert TNA Project have been provided in TORs, which is a component of contract.

The national consultants have undertaken the following tasks:

- Provided support to the identification and categorization of the country's priority sectors, and identification and prioritization of technologies for mitigation and adaptation through a participatory process with a broad involvement of relevant stakeholders;
- Facilitated the process of analyzing with the work groups how the prioritized technologies can be implemented in the country.

National consultants' tasks/area of expertise is generalized in the table 2.1-2.

Table 2.1-2. The background of national consultants contracted under the adaptation component of TNA Project.

National consultant	Title, position, institution	Background & Area of expertise
Druta Ala	Leader of Adaptation Team in the TNA Project, Dr. of biology, Chief of Plant Biology Department, State Agrarian University of Moldova	Vulnerability and adaptation to climate change; plant ecophysiology, crop production.
Gheriuc Ilie	Prof., Dr. habiitate in technics, State Agrarian University of Moldova	Irrigation, drainage and soil conservation; sustainable water use and management - sprinkler and dripping irrigation, rainwater harvesting
Vronskih Mihail	Acad., Prof., Dr. habiitate in agriculture, Research Institute for Filed Crops "Selectia", Coordinating researcher	Agronomy, selection and seed production, sustainable crop management - crop diversification and new varieties; drought - resistant crop varieties
Boincean Boris	Prof., Dr. habilitate in agriculture, Research Institute for Filed Crops "Selectia", Coordinating researcher	Agronomy, selection and seed production; organic agriculture, soil management - integrated soil nutrient management
Palii Andrei	Acad., Prof., Dr. habilitate in biology, State Agrarian University of Moldova, Head of Plant Biology Department	Crop breeding, plant biotechnology, plant genetics; sustainable crop management - new varieties through biotechnology
Cerbari Valerian	Prof., Dr. habilitate in agriculture, Institute of Pedology, Agrochemistry and Soil Protection 'N. Dimo', Head of the Pedology Laboratory	Pedology, agrochemistry and soil management, conservation tillage; sustainable farming systems - agro-forestry
Bucataru Nicolae	Prof., Dr. habilitate in agriculture, Technical University Moldova	Animal breeding, animal genetics; sustainable livestock management - selective breeding via controlled mating and livestock disease management
Taranu Lilia	Dr. of biology, Leader of the Climate Modeling Team, Climate Change Office,	Climate modeling, agroclimatology, vulnerability and adaptation to climate change; agricultural

[10] Republic of Moldova: Technology Needs Assessment Project. UNEP/RISO Centre (URC) Mission in the Republic of Moldova. Meeting with TNA Coordinator, members of the National Steering Committee and National TNA Committee and potential national consultants. Ministry of environment, April 12, 2011.

	Ministry of Environment	insurance; genetics, selection and seed production
Opopol Nicolae	Acad., Prof., Dr. habilitate in medicine, Head of the Hygiene and Epidemiology Chair of 'N. Testemitianu' University of Medicine and Pharmacy	Medicine; human health adaptation to climate change: thermal stress – reduce heat island effect, air conditioning; vector borne – vaccination programs, sustainable surveillance; water borne - improved water treatment; genetic screening of pathogens, etc.
Valeriu Mesina	Dr in Medicine, associate professor, Department of Hygiene, 'N. Testemitianu' University of Medicine and Pharmacy	Environmental hygiene, human health adaptation to climate change:

Sectoral / Technological Workgroups

The stakeholders are central to the TNA process therefore, to give an active role to stakeholders in the TNA process, constitution of workgroups was proposed. The workgroups were established by the National TNA Committee. The workgroups are on sectoral basis and they decide on the technologies appropriate for a sector, undertake market / barrier analysis and recommend an enabling framework for the sector.

During inception workshop the TNA Team and stakeholders agreed upon activities to be implemented during Project lifetime and budget allocated. A detailed draft of Work Plan was elaborated and discussed with stakeholders, and the final version was endorsed by the stakeholders and experts.

The **leading national Agency for implementing TNA assessment Project is the Climate Change Office**, Ministry of Environment, Republic of Moldova. In the implementing TNA Project the methodological guidance was provided during TNA workshop in Bangkok (8-11 August, 2011) and the following methodological sources have been used: UNDP Handbook *Technology Needs Assessment for Climate Change*[11], Climate TechWiki website,[12] *Multi-criteria analysis:* a *manual*[13], the TNA guide *Technologies for Climate Change Adaptation, Agriculture sector*,[14] guidance provided by URC Country Coordinator, UNEP Riso Centre website[15] information, and the Asian Institute of Technology**.** The activities were implemented according to the Working Plan time schedule approved during the inception workshop.

These methodologies have been adjusted to the country specific circumstances, collecting relevant data for performing TNA assessment.

2.2 Stakeholder Engagement Process followed in TNA – Overall assessment.

The TNA activities involved stakeholders in all stages of technology prioritization to ensure relevance of evaluated technologies and to engage stakeholders that will be central to implementation of prioritized technologies.

Meetings with selected stakeholders

During the assessment of adaptation technologies TNA core team tried to have a strong engagement of stakeholders in order to have their commitment in the implementation of further actions, bring knowledge skills, their experience in the area, new ideas. The TNA Team identified stakeholders involved in the mitigation and adaptation expertise. Firstly, the identification of those who are directly impacted by the climate change in the area of interest: Ministry of Environment, Ministry of Agriculture and Food Industry, Ministry of Economy, Ministry of Health, Academy of Sciences of Moldova, Institute of Ecology and Geography of the AS of Moldova, State Hydrometeorological Service, Agency of Innovation and Technology Transfer, other institutions. This initial group of stakeholders was requested to suggest other stakeholders who have interest in promoting technology transfer and are concerned of future climate change impact. An iterative method was applied in identifying other stakeholders, especially those in national institutions who have the power to support the technology transfer process. The audiences that are specifically targeted in this wise are planners and decision makers, sectoral planners and key stakeholders at the local and national levels. They are representatives of ministries, persons with strong political background, business representatives, sectoral experts,

[11] UNFCCC/UNDP. Technology Needs Assessment for Climate Change. Handbook, 2010
[12] http://tech-action.org/guidebooks.htm
[13] Multi-criteria analysis: a manual. Department for Communities and Local Government, UK. 2009
[14] UNEP/GEF Technologies for Climate Change Adaptation, Agriculture sector.TNA Guide, 2011
[15] http://www.uneprisoe.org/

academic and research communities' representatives, members of NGOs with climate change status, private sectors. The stakeholders group included men and women, youth and senior persons.

Ministry of Environment, Ministry of Agriculture and Food Industry and Ministry of Health of Republic of Moldova, National Agency of Energy Efficiency, key national institutions, are identified as potential leading institutions in technological transfer and included in the National Steering Committee of TNA Project. The table 2.1-3 generalizes stakeholders' involvement in TNA activities.

Table 2.1-3 Stakeholders involvement in the activities of TNA project.

Stakeholders	**TNA Activities**	
	Workshops	**Group meetings**
Ministries: of Environment; of Economy; of Agriculture and Food Industry; of Health.	• Inception workshop, • Sector's prioritisation workshop.	• Identification of national priorities, • Clustering of national priorities, • Prioritisation of the sectors, • Providing information and participation in the discussions of current state of technology in particular sector • Technology prioritisation applying MCDA.
Academic and research institutions: State University of Medicine and Pharmaceuticals of Moldova "Nicolae Testimiteanu". Technical University of Moldova; Institute of Power Engineering of the Academy of Sciences of Moldova; Institute of Ecology and Geography of the Academy of Sciences of Moldova; State Agrarian University of Moldova; State University of Medicine and Pharmaceuticals of Moldova "Nicolae Testimiteanu", Forest Research and Management Institute	• Inception workshop, • Sector's prioritisation workshop.	• Identification of national priorities, • Prioritisation of the sectors using MCDA; • Providing information and participation in the discussions of current state of technology in particular sector; • Technology prioritisation applying MCDA
Agencies National Agency for Energy Regulation, Agency for Energy Efficiency of Moldova.	• Inception workshop • Sector's prioritisation workshop	• Identification of national priorities, • Prioritisation of the sectors using MCDA; • Providing information and participation in the discussions of current state of technology in particular sector; • Technology prioritisation applying MCDA
Business representatives RED Union Fenosa S.A.;	• Inception workshop • Sector's prioritisation workshop.	
State Hydrometeorological Service	• Inception workshop • Sector's prioritisation workshop.	
NGO NGO "Ecospectr" NGO "Energie Plus"	• Inception workshop • Sector's prioritisation workshop.	

Approaches used for better engagement of stakeholders in the TNA Project.

A number of approaches were applied to have stakeholders' engagement in the current Project. These are formal and informal events: appreciative inquiries, informal meetings, workshops, including TNA inception national workshop, focus group meetings, sector group meetings policy dialogues, participatory events. Interactive participation involving experts and stakeholders in terms of joint analysis and joint action planning to build a strong sense of shared ownership and long term implementation activities was used during TNA assessment.

During the inception workshop selected stakeholders have been introduced to the TNA objectives, were proposed and agreed the Working Plan and Project time table.

Stakeholders' involvement in the clustering of national priorities.

The identification of national priorities has been done commonly by the TNA Project experts and interested stakeholders, members of working group. The team leader has informed working group members about the need to consult country's documents where national medium and long term priorities are articulated. In the activities related to national priorities clustering, especially valuable were opinions and experience of Ministry level stakeholders: Ministry of Environment (ME), Ministry of Agriculture and Food Industry (MAFI), Ministry of Health (MH). These stakeholders participated in the collection of the documents where national priorities specified and showed good knowledge and constructive approach during all the activities with national priorities involvement.

Stakeholders' involvement in sector and technology prioritizations.

The consultation with stakeholders was an on-going process during all phases of the Project done so far, of particular importance were their consultations and opinions in providing technological details about current situation in the sectors. Ministry of Agriculture and Food Industry representatives have provided details about current situation of technologies in the irrigation area, as one of the most needed and most difficult area of agriculture sector, challenged by many issues, including the use of new technologies.

The stakeholders have an important contribution in developing the final set of criteria and indicators used for technology options prioritization. Broad discussions were developed when considering different options of technologies in crop production, and also important arguments were brought up during the exercise of giving weight to criteria, as working group members judgment depending on their knowledge, interests, other considerations. During these discussions stakeholders' opinions and arguments were highly considered being decisive in setting short list of adaptation technologies.

Stakeholders from Agriculture sector had high involvement in sectors prioritization, providing data from different districts from Moldova about climate change effect on agriculture, emphasizing that farmers experience climate effect now, particularly drought, high temperature, frosts and hails damaging orchards and vineyards, wider temperature fluctuations, other climate impacts.

Organizations that could benefit from the TNA assessment include those specifically responsible for environmental sectors (Ministry of Environment), and those responsible for development sectors such as Ministry of Agriculture and Food Industry and Ministry of Health. The three organizations have extended experience in implementing national and international projects, and it will mainly be interested in the development and implementation of new technologies. Ministries of Economy and Finances which play an important role in deciding the funding level are also potential users of the assessment. Other government stakeholders are: Ministry of Education (MoEd), Ministry of Economy (MoEc), district and local administrative representatives. All stakeholders are keen to see that the implementation of the Project would bring high benefits to Moldova, as it would lead to an increased degree of competitiveness in the climate change adaptive capacity and resilience.

Challenges faced in involving stakeholders in TNA.

The MCA activities with stakeholders' involvement are to be grouped in an efficient way, to minimize the number of meetings held. The number of events involving different level of stakeholders is to be well considered. The involvement of high level position stakeholders must be only in impact activities, while ordinary activities (group meetings) are to be carried out on a regular base with the involvement of medium level staff. This aspect should be emphasized in the methodology in a clear manner.

To increase the participation of stakeholders, even to involve high professionals as national consultants is needed to see the real supporting opportunities for implementing newly proposed technologies.

Chapter 3. Sectors' prioritization of Adaptation component.

3.1 An overview of sectors and projected climate change with reference to the vulnerability and adaptation status and trends of the different sectors

Despite the economic growth and social development during recent years, Republic of Moldova is still one of the least advanced countries in the region, with low Human Development Index (0.727)[16]. The population size is 4,081,700 people, of which more than 55.1% is rural population. An overview of the key economic indicators for Moldova is presented in the table 3.1.1 below.

Table-3.1.1 Main economic indicators of the Republic of Moldova.

Indicator	Value	Year
Country surface area	33,850 km^2	2010
GDP growth	6.9%	2010
Total population	4,081,700	2011
Natural population increase and/or decrease	-3.2%	2010
Share of rural population	55.1%	2010
Unemployment	7.4%	2010
Food price Index	107.1	2010
Cereal imports as %of total exports	0.74%	2009

Source: National Bureau of Statistics (2011), Statistical Yearbook of the Republic of Moldova, Ch.: Statistica, 2011.

Currently (2010) GDP is back at 5,375 million USD and real growth rate is estimated at 6.9% (fig 3.1.2). The granting of EU trade preferences and increased exports to Russia will encourage higher growth rates, but the agreements are unlikely to serve as a panacea, given the extent to which export success depends on higher quality standards and other factors. The economy has made a modest recovery, but remains vulnerable to political uncertainty, weak administrative capacity, vested bureaucratic interests, higher fuel prices, poor agricultural weather and climate vulnerability.

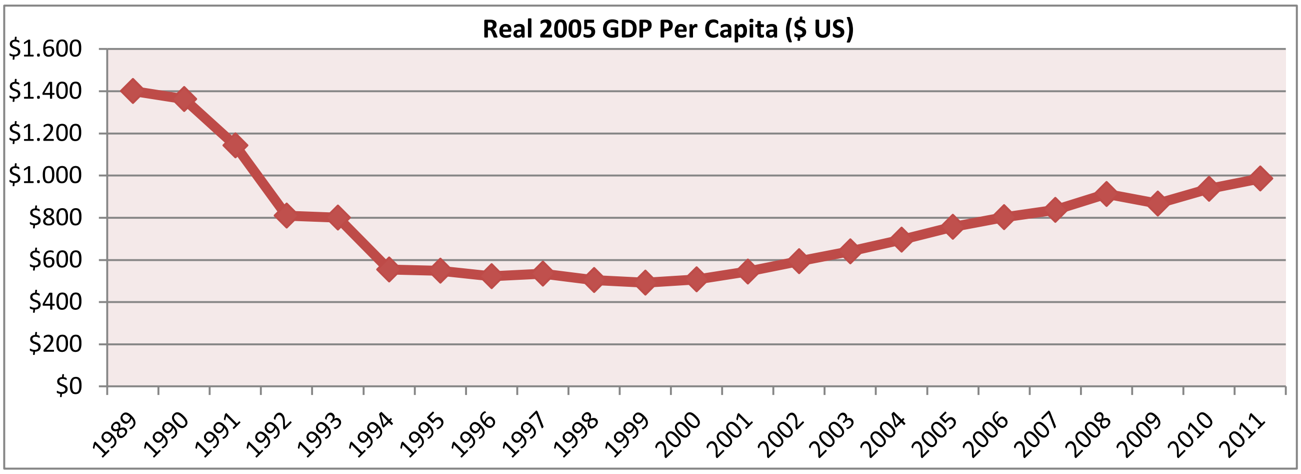

Fig. 3.1-2 The dynamic of gross national income per capita of the Republic of Moldova

Source: Economic Research Service, U.S. Department of Agriculture: **http://www.ers.usda.gov/data/macroeconomics/**

[16] UNDP (2010), National Human Development Report, 2010/2011. Republic of Moldova from Social Exclusion towards Inclusive Human Development. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf)

In the procedure of sectors prioritization the working group has collected data from documents about vulnerability analysis performed and vulnerable areas identified. Gathered data from performed studies and written reports on climate variability and climate change impacts on Republic of Moldova's economy, society and environment have been widely discussed among working group members. During the prioritization procedure were considered the adaptation measures specified in these documents. Some of the most important studies are:

- ***Moldova's First National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)***[17] ***(1998-2000)***. The reports presents risks factors conditioning vulnerability of the natural ecosystems, agricultural ecosystems, public health, reaction of natural and artificial ecosystems to various scenarios of climatic change. The adaptation actions were proposed to minimize the negative impact of climate change on economic sectors, ecosystems and public health along with costs-benefits analysis of adaptation action of the Republic of Moldova.

- ***World Bank: Rural Productivity in Moldova – Managing Natural Vulnerability, 2007***[18]***.*** This study outlines the key opportunities and considerations for the mitigation of natural hazards, especially for the highly exposed and vulnerable agricultural sector. An analysis of the occurrence, impact and potential mitigation options for a range of natural hazards affecting Moldova is undertaken within this report, with a focus on reducing risk through natural hazard mitigation or by addressing vulnerability.[19] Within the report, climate change is not analyzed as a separate threat but is broadly incorporated within a number of key threats.

- ***Ministry of Ecology and Natural Resources and State Hydro-Meteorological Service: Climate Monitoring and Droughts, 2007***[20]***.*** This comprehensive study covers both theoretical and practical aspects of climate and drought monitoring. It is based on the latest country-level climate data, including historic observations from local meteorological stations going back over 150 years. The study also includes detailed analysis of the impacts of projected future changes in climate on agricultural systems in the country, including the impact of extreme events.

- ***Moldova's Second National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)***[21] ***(SNC, 2009)***. The document includes climate projections for Moldova to 2100 and undertakes a preliminary vulnerability assessment of sectors including agriculture, water resources and forestry. This assessment includes an analysis of climate change impacts using three separate GCM's and time periods, as well as broad recommendations and potential adaptation and mitigation options for each sector. To assess the economics of mitigation and adaptation actions, the report also includes cost benefit analysis; however, no evaluation or prioritization of the adaptation options was performed.

- ***National Human Development Report (NHDR, 2010/2011):*** **Socio-Economic Impact of Climate Change in Moldova and Policy Options to Adapt**[22]*.* This report undertakes a comprehensive assessment of climate change vulnerabilities, impacts and adaptation measures at the sectoral level for Moldova. Sectors analyzed in this work include agriculture, water resources, energy, transport, human health and natural systems. Existing policies, laws and regulatory systems are assessed in relation to their effects on climate-induced vulnerabilities for a number of sectors including agriculture, forestry, disaster management and water.

- ***The Third National Communication of Moldova under the United Nations Framework Convention on Climate Change (UNFCCC) (ongoing, started in 2010, to be finalized in 2013***). To evaluate Moldova's environmental performance we have utilized the data referring to *Environmental Sustainable index* (ESI) and *Environmental Performance index* (EPI) annually produced by Yale University's and Center for International Earth Science

[17] UNDP/Ministry of Environment and Territorial Arrangement (2000), First National Communication of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Chisinau, 2000. – 87 p.

[18] World Bank: Rural Productivity in Moldova – Managing Natural Vulnerability, 2007 http://siteresources.worldbank.org/INTMOLDOVA/Resources/RuralProductivity.pdf

[19] World Bank: Rural Productivity in Moldova – Managing Natural Vulnerability, 2007

[20] *Ministry of Ecology and Natural Resources and State Hydro-Meteorological Service: Climate Monitoring and Droughts, 2007.* http://siteresources.worldbank.org/ECAEXT/Resources/

[21] UNEP/Ministry of Environment and Natural Resources (2009), Second National Communication of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Chisinau, 2009. – 316 p.

[22] UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf)

Information Network, Yale center for Environmental Law &Policy and Columbia University, USA in collaboration with the World Economic Forum and Joint Research Center[23].

According to above mentioned studies, Moldova is highly vulnerable to climate variability and change. The impacts of climate change are expected to intensify as changes in temperature and precipitation affect economic activity, the socio-economic vulnerability to these changes is high.

Following the information available in NCCAS[24], the socio-economic costs of climate related natural disasters such as droughts, floods and hail are significant and both their intensity and frequency are expected to further increase as a result of climate change. During the period 1984-2006, Moldova's average annual economic losses due to natural disasters were about US$61 million, or 2.13 percent of national GDP. More recent events have had a significant impact: the 2007 drought caused estimated losses of about US$1.0 billion; the 2008 floods cost the country about US$120 million.[25] The most recent floods in 2010 are estimated to have had an adverse economic impact on GDP of about 0.15 percent, with total damage and losses estimated at approximately USD 42 million. The floods primarily affected rural and agricultural regions of the country.

Adaptation is relevant to many sectors of Moldova's economy, but when it comes to it operationalization, at the district or country level, institutions could be overloaded by coordination, integration and monitoring requirements. Existing policy frameworks are usually not designed to promote integration of future climate projections and their uncertainties with sectoral priorities and measures at different levels and across different organizational structures and stakeholders. Communities operate on different spatial and time scales, have different priorities and may need different incentives to increase their capacities to respond to climate change.

Climate change is increasingly recognized as fact of national importance, but so far the national strategic framework lacks integrated climate change adaptation measures. Therefore, there is a need for a strategic framework at the national level to ensure that a qualitative, effective and coherent climate change adaptation process takes place. Together with the Low Emission Development Strategy of the Republic of Moldova to the year of 2020 (LEDS)[26], the National Climate Change Adaptation Strategy (NCCAS is currently under discussions). The NCCAS is intended to serve as an umbrella strategy a national policy framework to ensure an enabling environment for specific sectors ministries to develop their own concrete action plans for adaptation. Climate change adaptation further requires coordination and a supportive institutional and legislative environment.

Institutional arrangement with regard to climate change

The institutional arrangements in the Republic of Moldova, with regard to climate change and adaptation, have significant room for improvement. Given the complexity and multi-disciplinary nature of climate change, a number of institutions are each focused on different aspects of this issue and its associated challenges. However, in order to address climate change in an efficient and systematic way, there is a need for formal structures for coordinating across relevant ministries that will ensure a better overview of climate change policy. The Ministry of Finance would also be an important stakeholder in creating and overseeing such a structure, given its critical position in terms of resource allocation.

The Ministry of Environment (MoEN) is the national environmental authority and is also the Designated National Authority (DNA) on climate change and the Clean Development Mechanism (CDM) to the UNFCCC for Moldova. MoEN is responsible for the development and promotion of policies, strategies and action plans for environmental protection, management and use of natural resources and waste management. MoEN is also responsible for a number of other institutions that fall under its jurisdiction, including the State Hydro meteorological Service (SHS), the Agency for Geology and Mineral Resources, Agency "Apele Moldovei" and the Institute of Ecology and Geography. In relation to agriculture and climate change the SHS is an important organization and is responsible for weather forecasting and climate projections. The meteorological department operates and maintains the country's system of posts and weather stations. The department also issues public forecasts, including those concerning hazardous meteorological and hydrological events. Management of Moldova's water resources is also an important function of MoEN via Agency "Apele Moldovei". This institution has a variety of responsibilities, including the development of irrigation and water

[24] UNDP/Ministry of Environment (2011), Draft National Climate Change Adaptation Strategy of the Republic of Moldova. Chisinau, 2011. 73 p. (see it available on: http://www.clima.md/lib.php?l=en&idc=237&).

[25] World Bank, "Project Appraisal Document on a Proposed Credit to the Republic of Moldova for a Disaster and Climate Risk Management Project", July 6, 2010.

[26] UNDP/Ministry of Environment (2011), Draft Low Emissions Development Strategy of the Republic of Moldova to the year 2020. Chisinau, 2011. 174 pages (see it available on: http://www.clima.md/lib.php?l=en&idc=236&).

management policy and maintenance of major irrigation infrastructure (drainage pumping facilities, irrigation delivery channels, reservoirs, etc.) across the Republic of Moldova.

Sectors' profile in relation to climate change vulnerability, environmental impact and adaptation options.

Agriculture Sector

Agriculture is the dominant sector of employment in Moldova. Following privatization reforms undertaken during the past decade, some 85% of Moldovan households today own agricultural land. The majority of the farms (400,000) are small with an average landholding size of only 1.6 to 1.8 hectares. Together they represent about 45 percent of the utilized land and an overall share of some 72 percent of the total agricultural produce.

Moldova has seen a dramatic decline in agricultural output, in large part due to the change in subsidies and access to markets that were guaranteed in the Soviet era, as well as changes in the farming structure (growing share of subsistence, at the expense of commercial farming), land reform and productivity declines related to soil degradation and a lack of irrigation infrastructure. Unfavorable climate conditions, most notably the severe droughts of 2003 and 2007, have also negatively affected production. These conditions will persist and intensify even without climate changes. In 2011, agricultural production totaled MDL 21.7 billion in current prices, or only 59.0 percent of the 1990 level[27]. The contribution of the agricultural sector to GDP decreased from 31.2 per cent to 11.9 percent, in 2010[28]. According the National Bureau of Statistics of the Republic of Moldova (2011), 27.5 percent of the active population is employed in agriculture[29].

Possible impact of climate change on agriculture

Climate change projections combine with adverse agricultural implications to frame the challenge for Moldova. Although mean annual rainfall is only projected to decline moderately, the climate is expected to become more arid and risky for agricultural production, due to increasing temperatures and longer dry periods. With increased temperatures and drought risk, the threat to crop yields is clear, especially for summer crops. Furthermore, changing climatic conditions may lead to problems associated with an array of agronomic issues, including changes in soil drainage patterns leading to salinity, erosion and exposure to new pests and diseases that challenge existing plant and animal genetics and management. However, across Moldova the length of the growing period will increase, as the number of frost days is projected to greatly reduce. This reduction in frost days will provide opportunities for crop distribution changes and longer season varieties, if Moldova can move to exploit them.

Increased country vulnerability is greater in declining rural areas struggling with challenges that affect their overall capacity to adapt. Republic of Moldova agriculture has been exposed to various weather events and their consequences, including periods of drought, heavy rainfall, hail and diseases. In the context of increasing variability of weather patterns coupled with economic stresses, the vulnerability of agricultural sector as a whole is increasing, raising concerns about its potential to cope with impacts of climate change and climate variability. Adaptation as a response to climate change depends on the capacity of agriculture sector to respond to changed conditions as a function of not only climate, but also socio-economic conditions, markets and technological development.

The vulnerability-based framework under the NCCAS was centered on identifying the vulnerability of agricultural sector in the context of current and future climate changes, giving consideration to exposure, sensitivity of agricultural sector and the available capacity to address the exposure. During the assessment were identified the risks Moldova has to face as result of climate change, the assessment followed the steps of risks identification, their prioritization and proposing adaptation measures and action plan, developing National Adaptation Strategy. The NAS currently is passing the second round of discussion with national stakeholders.

The combination of long-term changes and the greater frequency of extreme weather events are likely to have adverse impacts on the agricultural sector, and these changes often have many knock-on effects at the macro-economic level. For example direct impacts on agricultural production and declining yields as a result of increased pest and disease problems could further lead to fluctuations in market prices and changes in crops. The combined effect of changes to the water regime could result in insufficient water for irrigation, and increased water competition, which could

[28]National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 13.21 “Share of main economic activities in the generation of gross domestic product” (see on page 269).

[29] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 3.1.4 “Distribution of employment by economic activities” (see on page 73).

ultimately result in higher prices and regulatory pressure. Drought will lead to soil degradation, which is a major threat to the sustainability of land resources and may impair the ability of Moldova's agriculture to successfully adapt to climate change. Increased salinity may result in land abandonment as it becomes unsuitable for cropping.

According to the SNC (2009)[30], the climate change is expected to bring both advantages and disadvantages for agricultural crops in the Republic of Moldova. Although warmer temperatures would increase the length of the growing season, they could also increase crop damage due to heat stress, changes in precipitation patterns, and pest problems. Impacts would vary regionally and with the type of crop being cultivated. Productivity of the winter wheat may decrease from 14.3% (HadCM2 model) to 17.8% (ECHAM4); sugar beet by 6.1% – 6.5% (under all climatic models assessed) and for sunflower a slight decrease from 0.6% (HadCM2 model) to 1.6% (ECHAM4) by 2039. While, according to CSIRO-Mk 2 model, it is possible even a small increase in the productivity by 2.8% compared with the average recorded productivity in the reference period. There are some potential benefits. The longer growing season will potentially increase grass yields, while increased temperatures will increase the potential for growing forage legumes. The longer growing season should also reduce the costs of housing livestock. There may also be benefits for horticulture, both with respect to reducing costs of indoor production and increasing the range of horticultural crops that can be grown outdoors.

However, in the Republic of Moldova, most of the impacts on agriculture are predicted to be adverse. Cropping patterns in Moldova have shifted with declines in the industry, with a move away from high value-added products such as fruit and meat, to an expansion of areas sown with wheat and sunflower, and sugar beet. Increased summer temperatures and drought risk could make it difficult to achieve the potential yield increases from increased concentrations of CO_2 and perhaps threaten current productivity levels. Some crops will be more vulnerable to hotter and drier summers.

Yields of vegetables and potatoes, both of which are frequently irrigated under current conditions, are likely to be reduced more than the yield of cereals. The summer growth of forage crops also appears likely to be reduced. An increased frequency of extreme weather events may also lead to crop damage or failure. There may also be problems arising from the introduction of new pests and diseases. A large proportion of soils in Moldova's agro-climatic zones are Chernozems. These soils have large organic matter content and breakdown of Soil Organic Matter (SOM) is likely to increase with warmer temperatures. While this breakdown will increase soil fertility in the short term (via release of nutrients) in the longer-term soil fertility is likely to be reduced. The result of long-term research undertaken at the national level[31] indicates that during the last 100 years, the content of SOM in arable soils in the Republic of Moldova has decreased, while the average annual air temperature has increased in the same period of time[32].

Changes in the frequency and intensity of extreme events (e.g., droughts, floods and heavy rains) have been identified as the greatest challenge that would face the agricultural industry as a result of climate change. Extreme events, difficult to both predict and prepare for, can devastate agricultural operations, as has been demonstrated several times in the past. Drought and extreme heat have also been shown to affect livestock operations. Model projections and observed trends suggest that warming would be greatest during the winter months. Although warmer winters would reduce cold stress, they would also increase the risk of damaging winter thaws and potentially reduce the amount of protective snow cover. Climate warming is also expected to increase the frequency of extremely hot days, which have been shown to directly damage agricultural crops. Future changes in moisture availability represent a key concern in the agricultural sector. Climate change is generally expected to decrease the supply of water during the growing season, while concurrently increasing the demand. In addition to the direct problems caused by water shortages, the benefits of potentially positive changes, including warmer temperatures and a longer growing season, would be limited if adequate water were not available. Water shortages are expected to be a main problem in several regions of Moldova in the future.

For agriculture in the Republic of Moldova, five of the identified risks listed below are considered to be high priority:

- Increased risk of drought and water scarcity;
- Increased irrigation requirements;
- Soil erosion, salinisation, desertification;

[30] UNEP/Ministry of Environment and Natural Resources (2009), Second National Communication of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Chisinau, 2009. – 316 p.

[31] Ursu, A. (2000), Soils Degradation and Desertification (in Romanian). Chisinau, 307p.

[32] UNEP/Ministry of Environment and Natural Resources (2009), National Inventory Report: 1990-2005. Greenhouse Gas Sources and Sinks in the Republic of Moldova. Chisinau, 2009. 352 p.

- Increased risk of agricultural pests, diseases, weeds; and
- Wheat and maize yield decrease.

Three of these risks concern the consequences of potential changes in the precipitation pattern, with increased rainfall in winter and decreased water availability in summer. Hence strategies need to be considered to conserve as much water as possible over winter to maintain supply during the summer. Much of the adaptation research in the agricultural sector should be focused on strategies for dealing with future water shortages. Such adaptations as water conservation measures and adjustment of planting and harvesting dates could play a critical role in reducing the losses associated with future moisture limitations.

Other adaptation options being identified include the introduction of new species and hybrids, for example, those that are more resistant to drought and heat, and the development of policies and practices to increase the flexibility of agricultural systems. Better definitions of critical climate thresholds for agriculture will also be beneficial for adaptation planning. Of the two opportunities presented in the table, the potential for increased production of some crops, either as a result of the increased yield potentials under the new climatic regimes or an increase in the area over which new crops might be grown, was considered a high priority. Hence attention needs to be given to the promotion of crops that have the potential to flourish in the changed conditions.

Forestry Sector

Forestry ecosystems (represented by forestland and other forestry vegetation) cover around 450.9 thousand ha, or about 13.3% of the Republic of Moldova's territory[33], and play an extremely important role in watershed protection, while at the same time providing a number of direct and indirect economic and environmental benefits to rural communities: fuel-wood, non-wood products, ravine stabilization, landscape beautification and other benefits. Fuel-wood is particularly salient for poorer households, which are unable to afford high household energy costs for gas and electricity.

The country’s forests are primarily concentrated in the central region (60% of the forest estate), with lower coverage in the northern and southern regions (26 and 14% respectively).

Possible impact of climate change on forest resources

Researchers expect that even small changes in temperature and precipitation could greatly affect future forest growth and survival, especially at ecosystem margins and threshold areas such as Moldova's forests.

Climate change would impact future moisture conditions in forests through changes in both temperature and precipitation patterns. As the temperature increases, water loss through evapotranspiration increases, resulting in drier conditions. Higher temperatures also tend to decrease the efficiency of water use by plants. In some areas of Republic of Moldova, future decreases in precipitation will accentuate the moisture stress caused by warming. Changes in the seasonality of precipitation and the occurrence of extreme events, such as droughts and heavy rainfalls, will also be important.

For example, tree ring analysis of oak and ash trees stems in the center of Moldova revealed reduced ring growth to as little as 50% of the previous year and compared to the multiannual average of the past 10 years was associated with the 2007 drought[34].

For the forest sector in the Republic of Moldova, seven of the identified risks in the Table below are considered to be high priority:

- Negative consequences for species sensitive to temperature changes;
- Changes in the regeneration rate;
- Changes in species sensitivity to water shortages;
- Changes in individual tree density;
- Changes in the phytosanitary conditions;
- Changes in species composition
- Possible increase in tree mortality

[33] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 1.3.1 “Available Land, as of 1st of January 2011” (see on page 21).

[34] UNEP/Ministry of Environment and Natural Resources (2009), Second National Communication of the Republic of Moldova under the UNFCCC. Chisinau, 2009. – 316 p.

Adaptation measures in the Temperate Continental bioclimatic zone[35], which also includes the Republic of Moldova's forests, are very versatile. On-going and planned research includes adapted seedlings, biotic and abiotic damages, biodiversity, especially genetic diversity, silviculture treatments, and protection functions of forests. Measures at stand level (forest regeneration, tending and thinning of stands, harvesting) are aimed at decreasing risks of abiotic disturbances, i.e. fire, wind, drought, as well as biotic disturbances, i.e. pests and pathogens. Building stable diversified forests is an on-going measure and it is planned to improve stand stability by selection of suitable species, provenances and genotypes.

Energy Sector

Most of Moldova's installed capacity for energy is obsolete, and energy inefficiency is high. The losses of energy (electricity and heat) transmission and distribution have been excessive in the past and are still considerable, affecting adversely the energy sector's energy efficiency. Due to organizational and technical measures, the losses in the electricity distribution networks dropped from over 39.9% in 2001 to 9.9-13.1% in 2010[36]. Losses of heat in Chisinau and Balti are as high as 19.8%[37]. Reducing losses of energy networks remains a priority for the energy sector and complies with EU policies.

Given the limited capacity to generate energy domestically, Moldova is heavily reliant on imports for its energy needs – imports made up almost 94.3% of total energy in Moldova in 2010[38]. This leaves Moldova very vulnerable to disruptions and price hikes in foreign energy supply, and can have significant impacts on human development.[39]

The breakdown of final energy consumption per sector in 2010 is dominated by the residential sector (46.8 per cent), transport sector (24.3 per cent), industry sector (7.3 per cent), commercial and institutional sectors (10.7 per cent), agriculture sector (3.3 per cent) and others (7.7 percent). The breakdown of final fuel consumption per type in 2010 was dominated by natural gases (40.5 per cent), diesel oil (19.5 per cent), electricity (11.1 per cent), gasoline (9.8 per cent), coal (6.8 per cent), liquefied natural gases (3.3 per cent) and firewood (2.6 per cent)[40]. The Republic of Moldova has the potential to employ a greater share of renewable sources, including biomass, solar, wind, hydro and geothermal, and these are governed by the National Programme on Energy Efficiency (NPEE) 2011-2020, approved through Government Decision No. 833 of 10.11.2011.[41]

Possible impact of climate change on the energy sector

As the climate of the world warms, the consumption of energy in climate-sensitive sectors is likely to change. Possible effects of warming, that could be relevant in Moldova, include (1) decreases in the amount of energy consumed in residential, commercial, and industrial buildings for space heating and increases for space cooling; (2) decreases in energy used directly in certain processes such as residential, commercial, and industrial water heating, and increases in energy used for residential and commercial refrigeration and industrial process cooling (e.g., in thermal power plants); (3) increases in demand for energy used to supply other resources for climate-sensitive processes, such as pumping water for irrigated agriculture and municipal uses; (4) changes in the balance of energy use among delivery forms and fuel types, as between electricity used for air conditioning and natural gas used for heating; and (5) changes in energy consumption in key climate-sensitive sectors of the economy, such as transportation, construction, agriculture, and others.

Changes in supply could also occur – extreme events extreme temperatures can cause damage to energy supply infrastructure, and development of renewable energy sources is very dependent on water, wind and biomass potential, all of which are expected to change under climate change.

For the energy sector in the Republic of Moldova, five of the identified risks are considered to be of high priority:

- Increase in energy used for residential and commercial refrigeration and industrial process cooling;

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[36] Report on the Activity of the National Agency on Energy Regulations for 2010 year (see Table 8 on page 22): http://anre.md/upl/file/Rapoarte/Raport%20anual%20de%20activitate%20a%20ANRE%20pentru%20anul%202011.pdf
[37] Report on the Activity of the National Agency on Energy Regulations for 2010 year (see Table 9 on page 23): http://anre.md/upl/file/Rapoarte/Raport%20anual%20de%20activitate%20a%20ANRE%20pentru%20anul%202011.pdf
[38] National Bureau of Statistics (2011), Energy Balance of the Republic of Moldova, 2010: Statistical Book. Chisinau, 2011. – 73 p. See on: http://www.statistica.md/public/files/publicatii_electronice/balanta_energetica/Balanta_energetica_2011_rom.pdf.
[39] UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf).
[40] National Bureau of Statistics (2011), Energy Balance of the Republic of Moldova, 2010: Statistical Book. Chisinau, 2011. – 73 p. See on: http://www.statistica.md/public/files/publicatii_electronice/balanta_energetica/Balanta_energetica_2011_rom.pdf.
[41] http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=340940

- Increase in damage to supply grids which present a threat to electricity transmission and distribution;
- Changes in the balance of energy use among fuel types;
- Growing water scarcity may become the main obstacle to enhancing hydro- and cogeneration power production; and
- Decrease of biomass yield.

In this case, three opportunities associated with climate impacts on the energy sector exist: decrease in energy used in residential, commercial, and industrial water heating in Chisinau municipality, Centre and South regions; wind speed and direction may increase wind generation potential and efficiency with high probability in South and to a lesser degree in Centre and North regions; and cloudiness which may increase solar generation potential in South part of the country and in Chisinau municipality.

Tourism Sector

At present tourism accounts for a relatively insignificant portion in the national economy. The modest infrastructure in the tourism and low incomes generated by the tourist businesses rates the Republic of Moldova among the countries where tourism is developed poorly. In 2010 the total tourist accommodation capacity of the collective accommodation facilities was 28.37 thousand beds, registering an decrease of 0.3 percent as compared to the preceding year. In the total tourist accommodation capacity, summer camps for schoolchildren account for 57.3 percent, hotels and motels for 12.7 percent, recreation camps and other holiday facilities for 18.2 percent, health-care homes for 6.5 percent, hostels for visitors for 2.7 percent, tourist and agro-tourist boarding houses for 2.6 percent[42].

The services of the collective tourist accommodation facilities were used in 2010 by 229.9 thousand tourists, or 0.9 percent more than in 2009, of which 63.6 thousand tourists were foreign nationals (6.8 percent more than in the preceding year). The countries accounting for the highest portions in the total number of foreign tourists using the services of the accommodation facilities were: Romania (24.2 percent), Ukraine (9.6 percent), Russia (10.2 percent), Turkey (3.4 percent), Italy (6.2 percent), USA (4.9 percent), and Germany (5.5 percent). The total number of man-nights spent by the tourists in the collective accommodation facilities in 2010 was 1412.2 thousand (an increase by 0.9 percent as compared to 2009). The total net utilization rate of the operating tourist accommodation facilities was 32.7 percent. The economic revival period which started in 2000 was characterized with the growth of indicators in the tourist industry, and in particular owing to the growing domestic tourism.

During the last 8 years, the demand at the domestic tourist market grew 68.6%. The number of foreign tourists visiting the Republic of Moldova has grown as well. It should be noted that in the last 3 years a declining pattern was registered in the number of foreign tourists visiting Moldova; it is hardly possible however that the above pattern will persist in the long term, because both the infrastructure and the offered tourist destinations are developing rapidly. Thus, for example, in 2010 travel agencies and tour operators provided their services to 126.2 thousand of tourists and excursionists (23.1 percent more than in the preceding year). The total number of foreign tourists and excursionists, who visited Moldova and used the services of the Moldovan travel agencies and tour operators in 2010, was 9.0 thousand, or 2.5 percent less than in 2009. The total number of Moldovan tourists and excursionists, who travelled abroad using the services of the Moldovan travel agencies and tour operators in 2010 was 114.8 thousand, or 25.0 percent more than in 2009[43]. The above statistics reflects only the trips arranged by the Moldovan travel agencies and tour operators and does not include trips arranged by the travelers personally. Moldova's current national policy in the sphere of tourism is reflected in the Strategy paper on the long-term development of tourism for 2003-2015 period. That strategy provides for the expansion of tourist areas, establishment and maintenance of special tourist routes, etc.

Transport Sector

Transport infrastructure is critical for human development, as it provides a lifeline for delivering key services, and access to markets. The transport sector plays a significant role in the national economy of the Republic of Moldova, its current contribution to the Gross Domestic Product being circa 11.4 percent, and it has an increasing trend (from 4.8

[42] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 11.3 "Existing capacity of establishments of collective touristic reception with functions of accommodation, as of 31st of December 2010" (see on page 230).

[43] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 11.8 "Tourism organised by travel agencies and tour operators" (see on page 234).

percent in 1990, to 11.4 percent in 2010)[44]. The transport sector provides jobs to 64 thousand persons, or to 5.6 percent of the employed population of the country.[45]

The Republic of Moldova's transport sector is comprised of the following segments: road transportation, railway transport, air transportation and naval transportation. Because Moldova is geographically small, and landlocked, roads are a key form of infrastructure. Presently 97.5 per cent of passengers and 85.7 per cent of freight is transported by road[46].

Long-lasting heat waves can worsen or even destroy the asphalt pavement of the national roads. This phenomenon has already been witnessed both in 2003 and 2007, when longer periods of high temperatures were registered. The most serious damage was to the Chisinau - Balti highway. Even on the newly rebuilt Chisinau – Leuseni national highway, long portions of the road were deformed. The roads from Rabnita and Rezina were almost completely destroyed by trucks carrying cement from the local factories.

Heavy summer rains almost stopped vehicular circulation in downtown Chisinau in 2005, 2008, and 2009 causing additional damage to the pavement of city streets, pavement that is already in a poor condition. The rainfall water collection system is outdated and unable to accommodate heavy rain episodes[47].

Possible impact of climate change on the transport sector in Moldova

The transport sector comprises roads, rail, ports and air, with very different types and ages of infrastructure. The transport sector is vulnerable to the predicted increase in frequency and intensity of storms (wind, rain, snow), which could result in raised costs related to the construction, maintenance, and operations of transportation infrastructure and vehicles. Furthermore, maintenance costs will increase for some types of infrastructure because they deteriorate more quickly at temperatures above 32°C.Construction costs could increase because of restrictions on days above 32°C, since work crews may be unable to be deployed during extreme heat events and concrete strength is affected by the temperature at which it sets. Increases in daily high temperatures would affect aircraft performance and runway length because runways need to be longer when daily temperatures are higher (all other things being equal).

In summary, examples of adaptation measures to reduce losses/risks in transportation sector to climate change could be follows:

In the case of increased temperatures and heat waves:

- Development of new, heat-resistant paving materials;
- Greater use of heat-tolerant street and highway landscaping;
- Proper design/construction, milling out ruts;
- Overlay with more rut-resistant asphalt;
- Increased ongoing maintenance;
- Shifting construction schedules to cooler parts of day;
- Designing for higher maximum temperatures in replacement or new construction; and
- Adaptation of cooling systems.

In the case of increases in intense precipitation events:

- Improve flood protection;
- Conduct risk assessments for all new roads;
- Upgrading of road drainage systems;
- Pavement grooving and sloping;
- Improved asphalt/concrete mixtures;

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[44] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 13.21 "Share of Main economic activities in the generation of Gross Domestic Product" (see on page 269).

[45] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 3.1.4 "Distribution of employment by economic activities" (see on page 73).

[46] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 18. 1 "Goods transport, by modes of transport" (see on page 390) and Table 18.7 "Passenger transport, by modes of public transport" (see on page 395).

[47]UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf)

- Greater use of sensors for monitoring water flows;
- Increases in the standard for drainage capacity for new transportation infrastructure and major rehabilitation projects; and
- Engineering solutions, increase warnings and updates to dispatch centers, crews and station.

Human Health Sector

Life expectancy is generally accepted as a key indicator of the overall state of a nation's health. In terms of life expectancy at birth, Moldova is presently in a slightly better position than in the pre-transition period. At the same time, in 2010 life expectancy in rural areas was shorter than in urban ones (67.4 years and 72.0 years correspondingly)[48], and this is attributed to a variety of factors, including lower levels of access to health care, poor water quality, poverty and cultural factors in rural areas. While the overall health conditions of the Moldovan population have tended to improve in the last decade or so, the comparative statistics show that the situation in most of the transition countries improved to a greater extent than in Moldova.[49]

In 2010 the number of beds in hospitals was circa 22.0 thousand or 61.8 beds per 10,000 people; the total number of doctors was 12.78 thousand, or 35.9 doctors per 10,000 population. In 2010, health care expenditures accounted for circa 13.6% of the State Budget[50]. The most frequent types of diseases (as a primary diagnosis per 1000 population for 2010 are: (i) respiratory diseases (108.5 cases), (ii) pregnancy, childbirth and post-natal complications (49.1 cases), (iii) traumas, intoxications and other consequences of external causes (52.1 cases), (iv) infectious and parasitic diseases (28.1 cases), (v) diseases of digestive organs (23.7 cases), (vi) diseases of the nervous system and sense organs (21.9 cases), (vii) skin and hypoderm diseases (21.1 cases) and (viii) diseases of urogenital system (20.3 cases). Other prevalent diseases relate to the diseases of circulatory system (15.4 cases) and to the diseases of bones and joints, muscles and connective tissue (15.1 cases)[51]. The most important causes of lethal events in the country are blood circulation diseases, trauma and intoxications, and malignant tumors, as well as digestive system diseases.

Possible impact of climate change on health in Moldova

It is clear that climate change and extreme weather events have a direct impact on health. However, they can also affect forestry, agriculture and the economy resulting in problems related to food security and poor sanitary conditions that can, in turn, lead to serious mid- to long-term health effects. The health effects of drought could, for example, cause a decrease in food production and result in nutritional problems in the population, making them more vulnerable to disease. In a UNICEF survey conducted in the Republic of Moldova[52], local leaders anticipated that the most severe impact of the 2007 drought would be its effect on the health of the population. In fact, eight out of ten respondents (and 91% of the medical personnel interviewed) considered that it had already done so. However, the long-term effects of drought may be even more devastating. The increasing competition for arable land may eventually result in migration to cities and abroad, and conflict as resources dwindle.

For health in the Republic of Moldova, six of the identified risks are considered to be high priority:

- Increase in heat wave-related deaths;
- Increase in air pollution-related diseases;
- Increased risk of allergic disorders;
- Increased risk of drought and water scarcity; and
- Increase the burden of waterborne and foodborne diseases.

However, within these regions, the analysis should take into account that climate changes do not hit different population groups in the same manner: some groups are obviously more vulnerable than others. For example, the health care services infrastructure is much less accessible in rural areas, and the rural population has a much higher share of persons who are not registered with family physicians (62% of the total non-registered) as well as a much

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[48]National Bureau of Statistics: http://statbank.statistica.md/pxweb/Dialog/varval.asp?ma=POP0205&ti=Speranta+de+viata+la+nastere+pe+medii%2C+1958-2010&path=../Database/RO/02%20POP/POP02/&lang=1

[49]UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf)

[50] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 22.2 "Structure of national public budget" (see on page 486).

[51] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 8.14 "Population morbidity, by main classes of diseases" (see on page 194).

[52]UNICEF Moldova "Drought after-effects upon population of the Republic of Moldova." Chisinau, 2007.

higher share of those not holding obligatory medical insurance (27.3% of the rural population vs. 19.9% of the urban population). Moreover, every third person who does not hold medical insurance is from the fifth poorest quintile. Secondly, the rural population (around 60% of the total) is much more dependent on the decentralized supply of water than the urban population, and the decline in the quality of water will affect the rural population (one of the most vulnerable group to intestinal diseases is children).

Another important vulnerability is the risk of malnutrition which appears when severe climate events, such as droughts, floods and hails may ruin crops, leaving small farmers with no food and no income meaning that rural populations will face serious nutrition risks.[53]

Vulnerability caused by political factors. The division of the country remains the most influential factor, as the territory on the left bank is separated and out of control of the Government of the Republic of Moldova. Although located in a favorable geographical area and it benefits from water resources of the Dniester River, this area is quite vulnerable to floods and heat waves.

Demographic factors. In recent years the number of population has reduced, and by 2011 it reached 3.56 million due to a negative natural population growth, and a phenomenon known as depopulation of the country[54]. This phenomenon started in 2000 (the natural population growth being minus 1.1 to 1000 population), and it is on-going at present (in 2009 the natural population growth was minus 0.1 per 1000 population). The second adverse process is the migration of young adults in search of jobs in other countries. It is estimated that about 25% of Moldova's economically active population has emigrated. This causes the imbalance between the age groups with all resulting consequences.

Health status. Life expectancy at birth in Moldova has followed the same trend as in other CIS countries that have experienced economic transition in the 1990s, and decreased from 69.0 years in 1989 to 65.9 years in 1995, and subsequently found an intermediate position among the countries of this group. After reaching the minimum level, the figures have improved, reaching an average life expectancy of 69.1 in 2010 which corresponds to the figures before independence[55]. The level of all-cause mortality of the population is quite high and, mortality in active working age is at very high level. The Republic of Moldova has the most worrying statistics on chronic diseases and liver cirrhosis throughout the WHO European Region, associated with increased incidence of viral hepatitis and alcohol abuse, which in turn are associated with social stress and poverty.

Human potential. Understaffing is a major impediment to ensuring people's access to health services. Although the country has trained a large number of doctors and health care staff with secondary education, their numbers are reducing because of migration. For example, in 2010 the number of physicians was 10 612, while in 2009 this number was higher - 10 762. The same situation was with health care staff with secondary education - 23 441 and, respectively 22 996. The most significant shortcoming is the number of family physicians who provide primary health care[56] Financing the health system. Ministry of Health of the Republic of Moldova has strongly promoted the important measures aimed at financing the health sector from public funds and maintaining the amount of medical services provided to population, as a priority. Providing access and improving the overall quality of health care were the main landmarks for the health system. All financial resources, which, compared with year 2009, increased by 149.7 mln. mdl or 3.9%, representing 5.6% of GDP (- 0.8%), were targeted towards these objectives. Although allocations for health increases essentially, the share of public expenditure still remains almost two times lower than in neighboring countries. The State budget contribution in financing the health system in year 2010 was 2,440.6 mln. mdl which accounts for 61.1% of the funds allocated to health care. Financial resources effectively used by public health care facilities in 2010 accounted for 3647.3 million lei, by 341.5 million lei (10.3%) more than in 2009. However, year 2010 features an insufficient level of coverage with mandatory health insurance - 80.8%, which is an essential barrier increasing the vulnerability of the health sector.

The WHO Regional Office for Europe[57] states that the prevention of and response to the health effects of climate change will require a portfolio of action at different levels: from health system preparedness coordinated with

[53]UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf).
[54] Statistical Yearbook, 2010
[55] Health Annual Report, 2010,
[56]*Health Annual Report, 2010*
[57]*Menne B et al., eds. "Protecting Health in Europe from Climate Change." Copenhagen, WHO Regional Office for Europe, 2008 (http://www.euro.who.int/Document/GCH/Protecting_health.pdf?language=French, accessed 8 August 2008).*

meteorological early warning systems to timely public and medical advice and improvements to housing and urban planning. Action within the health system could include: (1) strengthening health security; (2) advocating health to other sectors; (3) sharing good practices in However, within these regions, the analysis should take into account that climate changes do not hit different population groups in the same manner: some groups are obviously more vulnerable than others. For example, the health care services infrastructure is much less accessible in rural areas, and the rural population has a much higher share of persons who are not registered with family physicians (62% of the total non-registered) as well as a much higher share of those not holding obligatory medical insurance (27.3% of the rural population vs. 19.9% of the urban population). Moreover, every third person who does not hold medical insurance is from the fifth poorest quintile. Secondly, the rural population (around 60% of the total) is much more dependent on the decentralized supply of water than the urban population, and the decline in the quality of water will affect the rural population (one of the most vulnerable group to intestinal diseases is children).

Another important vulnerability is the risk of malnutrition which appears when severe climate events, such as droughts, floods and hails may ruin crops, leaving small farmers with no food and no income meaning that rural populations will face serious nutrition risks.[58]

Adaptive capacities of health sector

Legal support. In Moldova adaptation measures to extreme events of climate change are specified in detail in the *National Health Policy* (approved by the Government by the Government Decree No. 886 as of 06.08.2007), and provide for creating a healthy and safe environment, controlling infectious and non-contagious diseases, promoting health and disease prevention, etc.

Specific measures in public health sector are specified in the *Law on State Surveillance of Public Health* (2009). In addition to general measures aimed to ensure continuous sanitary-epidemiological welfare of population, the law includes a special chapter, namely, Chapter IX (Articles 54-62).

Another decision made by the state is formulated in the *International Health Regulation*, focusing on preparedness and response to emergencies which are organic part of the UN International Strategy for Disaster Reduction, decision of the Commission on Human Security and the WHO Health Action in Crises. For this purpose the Action Plan for implementation of the International Health Regulation in the Republic of Moldova was developed and approved by the Government Decree No. 475 as of 03/26/2008. The Plan has a cross-sector nature and most of the measures are implemented.

The Ministry of Health of the Republic of Moldova has demonstrated a political commitment for crisis management by issuing ministerial orders approving the establishment of the Disaster Medicine Service. However, there is no other legislation in the health sector, except for the two laws mentioned above, that would provide for the necessary legal framework for preparedness and response to crises caused by climate change event.

Institutional support. Aiming at ensuring optimal conditions for accomplishing the health potential of each individual through the organized efforts of society to prevent disease and promote health, including in the circumstances of extreme events generated by climate change, the Department of State Surveillance of Public Health was established through the Law on the State Surveillance of Public Health (2009). One of the responsibilities of this Department is to monitor health in relation to those determinants that depend on the environment. The responsible authority in this field is the Civil Protection and Emergency Situations Department established on the basis of the Law on Civil Protection and Emergency Situations (2007).

Methodological support. Methodological support for prevention and control of diseases is well enough developed in Moldova, focusing on immunity-manageable diseases, water and food-borne diseases, natural hotbed diseases, an important element in relation to health effects of extreme event conditioned by climate change. Methodological support for prevention and reducing non-contagious disease is poorly developed and is a priority task for the future.

The WHO Regional Office for Europe[59] states that the prevention of and response to the health effects of climate change will require a portfolio of action at different levels: from health system preparedness coordinated with meteorological early warning systems to timely public and medical advice and improvements to housing and urban

[58]UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p.

[59]Menne B et al., eds. "Protecting Health in Europe from Climate Change." Copenhagen, WHO Regional Office for Europe, 2008 (http://www.euro.who.int/Document/GCH/Protecting_health.pdf?language=French, accessed 8 August 2008).

planning. Action within the health system could include: (1) strengthening health security; (2) advocating health to other sectors; (3) sharing good practices in intersectoral action; (4) building capacity in the health workforce; (5) providing intelligence; and (6) setting an example by “greening” the health services.

Biodiversity and Ecosystems Sector

Climate change impact upon the components of flora and fauna

Climate change has a direct and an indirect impact upon the animals. Direct influence is less pronounced, because animals, unlike plants, can adapt to some changes and behavioral and ecophysiologic mechanisms. Animal world will be influenced indirectly by the degradation of plant associations, shortages of food, water and breeding sites. In a more difficult situation are now the species of endangered, vulnerable and rare categories, which are at their limit of minimal reproductive number. Taking into account the fact that within animal populations, there are some with a greater ecological adaptation, we might admit that common species will have time to adjust themselves to new living conditions. An example may serve the species of birds from *Corvidae f*amily - *Corvus frugilegus, Corvus corone cornix*, *Corvus corax, Pica pica, Corvus monedula, Garrulus glandarius, Columbidae - Streptopelia decaocto, Columba palumbus, Streptopelia turtur* etc. Some animal sps, *loce Streptopelia decaocto, Fringilla coelebs,Phoenicurus ochruros, Columba palumbus, Martes foina, Erinaceus europaeus, Dryomys nitedula* etc. are adapting themselves to the urban environment, and thus are less affected by the environmental changes. As it was mentioned above, the current situation of animal world and vegetation in the country is quite a difficult one due to the decreased functional capacity of natural ecosystems.

Most of the natural ecosystems are degraded and fragmented. Degradation of natural ecosystems, plant and animal communities is determined mainly by the anthropogenic factor which overlaps with the deficit of humidity on the most territory of the country. It is noticed that in river basins there is intensification of eutrophication process of water, and in the steppe and meadow ecosystems – the process of xerophyitisation and the replacement of plant species characteristic to these ecosystems with ruderal plants. Following the disappearance of species of bulb plants *(Poa*), the number of *Spermophilus citellus* and other small rodents is reducing. Taking into account that they are the main source of food for many species of terrestrial vertebrates, as: *Mustela eversmanni, Mustela erminea, acvilas*, pigeon hawk etc, which are endangered and are under the risk of disappearance. Clearing of trees at the rivers’ banks led to the increased level of water evaporation and the decrease of environmental capacity of aqua basins to maintain the rich diversity of aquatic animals.

The dryness of steppes will further cause the decrease of the number of plant and animal species characteristic to this, and not only this, ecosystem. Steppe vegetation is present in all climatic zones of Republic of Moldova. In the Northern part (Balti field) and in the southern part (Bugiac steppe) will be extended the formations of the following herbs: *Stipa capillata, S. pinnata, S. tirsa, S.ucrainica, Festuca valesiaca*. These plant formations are highly influenced by the anthropogenic factor (excessive grazing and plou ghing) including the dryness. It is necessary to introduce a protection regime for meadows to restore until its floristic and plants components, i.e. a real meadow. Xerophile meadows (steppes) of Republic of Moldova are strongly connected with current climate and by stopping the massive anthropogenic influence, there still might be chance to extend meadows in a short time on large surfaces, including the raw agricultural lands. A drier and warmer climate is favorable for numerous numbers of endangered species from steppe ecosystems in extending their coverage.

A part of prey birds that are living in forest ecosystems (acvila, pigeon hawk) and aquatic ecosystems *(Circus aeruginosus*) feed with rodents (gopher, microtine, mice) of steppe ecosystems and in the absence of such sources, they become vulnerable species are doomed to extinction. In the future out of species of animals, especially insects and other local invertebrates, as well as foreign species, will appear new depredators, that will cause considerable crop damage, affecting food security.

In Moldova there are animal species of different zoo-geographical origin. In ornitofauna, the predominant species are those of trans-arctic-pole and west-arctic-pole. In teriofauna prevails European elements, followed by those of arctic-pole. In serpentofauna dominate species of European and Ponto-Caspian origin. As a result of climate change and the trend of expansion of the drying process, different structural changes in ecosystems are taking place, particularly in the forest. Consequently the area of animal species of European origin is reducing, and the coverage 11of south-eastern species will widen. Gradually are diminishing the populations of animal species of whose eastern limit of the area is passing through the territory between the Nistru and Prut: *Spermophilus citellus, Felis silvestris, Vipera ursini, Elaphe longissima, Elaphe quatuorlineata etc.*

The location of the republic in a region of bio- geographic interference, presence of three types of fauna on a relatively small surface created a rich biological diversity, including. It shall be noted that as natural ecosystems, as well as a lot animal species are at their limits, where living conditions are extreme. These conditions increase the vulnerability of biological resources, the trends of their structural and functional changes. Due to the dominance of southern and south-eastern elements of flora, will increase the number of forms and species of the respective kind. Still, according to the opinion of experts, successions in the respective ecosystems and biocenosis shall be done in slower way during centuries. Many animal species have a high capacity to accommodate to the new living conditions. For example, rodents' preferences towards temperatures vary significantly from one season to another and geographic zones.

Water Resources Sector

Possible impact of climate change on water resources in Moldova

Climate change is only one of many factors that will determine future patterns of water availability and use. Non-climatic factors could aggravate or attenuate the adverse effects of climate change on water availability and quality, as well as have a significant influence on water demand. Population growth and economic development (and, by extension, changes in lifestyles and diets) will play a dominant role (as highlighted above, economic decline is a significant factor in the stability of water resources to date, and hence water withdrawals will be expected to increase with economic recovery). According to the water-intensive target of national economic development, secure supply for all water users will be threatened by climate-related change in water resources already in the 2020s, when the intensity of surface water use will be close to 100 percent. However, taking into consideration ground water supply as well, the point when water scarcity will become a brake to development is likely to set in after 2030[60]. Non-climatic impacts could be generated through many realms—from policies and legislation to technologies and infrastructure to land-use patterns and agricultural activities/irrigation.

The water scarce area occupies one third of the country's territory. It embraces 1/3 of the country's urban settlements, almost ¼ of the villages, 28% of urban and 30% of rural population. On its territory more than 1/3 of arable land, ¼ of forests, orchards and pastures about 30% each, and almost half of vineyards are situated. This area suffers from insufficient precipitation, and irrigation is required for many of the crops.

The geographical location of water users will play the most decisive role in the future in ensuring access to a secure water supply. The water scarcity area, has, as it extends northwards, already reached the most populated areas, which place the biggest load on water resources and are most intensive in water use. The expected impact of diminishing water resources likely to occur in the near future will be differentiated into three types of areas, depending on human and economic activity within the affected regions:

- Traditionally water deficient zones. In these areas climate change will put pressure on current economic activity, but water scarcity will not be a new phenomenon for the area and its inhabitants;
- Areas with vulnerable, mainly rural, populations. These are areas, especially the Southern Transnistria region, which are already experiencing water shortages as well as decreasing water table depth in unconfined aquifers due to overexploitation;
- Central Moldova. This part of the country is exposed to the complex impact of likely diminishing water resources on both rural and urban populations.

For water resources in the Republic of Moldova, e the identified risks are considered to be high priority:

- Increased risk of drought and water scarcity. The hydrology of arid and semiarid areas is particularly sensitive to climate variations. Relatively small changes in temperature and precipitation in these areas could result in large percentage changes in runoff, increasing the likelihood and severity of droughts and/or floods.
- Increased irrigation requirements;
- Flood frequencies are likely to increase in many areas, although the amount of increase for any given climate scenario is uncertain and impacts will vary among basins.
- Decrease water availability from surface sources or ground water. The frequency and severity of droughts could increase in some areas as a result of a decrease in total rainfall, more frequent dry spells, and higher ET.

[60]UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf)

- Changes in water demand, change in the potential evapotranspiration (ET). Consequently, even in areas with increased precipitation, higher ET rates may lead to reduced runoff, implying a possible reduction in renewable water supplies.
- Water quality affected by higher water temperatures and variation in runoff. Water quality problems may increase where there is less flow to dilute contaminants introduced from natural and human sources.
- Higher pollution with pesticides and fertilizers to water due to higher runoff; and
- Changes in river flows both increase and decrease

Adaption options

Moldova's climate has been steadily moving toward drier conditions since the 1990's. Nine significant dry periods or droughts have been recorded since 1990, including a catastrophic drought in 2007 that resulted in losses of up to 75% for major crops such as wheat, maize and sunflower. Drought is becoming endemic in many parts of the country and is increasingly affecting rural livelihoods and development. Adaptation measures for flood and drought impacts include efficient operation of dams, dikes and open channels; wetlands protection (one of the main positive functions of wetlands is to allow groundwater recharge and reduce peak discharges downstream); measures for protection of the irrigation infrastructure from floods; techniques to improve soil texture, aggregation, organic matter content and surface ground cover to manage water usage during dry periods; improved flood forecasting; installation of systems to provide dam break alerts; technical assistance through agricultural extension in coordination with irrigation upgrades to assure dissemination to farmers of techniques to minimize their vulnerability to weather events; and elaboration of effective collaboration between Moldova, Ukraine, and Romania to monitor water discharges, improve weather/flood forecasting and early warning for all downstream countries.

3.2 Process and criteria of prioritization

Establishment of the decision context

The methodological guidance used in the sectors' prioritization was provided during TNA workshop in Bangkok (8-11 August, 2011) and also using TNA Guide and Multicriteria Analysis manual. The prioritization of the sectors was done with extensive involvement of stakeholders from relevant organizations. According to the TNA Project Work Plan, during the meetings of sectoral working groups, the representatives from Ministry of Environment, Ministry of Agriculture and Food Industry and Ministry of Health of the Republic of Moldova, experts, specialists from the main sectors of economy (Agriculture, Energy, Human Health, Water resources, Tourism, Forestry) have been familiarized with Multi criteria Analysis concept and tools prior to conduct sector's and technology's evaluations. Before proceeding to the prioritization procedure, the TNA team leader emphasized the importance of having the selecting procedure transparent, correctly performed with the engagement of representatives from each considered sector, particularly stakeholders.

The prioritization of the sectors was based on:

a) data from the previous country and sectors vulnerability assessments that show vulnerabilities to climate change of each sector;

b) the adaptation potential of the sectors;

c) how the improvements (potentially implemented technologies) in the selected sectors can contribute to achieving country's development priorities.

The participants used the data about country's ***vulnerability to climate change***, its long term impact on country's social, economic and environmental development, data collected from the vulnerability assessments under the First and Second submitted National Communications and also during the undertaken vulnerability assessment activities in the on-going Third National Communication in which many of experts have participated, also assessment reports done by the National Human Development Report (NHDR, 2009), UNDP & The Expert Group: Socio-Economic Impact of Climate Change in Moldova and Policy Options to Adapt, World Bank: Rural Productivity in Moldova – Managing Natural Vulnerability, 2007, Ministry of Ecology and Natural Resources and State Hydro-Meteorological Service: Climate Monitoring and Droughts, 2007, elaborated National strategy on Adaptation along with working group members knowledge about vulnerable aspects of each sectors.

The ***adaptation potential*** of each sector was another important aspect the working group members have considered, along with sector's capacity to operate further selected technologies, including institutional support, organizations working in the area, policy regulation stage, potential to market new technologies, other relevant aspects. In prioritizing the sectors, the stakeholders and experts had to select sectors that provide the most effective actions for adaptation to future climate change of the Republic of Moldova.

The practical judgment was how implementation of adaptation technology would contribute to improvements in the particular sector. When considering each sector, the working group compared the current technological situation and contribution of new, environmentally friendly technologies to sectoral improvement based on the beneficial criteria and how new technologies would contribute toward achieving environmental sustainability and climate change resilience.

The prioritization of sectors was done by application of MCDA tools. The Performance Matrix (Table 3.2-1) was used for sectors prioritization with experts' justification of the score given to each sector and criteria contribution chart bar (fig 3.2-1), emphasizing the contribution of each criterion in the overall score for each sector.

The working group members come to common agreement the sectoral assessment to be based on the following criteria:

a) **Economic:** Participants included economic criteria in sectors' prioritization considering that environmental friendly technologies and new 'cleaner' primary inputs will bring about cleaner production processes. These industries will benefit economically from increased sales as will society from increased employment in these sectors. The stakeholders expressed the opinion that national government should focus on putting in place policies that enable private sectors to effectively assist in adaptation, particularly in agriculture sector.

b) **Environmental:** All participants agreed that the highest benefits from the implemented new technologies will be environmental. Participants have mentioned the importance of implementing environmentally friendly technologies in the strategically important Agriculture sector for major crops cultivated in Moldova: cereals, grape, orchards that would contribute to increased crop yield, biodiversity conservation, good maintenance of arable soils.

c) **Social:** The social benefits of new technologies relate to improvements of the quality of life, improved health of population. The NGO representatives insisted on informing and involving the public society in the climate change resilience activities that help to build trust within communities and between communities and government (and potentially industry) and can improve social cohesion.

d) **Potential for adaptation.** Human and social capital is key determinants of adaptive capacity, as important as income levels and technological capacity, population development and governance structures. However, within the country different sectors have different adaptive capacity, i.e. a different ability to adjust to climate change or to cope with the consequences and working group members agreed to include this aspect in sectors' prioritization. The following sectors were included in the sectoral prioritization in the TNA of the Republic of Moldova:

Agriculture Energy

Forestry Tourism

Water resources Transport

Human health Biodiversity and Ecosystems

The working group members scored the sectors based on 0-5 scale with following rating scheme:

1. -no benefits;
2. -faintly desirable;
3. -moderately desirable
4. -very desirable
5. -extremely desirable

The final score represents the average of points given by all participants (round numbers).

Table 3.2-1 Performance Matrix used in sectors' prioritization

Performance Matrix of Sectors

Priorities / Sectors	Economic priorities	Social priorities	Environmental priorities	Potential for Adaptation	Total
Agriculture	5	4	5	4	**18**
Forestry	3	2	5	3	**13**
Energy	5	3	4	3	**15**
Tourism	2	3	2	2	**9**
Transport	4	3	4	3	**14**
Human health	3	5	4	4	**16**
Biodiversity and ecosystems	2	2	5	3	**12**
Water resources	4	4	4	3	**15**

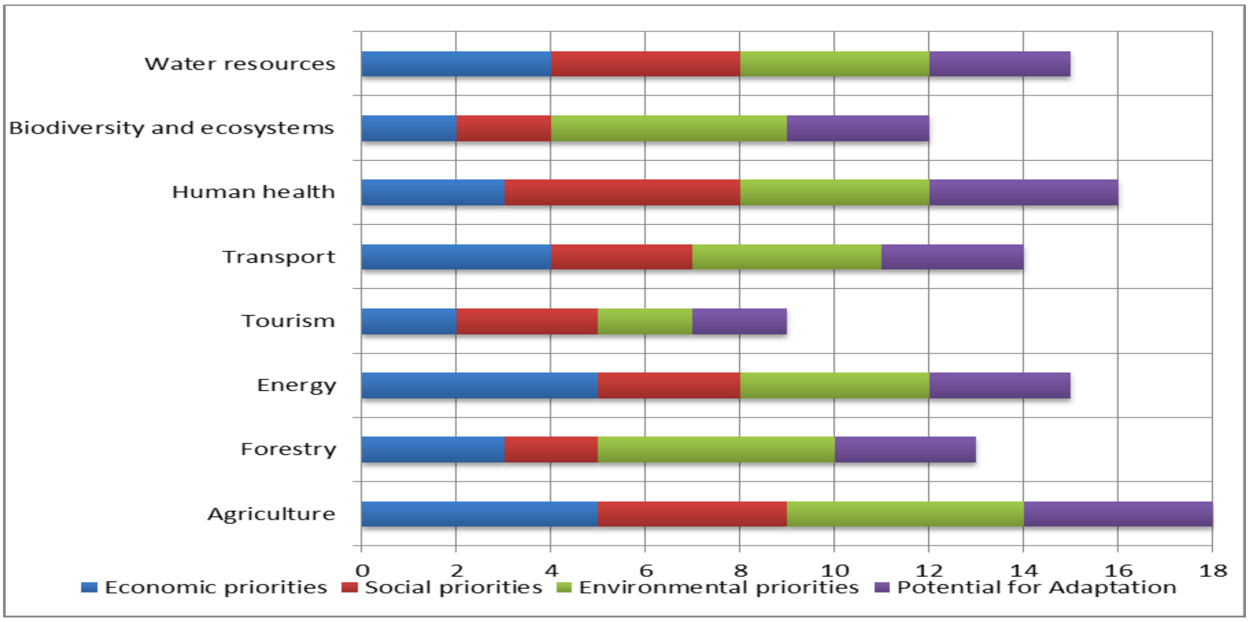

Fig. 3.2-1 Criteria contribution chart bar in the sectors prioritization.

As a result of multilateral consultations, inputs and collaboration between experts and stakeholders during sector's prioritization, sectors' Short List consists of:

1. **Agriculture Sector**
2. **Human Health Sector**

According to performed prioritization, the two sectors Agriculture and Human Health have accumulated 18 and 16 points respectively and working group members agreed that these two sectors will make a strong contribution to Republic of Moldova development priorities. Technological improvements in these sector would significantly decrease country's vulnerability to current climate variability and future climate change and enhance environmental protection. Given the strategic importance of Agriculture and Human Health sectors to country's economy, population wellbeing and social development, during the process of sensitivity analysis there were no disputes and disagreements with regard to prioritization results among working group members. These two sectors had already been identified in previous vulnerability and adaptation assessments as having potential of adaptation to climate change, contributing to country's resilience to climate change. The participants commonly agreed that technological improvements in these sectors would impact the whole society and enhance country's coping capacity to climate change.

Detailed portfolios of Agriculture sector and Human Health sector are provided in the Chapter 4 and Chapter 3 of the current Report.

3.3 Current status of technologies in the selected Agriculture and Human Health sectors.

Before proceeding to the prioritization of proposed technological options, it was necessary the working group to get an overview of the current technological status. For this purpose the experts have provided the information about the most common practices and techniques and measures currently used in the Agriculture and Human Health sectors. This information was discussed during the meeting of working group.

Agriculture Sector

Agriculture sector is crucial to meeting Moldova's economic growth, as the country has agriculture based economy. The agricultural sector is one of the most important in Moldova, providing 41.4% of total employment[61], with high contribution to GDP, 31.2%-11.9% during 1993-2010years[62]. The cultivable area is estimated at almost 2.6 million ha, which is 76% of the total area of the country[63]. By far the most significant land use is arable land for annual crop production. Much of this arable land sits on highly fertile and productive black chernozem soils, which cover 75% of the country, especially the northern districts and the Dniester River valley. High quality soil resources, along with various microclimates, support a wide array of annual and perennial crop production across the country. By area, the major annual crops grown are maize, wheat, sunflowers and barley. Cereals constitute 0.95 million hectares and other crops about 0.7 million hectares.[64] Vineyards and fruit trees are the main perennial crops. As nearly 90% of this production is rain-fed, there can be significant changes in the crop mix and area planted on a year-to-year basis, depending on the timing and quantity of rainfall and associated extreme events, like drought.[53]

Agriculture has traditionally been a major component of the Moldovan economy, especially during the transition to independence. However, the impact of this transition and the associated breakdown of collective and state farms had a negative consequence for growth in the agricultural sector. Despite the decreasing contribution to GDP, when the agricultural sector is combined with the agro-processing sector, the importance of agriculture to the Moldovan economy becomes more fully illustrated, with the combined sectors accounting for approximately 30% of GDP, 60% of exports and 50% of industrial output (fig.3.3.1).

[61] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 3.1.4 "Distribution of employment by economic activities" (see on page 73).
[62] National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova, 2011, Table 13.21 "Share of main economic activities in the generation of gross domestic product" (see on page 269).
[53] World Development Indicators, 2009, World Bank.
[63] World Bank, 2010
[64] Area harvested is estimated based on linear trends using FAO reported data from 1995-2008 due to annual fluctuations in area harvested (FAO 2011).

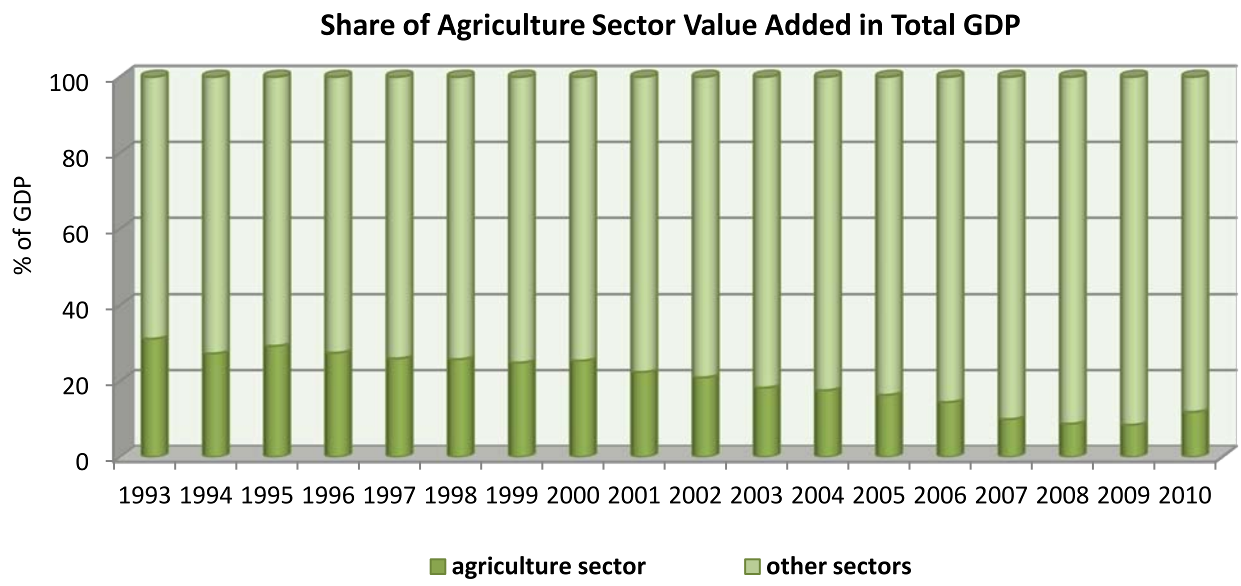

Fig.3.3-1 The dynamic of agriculture share value added in total GDP

Source: Ministry of Economy of the Republic of Moldova, Department of Macroeconomic Analysis and Forecasts (2012).

These figures highlight the inherent vulnerability of the national economy to climate related events that impact the agricultural sector. This level of vulnerability is further compounded at a livelihoods scale, as 90.8% of the rural population earns less than $5 per day and is highly vulnerable to any changes in agricultural income.

Sector assessments show high agronomic potential based on country's favorable geographical characteristics: mild climate, rich soils, topography and agricultural traditions. The market potential is also estimated high, due to the country's proximity to EU market and also following the traditional agro-food trade with Eastern market (Fig.3.3-2).

Despite its good agricultural potential, Moldova still is one of the poorest country in Europe, its economy and social life highly affected by global crisis with strong repercussion on the environment. Moldova's agriculture already vulnerable due to socio-economic challenges of long term transition period (such as low market prices, increasing input prices, marketing challenges in comparing to EU agricultural systems) is more sensitive to impact of climate change.

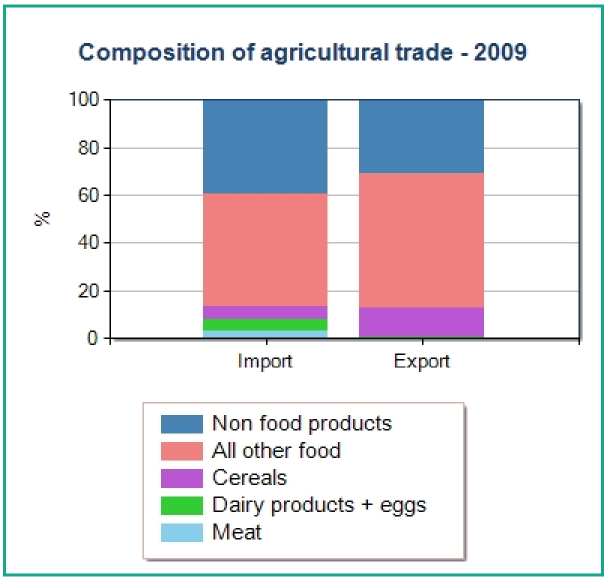

Fig.3.3-2 Composition of agricultural trade of the Republic of Moldova, 2009

Source: http://faostat.fao.org/

Republic of Moldova has large share (59%) of rural population engaged in agricultural production, high rates of food insecurity and poverty, and adverse impacts from extreme climate events. These circumstances imposed Government to develop the Action Plan. The Action Plan for the implementation of the National Agriculture Sector and Food Processing Industry Sustainable Development Strategy of the Republic of Moldova for 2008-2015 provides for certain actions to promptly replace the current traditional farming with the agriculture based on the sustainable practices of exploiting the fertility of agricultural soils. The programs to be developed and implemented within the respective period will include most certainly the measures to conserve carbon in soils, because it is the foundation for sustainable agriculture, e.g.:

- implementation of the Program to Prevent Soil Erosion and Manage Low Productivity Areas;
- implementation of the Agricultural Land Consolidation Program;
- improved agricultural land management;
- comprehensive soil evaluation and identification of the available resources, priorities, limitations and risks;
- development and implementation of the projects to create green protection strips;
- creation and implementation of an integrated system for soil fertility increase and reproduction;
- review of the National Horticulture Development Program;
- production of the Technical Crops Development Program;
- development of the Vegetable Production Program;
- production of the Grain Crops Development Program;
- implementation of the Tobacco Sector Development Program in 2003-2010;
- implementation of the National Program for the Development of Nut Production until 2020.

The Institutional Context

The Ministry of Agriculture and Food Industry (MAFI) is responsible for the formulation and promotion of policies and strategies related to the development of the rural sector and food industry. Given the level of rural poverty, MAFI has an important role in improving rural livelihoods through increasing farm competitiveness and access to markets, while simultaneously reducing barriers for private investment in the sector. MAFI has departments relating to the regulation, administration, technical support and oversight of agricultural production and processing throughout the country. MAFI also provides research, development, extension, education and training services through a range of organizations, including the Soil Institute, the Animal Breeding and Veterinary Medicine Institute, the State Agrarian University and the Institute for Field Crops. This last institute focuses on a number of activities, including crop breeding, seed multiplication, farming systems research, organic agriculture development and farm modernization.

Forestry Agency "Moldsilva" is a state institution responsible for forestry policy development and the management of state forestry resources. This includes the establishment of new forests, management and protection of existing forests, research and monitoring of forest ecosystems and the rehabilitation of degraded and eroded agricultural lands via afforestation programs.

Farm Associations and Industry Groups are primarily responsible for representing the interests of different sectors of the agricultural community. A number of these organizations have been recipients of capacity building efforts and resources from donor-funded projects and are important channels for the dissemination of information and the collection of data at the producer level. These organizations include the National Farmers Federation, National Federation AgroInform, the UniAgroProject network of 15 regional Agricultural Producers Associations and local Water User Organization[65].

Research and extension.

The **scientific research** in the agricultural and food sector is carried out by a network of institutions subordinated to the Ministry of Agriculture and Food Industry. Within the 9 institutions carrying out plant breeding activities in Moldova, only one belongs to the private sector. This is a relatively high number of institutions, taking into consideration the country's size and its total agricultural area. Most of these institutions have a long tradition of breeding and a relatively high number of academically well-prepared research staff.

The following institutions are conducting agriculture research studies in the Republic of Moldova:

- Faculty of Agronomy, State Agricultural University of Moldova (UASM)

[65] World Bank, The Republic of Moldova Climate change and Agriculture note, November, 2010

- National Institute of Wine and Viticulture Research (NIWVR)
- Genetic Research Institute (GRI)
- Botanical Garden Research Institute (BG)
- Institute of Crop Sciences Research (ICSR) Baltsy
- Institute for Maize and Sorghum Research (RIMS)
- Institute of Fruits Trees Research (ITFR)
- Centre of Scientific Research "Magroselect".

Agricultural research and extension services need greater capacity to enable response to climate change, including adequate funding and policy support for requisite expertise in climate science and agricultural science. The available structures, such as adequate experimental fields, laboratories and equipment, suffer as a result of reduced investment in biotechnology research. The shortage of personnel, especially young staff, is also a major issue. National institutions need significant investments in research capacity; inadequate financing is the main constraint for studying agriculture under climate change in Moldova.

The extension services to agriculture in Moldova are represented by ACSA. The Agency for Consultancy and Training in Agriculture (ACSA) has an important role as the lead agency for agricultural extension services in Moldova. Throughout the country the ACSA employs more than 350 consultants to deliver farmer advisory services via direct consultations, seminars and trainings on an array of agricultural and production system topics. The private extension service is not developed in Moldova. The new challenges and opportunities brought by climate change reinforce the pressing need for revitalization of a holistic extension system that can help farmers make locally appropriate innovations.

Main areas of agriculture production in the Republic of Moldova

Crop production

In Moldova cereal crops are grown mostly extensively and occupy about 65% of cropping land however, their contribution by value is comparable to that of grapes and apples, which garner a higher price (fig.3-3-3).

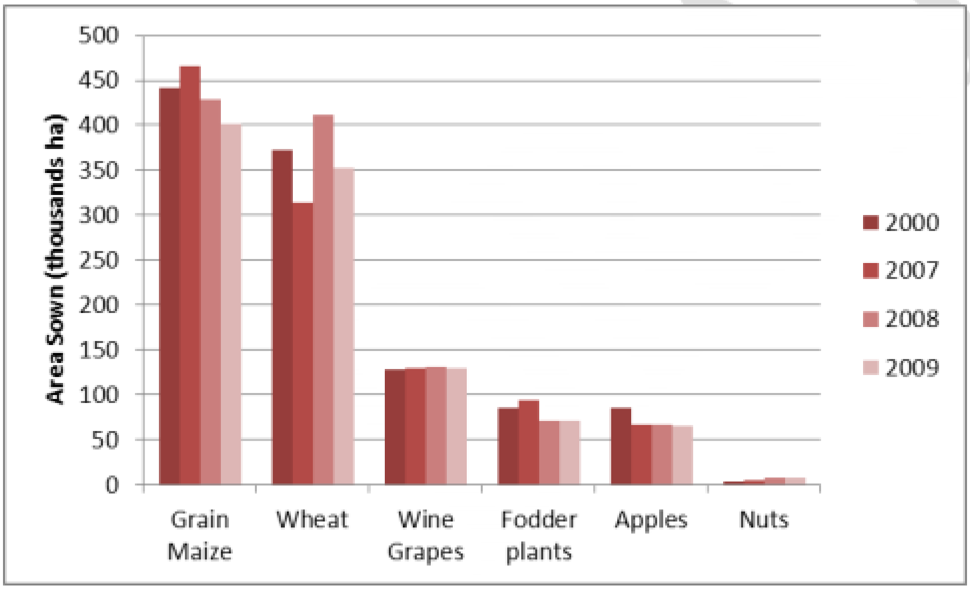

Fig. 3.3-3 Area sown by main crops in Moldova.

Source: National Bureau of Statistics, 2009.

During last decades the structure of grown crops has changed in the favor of cereals such as maize and wheat (fig.3.3-4). This hidden extensive type of technology was possible by shrinking output of high value added agricultural products such as apples, tomatoes, grapes and meat; and by an expansion of the areas sewn with wheat and sunflower. Between 1995 and 2007, the total area of orchards decreased by 30 per cent and that of vineyards by 20 per cent, while the area of lands sewn with grains increased from 50 per cent of the total area of crops in 1994 to 65 per cent in 2004. These developments are a consequence of farmers' diminishing incomes, since they cannot finance needed investments in higher value-added crops. The high value-added crops require more sophisticated technologies and better protection against unfavorable climate conditions.

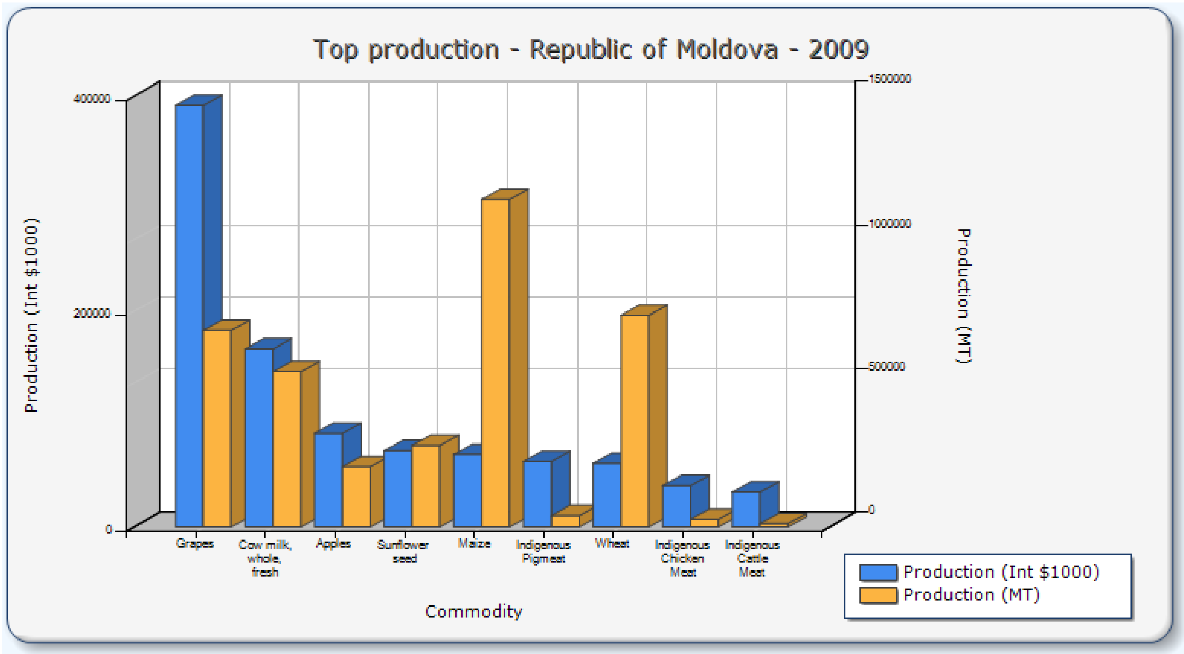

Fig. 3.3-4 Commodity level production in the Republic of Moldova, 2009.

Source: http://faostat.fao.org/

It should be noted that the increasing area of land sewn with grains and industrial crops (sunflower and sugar beet) was accompanied by unstable yields per hectare. Yields of winter wheat, seed corn and sunflowers have fluctuated over the years, with 2008 yields of sugar beets considerably higher than previously. This suggests that yields have varied at least partially with climate conditions. The recovery of the crops sector in 2008 was paralleled by a further fall in animal husbandry. On average, the yields obtained in Moldova's agriculture between 1996 and 2008 are rather close to the levels registered in 1960s. This is an underlying indicator showing the depth of the current crisis in Moldovan agriculture.[66]

Technologies for conventional agriculture with high inputs of mineral fertilizers and pesticides, with modern equipment and high yielding varieties (hybrids) of crops. Such technologies for different field crops are used on limited area because of high prices for inputs. Technologies with fewer inputs per unit of sowing area are dominating in Moldova. Unfortunately they both are based on mining the natural fertility of soils, and reducing the biodiversity above and under soil surface, pollution of soils and water. Technologies used in ecological farming are very limited.

Plant breeding

Currently in Moldova there is a trend of reducing the spectrum of used species, both in plant growing and livestock sectors that can lead to the so-called danger of *genetic erosion*. Thus, pedoclimatic conditions in Moldova are quite favorable for the growth of a large range of crops that include about 80 species of plants. However, in the last 4-5 decades about 50% of agricultural lands were occupied by six species - winter wheat, corn, barley, sunflower, sugar beet and vine.

Insufficient financial assistance for the implementation of new technologies, including technologies of "in vitro" culture aimed at more efficient production of planting material and ensuring vegetal biodiversity.

Lack of sufficient investment in agriculture has led to a significant shortage of manpower in agriculture and a mass exodus from rural areas. As a result, of 1.6 million ha of arable land about 400 000 ha were left fallow, a situation that

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[66] UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf).

endangers food security of the population, limiting the competitiveness of agricultural products towards the CIS markets (developing countries).

Currently in use fruit trees planting material production methods (fruit trees nursery)

The fruit trees planting material necessary for planting modern plantations, is grown in fruit trees nurseries.

Organization of a fruit tree nursery implies activities in three sectors:

1. *The sector of mother plantations of fruit trees and bushes consisting of:*

- mature seed plants, yielding the stones and seeds needed for generative rootstocks (sour cherry, wild cherry, etc.);
- elite plantation for grafts (standard plantation) which includes varieties from which the shoots and branches necessary for rootstock grafting are obtained ;
- elite plantation for harvesting cuttings needed to obtain plants on own roots (without grafting) such as: quince, olive, fig, etc.

2. *Rootstocks propagation sector* is an area used to obtain fruit trees rootstocks. It has three sub-sectors: a) rootstock nursery where rootstock from stones and seeds are obtained as annual cultures sown in autumn or spring and yielding rootstock seedlings next autumn,

- stock-nursery for producing vegetative rootstocks, especially apple, quince, some types of plums, cherry, etc.
- cuttings nursery where rootstock of easily rooted species, such as quince, are obtained;
- grafted trees are produced in sector I and II of the nursery;
- sector II grafts are grown and form the first branches of the future tree crown.

Reproduction of fruit shrubs, undergrowth and strawberries.

It is divided into several sectors depending on reproduction methods of these plants and includes the following subsectors:

- currant seedlings nursery;
- stock - nursery for obtaining gooseberry planting material ;
- strawberry propagation sub-sector;
- ornamental shrubs and trees sector is a sector where roses and other ornamentals are grown.

Production of vine grafted planting material.

The vine planting material is produced in specialized units (nurseries) with have the following sectors:

- plantations of rootstock vine species resistant to phylloxera, which are used to obtain rootstock cords (cuttings);
- obtaining grafted vine by combining two components - the rootstock and the graft;
- vine nursery where vine is rooted and grown;
- plastic greenhouses (solar) for vine rooting and growing.

Production of no- grafted vines:
Non grafted vines are used to set plantations on sands and are obtained from cord grafts (cuttings), of 40-50 cm long.
In autumn, after harvesting the cords on plantations with identified and recognized fertile varieties, cuttings are shaped in conformity with the required lengths. In winter the material is kept in silos or refrigerators, cuttings are planted in nurseries in spring.

Livestock production

Traditionally, livestock was an important component of Moldova's agricultural economy. Over the last decades the livestock production Republic of Moldova had a declining trend with some growth between 2001 and 2006 years, followed by a drastic reduction of animal growth in 2007. During this period cattle and pig livestock have moved from the large corporate farms to the peasant farms and households, were livestock is raised mostly for subsistence and not for commercial purposes. According to National Human Development Report (NHDR, 2010)[67], big agricultural entities have almost entirely abandoned the cattle and sheep industry; today they produce 13% of meat, 3% of milk and 3% of

[67] UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf).

wool. A different situation is seen in the poultry production, where large companies produce 34% of eggs and meat. The fall in livestock numbers was the consequence of a lack of investment funds, a livestock is more capital intensive than crops.

Livestock breeders are continuously challenged by the need to evaluate new developments and new technologies. To date, most genetic progress for quantitative traits in livestock has been made by selection on phenotype or on estimated breeding values (EBV) derived from phenotype, without knowledge of the number of genes that affect the trait or the effects of each gene. In this quantitative genetic approach to genetic improvement, the genetic architecture of traits has essentially been treated as a 'black box'. Dairy farming is emphasized in districts where the natural conditions are favorable for growing grasses and crops for silage and where there are many pastures, a comparatively large work force, and many large cities demanding milk (fig.3.3-5).

Fig 3.3-5 Domestic production of cattle

Mostly dairy and beef cattle farming and swine breeding are developed in the districts where much of the land is plowed up and pastures are in short supply, grain farming is developed, and manpower in rural communities of Moldova is fairly abundant. Sheep raising and cattle breeding chiefly for meat production are most developed in South districts of Moldova, with steppe natural pastures, where grain and succulent forage are in short supply and the strength of the work force is unstable. The big complexes of livestock farms for the production of meat, milk, and eggs on a commercial basis could not be maintained during transition time and currently few of these big complexes exist (in 1990 there were 1150 of complexes, currently only 94 with a reduced number of animals 4.2 thousands of animals). Due to the same difficulties the concentrated livestock breeding disappeared and this technology is highly fragmented represented in the whole livestock production. Intensive livestock breeding that allows efficient use of the biological characteristics of the animals that helps to shorten the production process while using less labor and capital per unit of production is weakly represented in Moldova**.** Around large cities (Chisinau, Balti, Cahul) there is a network of farms that specialize in the production of whole milk.

Swine production has decreased from 2079 th animals in 1980 raised in big complexes of 24 000 - 54000 to 283 th animal nowrdays (fig.3.3-6). By volume, livestock production has the following structure: bovine - 36%, poultry - 29.2%, swine - 27.7%, sheep and goats - 5.3% and other products - 1.8%.

Poultry production also is represented by a significant share of domestic production -19102 th (85.1%), the remaining 14.7 % are grown at specialized poultry farms. There are also specialized poultry farms, poultry processing plants, and large poultry-raising companies. The egg production at these companies has a share of 38.6 %.

The state of the livestock sector continues to be determined by the situation of farmers' households, the largest share of livestock production belonging to them: milk production - 87%, cattle and poultry breeding - 80%, eggs production - 70%. 94% of bovine (including cows - 96%), 77% of swine and 97% of sheep and goats are concentrated in the private sector.

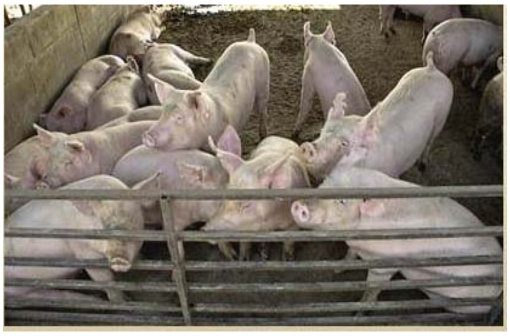

Fig 3.3-6 Swine growing in domestic farms

During 2008 meat processing enterprises purchased and processed 21.5 thousand tons of raw meat, including: Bovine - 6050 tons, swine – 8500 tons, poultry - 4850 tons, Category I sub-products - 1780 tons and other types of meat - 1320 tons. From this were produced: Smoked meat products - 2066 tons, sausages - 15571 tons, canned meat - 637 tons, semi-finished products - 1795 tons. In 2008, milk processing enterprises purchased and processed around 150 thousand tons of raw milk from which they produced: 26.1 thousand tons of milk for consumption, 22 thousand tons of other milk products, 4.3 thousand tons of butter, 2.6 thousand tons of cheese, 3.5 thousand tons of fresh cottage cheeses, 1.3 thousand tons of other cheese products, 3 thousand tons of skimmed milk powder and 7.4 thousand tons of ice cream.

There are 11 big and medium meat processing enterprises in the sector with an annual raw material processing capacity of 50.25 thousand tones which is used up to 65-70%. The main large companies are "Carmez" JSC and "Basarabia Nord" JSC. Milk processing industry is represented by 11 large and medium enterprises with an annual processing capacity of about 628 thousand tones which is used up to 65%. The main companies in the sector are „InComLAc" JSC, „InLAc" JSC, „JLC" JSC.

Agriculture Soils

According to its natural composition and fertility, the soils of the Republic of Moldova make part of the most valuable soils, characterized by a remarkable diversity, related to the local vertical and horizontal zone differences, covering 75% of the land find area. The big diversity of soils with limited areas represents favorable environmental niches for some crops such as vineyards, fruit trees, vegetables, etc. The average level of fertility of arable land constitutes 68 points. 84.8% out of agricultural lands have a good and very good fertility rate, 9.9% - average and 5.3% - low fertility.

From the economic point of view, soils are the most valuable composition of the natural resources. Taking into account the global trends in the depreciation and losses of agricultural land as well as the development of agriculture, the issue of preserving agricultural lands has to become a strategic concern of national security for our country[68].

The deterioration of the productive capacity of soils as a result of agricultural over-use of the last 50 years manifested through erosions, landslides, lack of humus, lack of mobile phosphor, salinization, areas with a periodical excess of humidity, clogging of deposits of less humid soils, taking away of fertile strata, etc. Erosion covers 33% of agricultural land. The area of eroded soils increases by 0.5-1.0% annually which will lead to the loss of the fertile strata by 20-40% in the next 50 years. Annual losses are equal with 2,000 ha of chernozem with all components. The negative effects of erosion extent on other spheres as well: lakes and other pools, soil pollution from deposits and phreatic waters with pesticides and mineral fertilizers, washed from the slopes, the destruction of the communications networks and hydro technic constructions, etc. The excavations of the soil while exploiting quarry before 1990 were not accompanied by replanting of areas; 5,000 ha of agricultural land with the average fertility rate of 50 points was destroyed. During the last 20-25 years, the soil losses (damaged, destroyed by ravines, landslides and excavations) constitute 78.8 thousand ha or 3% of agricultural land.

The small and very small reserve of humus is a key problem in the development of the ecological agriculture. Soils with a lack of humus constitute 40.6% of the agricultural lands. There is a risk that in the next decades, the composition of humus on arable land will reduce by 10-25%, which will considerably affect the physic qualities and micro biodiversity of soils. The annual losses are estimated at 10% of harvest. Only phosphate fertilizers can cover the exhaustion of the

[68] National Agriculture Sector and Food Processing Industry Sustainable Development Strategy of the Republic of Moldova for 2008-2015: http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=327309.

mobile phosphor reserves in the soil. Soils with phosphor deficit cover 30% of the agricultural land. The lack of fertilizers leads to the increase of the categories of this type of land and losses of crops.33

Soil cleaning on an area of 546 thousand ha (21% of the agricultural land) for the fruit and vineyards plantation led to the disturbance of the natural stratification of the genetic horizons and getting out to the surface of the less humid layers with a high composition of carbons. The fertility of these areas, used for crops, is 10-20% lower as compared to that of non-cleaned similar soils.

The pollution of agricultural lands exists although the use of chemicals per hectare reduced by 4.3 times during 1991-1998.The rate of soil biological pollution increased by 2 times due to the lack of systems to clean and use the livestock and agricultural wastes. The protection, improvement and sustainable use programs of the soil resources can be achieved only through multifunctional environmental development tools of the territory at the national level taking into account all the aspects of the natural and human capital. The cost of a similar work for 2000-2020 is estimated at $ 363 million or over $18 million per year.

Moldova is subject to erosion driven by water and by wind, an on-going process that results in irreversible damage to the agricultural resource base, as well as downstream impacts (fig. 3.3-7). Water erosion occurs as sheet erosion triggered by overland runoff, or as the sequence rill-gully-ravine by which tracts of land is eaten out at increasing width and depth, and wind erosion plays a role in Moldova's southern zone fig.3.3-8). The rate of erosion depends on four factors:(i) erosion of rainfall; (ii) topsoil properties; (iii) slope gradient and length; and (iv) land use, cover, and management. Moldova's risk is naturally elevated by the first three factors: high-intensity torrential rains are common; the silty topsoil is highly erodible (more so in drought conditions), and Moldova's terrain is hilly with long slopes.

About 43% of the agricultural land of Moldova is eroded to some degree, with about 6.4% considered "highly eroded". Annual loss of soils ranges from 5 to 10 tons per hectare for slightly eroded land to over 30 tons per hectare for highly eroded soils[69].

Fig. 3.3-7 Chernozem degraded into eroded soils, reducing its fertility by 80%

Over 65 per cent of Moldova fertile soils have been negatively affected by erosion, landslides and other degradation processes. Chernozem is the most important soil in Moldova, and is found on 2.510m ha, or 78 per cent of arable land. Such an asset is conducive to the development of conservation agriculture.

National food security depends on the quality and fertility of these soils. At the beginning of 1970, the average annual rating of soil quality across Moldova's arable lands was 70 points (on a scale from 1 to 100). According to the data from the 2008 land registry, the current average annual soil rating is 63 points (primary factors that influence the rating are fertility, soil structure, etc.). This decrease is the outcome of a range of soil degradation processes including soil erosion, landslides, decrease in humus, deterioration of the soils structure through compaction, increase.

[60] Rural Productivity in Moldova –Managing Natural Vulnerability, WB, 2007

Fig. 3.3-8 Degrading of agricultural soils as a result of their erosion

These processes break biological cycles, upset the balance of nutrients and humus, and diminish soil fertility. Poor soil structure and low fertility increase the vulnerability of agriculture to climate factors. This occurs because poor soil structure and low humus levels diminish water-retention capacity and lower plant resilience[70].

Irrigation

Irrigation is the most climate-sensitive use of water. The yields and profitability of irrigated land relative to dry land farming tend to increase as conditions become hotter and drier. Consequently, in the areas with available and affordable water supplies, hotter and drier conditions would increase both the land under irrigation and the amount of water applied per irrigated area. Increased water use efficiency attributable to higher atmospheric CO_2 levels would tend to counter the tendency to apply more water as temperatures rise.

Irrigation technologies currently in use:

Supply-side currently in use Technologies, Irrigation Application Technologies:
a) Medium to high pressure Sprinkler Irrigation Systems;
b) Low-flow, low-pressure and water serving Drip Irrigation Systems.

Demand-side currently in use Technologies, Water Requirements and Irrigation Scheduling Technologies:

Water Requirements Technologies at farm and field scale using Evapotranspiration (ET) estimation (mostly used in design);

a) Operational Irrigation Scheduling Technologies at farm and field scale using scientific research recommendations.

The traditional Irrigation Systems in Moldova are designed to use pressurized water application methods, including sprinkler and drip (trickle) systems. The predominant water application method is sprinkler irrigation. Almost all of the sprinklers which are traditionally used in Moldova are of medium or high pressure, and they are associated with relatively high pumping costs (compared to today's international tendency toward low-pressure sprinklers).

Drip irrigation is traditionally used to a much lesser extent, but in recent years this irrigation method has enjoyed increasing popularity for high-value crops such as orchards, vineyards, fruits, and vegetables.

Sprinkler Irrigation. *The DDA-100M sprinkler system is like a linear-move sprinkler machine, pumping water from a canal running straight through the irrigated area. However, the DDA-100M (which is 120 m wide) is pulled through the field by a tractor with a human operator, not automated with an internal power supply as for linear-move machines.*

The Dnepr sprinkler system is like a boom sprinkler, but it is periodic-move instead of continuous move (this means that it applies water while stationary, and only moves when the pump is shut off and the lines have been drained of water). The system is mounted on wheels to facilitate moving from one set to another. Most of the Dnepr sprinklers make 54-m moves between sets (the hydrants on the tertiary lines were spaced at 54 m), whereby a generator and electric motors are used to roll the system to each successive hydrant when changing sets. The duration of each set depends on

[70] UNDP (2010), National Human Development Report 2009/2010, Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf).

the application rate and the required depth of water application (based on water deficit in the crop root zone). After reaching the end of the field, the system is “dead-headed” (moved without operating the sprinklers) back to the starting end of the field, ready to begin the next irrigation. Figure 3.3-9 shows a plan-view schematic of a Dnepr sprinkler system.

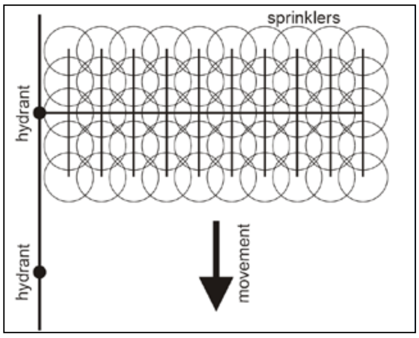

Fig. 3.3-9 Plan-view schematic of a Sprinkler Irrigation System

Some areas of Moldova had many Center Pivot sprinkler irrigation machines. These are known as “Fregat” systems (from the name in Russian language). Most of the Center Pivots are at low-lying, flat areas near the major rivers (Prut and Nistru), such as at Talmaza and Suvorov, although some “Fregat” machines are located in hilly terrain (fig 3.3-10).

Fig.3.3-10 “Fregat” (center pivot) sprinkler system in the Cahul district area

All of the Moldovan “Fregats” has above-lateral impact sprinklers, requiring medium to high operating pressures. This is in contrast with most Center Pivots in other countries at the present time which use drop-down low-pressure spray nozzles to reduce energy costs for pumping. The Center Pivot machines in Moldova almost exclusively use hydraulic (water-driven) tower motors to move the lateral around a circular path. This kind of technology is rarely used elsewhere in the world at present because electric motors require less maintenance and are more versatile. Also, the hydraulic motors take some of the pumped water from the lateral pipe and discharge it onto the ground during operation (which is intermittent to keep the lateral properly aligned, except for the end tower, in some cases). But perhaps most importantly, the hydraulic motors cause a drop in lateral operating pressure when they operate, and they require relatively high pressure in the lateral, so it is impossible to use these motors when a Center Pivot is fitted with low-pressure spray nozzles. Only a few of the “Fregat” systems (Fig.2) are still operable – most of them have fallen into disrepair or were dismantled and scavenged for parts.

The use of such sprinkler systems in the future is considered to be unlikely, as many farmers are currently opting for improved low pressure and water serving Sprinkler Irrigation technologies, such as: Center Pivots, Linear-move Sprinkler Irrigation Machines, and Traveler Sprinklers with Irrigation Boom.

Drip Irrigation. Existing Drip Irrigation systems in Moldova apply modern water application and filtration equipment, including pre-screening, media filters, disc filters, and others. Many of the media filters are set to automatically back-flush (clean themselves) when the pressure differential reaches a predetermined value. This is very typical of filtration equipment in agricultural irrigation in general, not just in Moldova.

Presently, Drip irrigation is becoming more widely used in Moldovan agriculture where high-value crops (e.g. grapes, orchards, fruits and vegetables) are grown. These are modern systems, mostly using imported materials and equipment, with trained operators who know how to run and maintain the systems in good condition. Drip irrigation is being applied to open-fields and greenhouses. Currently, drip irrigation can be found all over the country, and it is expected that drip irrigation will become more predominant with the transition to high-value agriculture and the increased availability of good-quality irrigation water (fig.3-3-11).

Fig. 3.3-11 Drip irrigation of tomatoes in open field Straseni area

The current technological situation in the Agriculture sector was well known by the working group members, yet, it was discussed during both sector and technology prioritizations and evaluation of new technologies have been constantly compared to those, currently in use.

Human Health Sector

The principles underlying the health system in the Republic of Moldova:

- Determining the fundamental values as a major element: human dignity, equity, solidarity and professional ethics.
- Stable financing, management and ensuring accessible and good quality health care to population. Financing the health system must allow for care to be provided to all equally and to ensure each individual's right to payment for services and equitable access to health care.
- Priority of primary health care and integrating primary health care services with the secondary and tertiary ones, with emphasis on disease prevention measures.
- Provision of high quality health care with use of progressive technologies, aiming mainly at health improvement.
- The diversity of organizational forms of health services (budget, health insurance, paid).
- Taking into account the opinion of citizens, encouraging their active participation in the operation of the health system, ensuring opportunities to choose physicians and services they need, and responsibility of each person for his/her own health.
- The operation of the system has a cross-sectoral nature, and it should be supported by policy makers, local authorities, community and professional organizations. Health system should be a public priority.
- Assuring the appropriate level of professional activity of physicians, compliance with professional ethics, provision of adequate health services and ensuring remuneration of labor based on amount and quality of health services provided
- Decentralization of management.

The structure of the health care system

The above principles and the need for health services determined the structure of the health system, as well as the structure of the administrative structure of the Ministry of Health of the Republic of Moldova. The following health care services are provided in the Republic of Moldova:

a) **preventive health care**, that covers health promotion, health protection services, and prevention as such;

b) **curative health care**, which includes primary health care (provided by family doctors' offices and health centers), secondary and tertiary health care (provided by hospitals, including specialized facilities and other health care facilities), as well as health rehabilitation services and nursing care.

Taking into account the increased vulnerability of certain groups of population within the health system, special attention is focused on women, children, disabled, elderly people etc., for which purpose specialized structures of medical assistance are created.

Basic principles of **state policy in public health** are:

- ensuring by the State of public health surveillance by coordinating and monitoring public efforts in the field;
- ensuring equitable access to health services for all citizens;
- individual and public responsibility for public health;
- active partnership with communities and with local public administration authorities and central government;
- focus on primary and secondary prevention and on the needs of communities and groups of population;
- concern for social, environmental and behavioral factors of health;
- multidisciplinary and cross-sector approach with a clear delimitation of responsibilities;
- scientific evidence based decisions and / or recommendations by competent international bodies;
- adhering to the principle of prudence in specific circumstances;
- transparency of decisions, including use of information technologies.

Health system priorities according to the Ministry of Health of the Republic of Moldova.

In its daily activity in 2010 the Ministry of Health has targeted its efforts towards accomplishment of the following priorities[71]:

i. ensuring access of population to high quality and cost-efficient health care services, both in primary and hospital health care;

ii. improving the public health state surveillance system and harmonization of national rules with international standards, and their implementation;

iii. motivation and professional development of health professionals;

iv. improving the rational management of medicines and medical devices, providing first need drugs and medical technologies;

v. increasing the role of private medical sector in financing, organization and service provision through development of public - private partnership, attracting foreign investment to modernize the health system;

vi. enhancing quality assessment of health care provided in each district, and improving health care services.

The Institutional Context

The **Ministry of Health of the Republic of Moldova** is the leading structure in the health service system. It fulfills the following basic functions:

i. develops public policies for the health system long-term, medium and short-term development, develops medium term budget framework and ensure their implementation,

ii. prepares and submits budget proposals for the health system, provides for the Ministry's and subordinated institutions budget execution, summarizes and makes public information on budget execution and performance;

[71] MH Report, 2011

iii. ensures regulation, within the limits and in compliance with lawful competencies, of implementation of the health system development public policies, promoting common values of solidarity, equity and participation of stakeholders in the design, implementation and monitoring of health policies, paying due attention to the needs of the population, especially from vulnerable groups;

iv. plans and implements the health sector reform to ensure the highest level of relevance of the health system to the needs, preferences and adequate expectations of population, especially vulnerable groups, with recognizing and honoring the rights and responsibilities regarding health.;

v. other important functions

The **Emergency Health Care Service** was established based on the Government Decree nr.891 as of 17.07.2003 "On establishment of Emergency Health Care Service of Moldova". Further development of the Service was carried out in conformity with the State Program, approved by Government Decree nr.564 as of 22/05/2006.

The Emergency Health Care Service is structured vertically and subordinated to the Ministry of Health. The health care facilities providing emergency assistance are self-financing, non-profit institutions, covered by the mandatory health insurance system. The leading institution within this service is the National Scientific-Practical Center for Emergency Medicine. Territorially, the Emergency Service is represented by four regional stations (North, Central, South and Gagauzia) which, in turn, have 44 substations and 88 posts of emergency health care thus covering the entire population throughout the Republic of Moldova. In 2010 the average number of calls was 282.7 per 1000 population, of which 61.7 were made by physicians.

The leading institution implementing health management policy, medical statistics and databases of the national health system is the **Health Management Center**. It collects, summarizes and makes the analysis of statistical data in public health, scientific, provides scientific rationale for the health care development strategy, development and implementation of health care system reform projects, formulates draft decision documents, standards, rules and regulations on health care, applies the principles of health management and marketing in practice etc.

Surveillance of Public Health

Based on Law No. 10-XVI as of 03.02.2009 on the state **Surveillance of Public Health**, and Government Decree no. 384 as of 12.05.2010, the was created State Service for Public Health Surveillance was created, subordinated to the Ministry of Health. The main activities of the State Service for Public Health Surveillance are: surveillance and evaluation of public health, establishing priorities, coordinating the implementation of national public health policies through integration into sectoral sustainable development policies and strategies, health protection through various ways, authorization of activities, services and products with impact on human health, prevention of diseases by making primary and secondary prevention interventions, promoting health through information, education and communication, ensuring appropriate level of public health emergency preparedness and public health emergency management, including restriction of movement of people and goods, etc. The Leading institution of the Service is the National Public Health Centre, which ensures substantiation of public health policies and strategies, provides research and development and highly specialized expertise, methodological and practical support in public health sector, etc.. There are 36 regional Public Health Centers subordinated to the Ministry of Health.

The Civil Protection and Emergency Situations Service. The Civil Protection and Emergency Situations Service is a responsible for emergency situation and have the reporting to Ministry of Interior Affairs of Republic of Moldova. It is an executive agency of the Government Commission for Emergency situation constitutes the cross-sectoral agency responsible for overall coordination in emergency situations and come under the authority of the Ministry of the Interior. It functions as an executive agency of the Government Commission for Emergency Situations. The overall mandate of the Civil Protection and Emergency Situations Service has the responsibilities:

- Mitigate the effect of crises
- Plan crisis preparedness for the population
- Risk assessment,
- Crisis planning, monitoring and evaluation
- Early warning,
- Mass causality management and public communication.

National Extraordinary Anti-Epidemic Commission

In Republic of Moldova there is a multi-sectoral mechanism for response to threats of epidemics caused by infectious and non-infectious diseases and bio-terrorism, it is provided by the National Extraordinary Anti-Epidemic Commission and the Territorial Extraordinary Anti-Epidemic Commissions, established under Government Decision No 919 of 30 August2005. The National Extraordinary Anti-Epidemic Commission, chaired by the Deputy Prime Minister, functions on a more operational level than the Government Commission for Emergency Situations and convenes meetings on the initiative of the Ministry of Health. The territorial commissions are chaired by the heads of local public administration.

In 2010 the **contribution of the State budget in financing** the health system was 2440.6 million Lei, which accounted for 61.1% of the funds allocated to health care sector. Financial resources effectively used by public health care facilities in 2010 accounted for 3647.3 million lei, by 341.5 million lei (10.3%) more than in the previous year. The NHIC increased the amount allocated by 87.3%.

In 2010 mandatory health insurance funds, for each type of care, were distributed as follows: hospital care - 50.7%, primary health care - 30.7%, pre-hospital emergency health care - 9.1 %, outpatient specialized care - 7.1%, high-performance medical services - 2,3%, medical care at home - 0.1%.

Health care system facilities

In terms of **ownership**, health care in the Republic of Moldova is a mixed system of state and private sectors. By 2011 the network of health care facilities was represented by 267 health care facilities, of which 166 were state owned and under subordination of the Ministry of Health, 101 state health care facilities were subordinated to other ministries. Of the total number of health care facilities under the Ministry of Health 34 are district hospitals, 10 are municipal hospitals, 18 are republican hospitals, 16 are polyclinics or independent health care centers, and 88 are primary health care facilities (see Annex Network of health care facilities). Health care facilities subordinated to the Ministry of Health are present in all the administrative-territorial units, are available to all population of the country. In addition, the private sector in early 2011 was represented by 11 private hospitals and 516 ambulatory individual enterprises.

Total number of beds available in the public hospitals subordinated to the MH is 19 838 beds, of which: 8005 are in the republican institutions (40.35%), 3550 – in municipal hospitals (17.90%), and 8283 - in district hospitals (41.75%). Chisinau municipality covers 52.1% of total number of beds, having 10,335 beds municipal hospitals and the 15 republican hospitals located in Chisinau. The level of coverage with hospital beds is 55.7 beds per 10,000 population.

In year 2010 the total number of hospitalizations was 606 434: 183,586 admissions in hospitals of republican level, 125,239 hospitalizations in municipal hospitals and 297,609 hospitalizations in the district hospitals. For the district hospitals the hospitalization level is 11.3 hospitalizations per 100 population, while for municipal hospitals - 13.4 hospitalizations per 100 population. In 2010 the republican health care facilities reported 2,385,960 bed days, the municipal hospitals reported 1,098,082 bed day, and the district hospitals - 2,295,990 bed days, with a total of 125 333 hospitalized patients.

According to official data, the share of positions held financed from the budget was 93.6% for physicians and 96.7% for paramedical staff[72]. The share of positions occupied by physicians in the hospital sector was 39%, primary health care sector - 23.7%, other health care institutions - 15.8%, which indicates a significant deficit of physicians. Coverage with curative and preventive medical staff (except for dentists) in health care facilities subordinated to the Ministry of Health is, on average, 22.4 to 10,000 population, which is regards as satisfactory for health services. The average number of visits per capita in one year is 6.5 (for the insured - 7.0), in particular, to the family doctor -2.9 visits (the insured -4.2).

A Ministerial Order specifies which hospitals are responsible for providing specific services and provides information on their current capacity, including the specialist teams that are available for mobilization. All hospitals are required to have an internal emergency plan (including evacuation procedures) as part of the community crisis plan. In large facilities, it is required that a civil protection plan is available on every floor.A plan exists for creating additional beds if needed, with the option of transferring patients to hospitals not affected by the crisis.

Most health facilities were built more than 30 years ago and therefore meet the building standards of the former Soviet Union for earthquakes of force 7–8 on the Richter scale. The local authorities are responsible for the maintenance of buildings but, although there is a national building standards mechanism, the regulations from the time of the former

[72] Statistical Yearbook of the Health System in Moldova, 2010

Soviet Union have not been updated. There is no national programme for ensuring the resilience of health facilities during a crisis.

Public health laboratory services

The National Preventive Medicine Centre is the institution in the health sector responsible for biological, chemical and radio-nuclear safety. It houses the public health reference laboratories currently attached to the various departments, including those for virology (hepatitis, polio and enteroviruses), bacteriology (zoonosis, enteric and cholera), sanitary bacteriology, sanitary hygiene, serology, parasitology, HIV/AIDS radiology and toxicology. It is planned to amalgamate all the bacteriology laboratories into one and to centralize those for serology and Polymerase Chain Reaction (PCR). The measles and polio laboratories are WHO accredited. There is a national laboratory accreditation body but it is not recognized by the European co-operation for Accreditation or the International Laboratory Accreditation Cooperation (ILAC). Preparedness and Response in reviewing laboratory legislation and developing standard operating procedures. A plan of action has been drafted to establish a national framework for laboratory support with a view to meeting international (ISO) standards.

In general, laboratories are poorly equipped with old, out-of-date equipment that lack modern safety features. The Laboratory for Particularly Dangerous Diseases and Combat of Bio-terrorism carries out testing for anthrax, plague, cholera, leptospirosis and tularaemia. Security procedures appear adequate with locked doors, hazard warnings, sealed storage units for strain collections, and a partially-installed automatic entry system. However, Level II safety cabinets for the protection of staff and Category 3 facilities are not available in the country. The methodologies employed are mainly classical and, therefore, confirmation of a diagnosis may take days rather than hours. Virology diagnostic services are only available in Chisinau and, although these include PCR, the unit is specifically for avian influenza and the equipment is used only occasionally because of the small number of samples. In addition, there is no laboratory capacity for the diagnosis of vector-borne diseases, such as West Nile Fever, so that the possibility of rapidly identifying unusual (unknown) pathogens is relatively low.[73]

A few boxes that meet international standards are available for the emergency transport of samples abroad for confirmation of diagnosis. The Republic of Moldova has some collaboration on testing (mainly for viruses) with neighboring countries, including Lithuania, Poland, the Russian Federation and Romania. However, apart from those for measles and polio, there are currently no lists of designated reference laboratories or WHO collaborating centres for specific diseases in the region with which relationships could be established. The Republic of Moldova is a member of the WHO salmonella network for surveillance and quality control (GlobalSalm-Surv GSS), but not of any other international or European disease-specific network, as required by European Commission Decision 2003/542/EU22. Laboratory data are not generally used independently from epidemiological data for surveillance purposes, other than for a few specific diseases, such as polio (acute flaccid paralysis) and avian influenza.

Public health laboratory services specifically for crisis situations are governed by Governmental Decision No. 961 of 21 August 06, which establishes a national laboratory network for the surveillance and control of the environment for contamination with radioactive, poisonous and highly toxic substances and biological agents. The document clearly defines the competencies required from and the roles and responsibilities of the various laboratories in the network in a crisis situation. Of the 162 laboratories listed, 38belong to the Ministry of Health, 74 to the Ministry of Agriculture and Food Industry, 29 to the Ministry of Environment, 13 to State Hydrometeorological Service, 4 to large enterprises and 1 to the Civil Protection and Emergency Situation Service. Of the 73laboratories belonging to the Ministry of Agriculture and Food Industry, 3 are for veterinary diagnosis and the remainder for food testing. PCR is available in the National Preventive Medicine Centre and the Ministry of Agriculture and Food Industry. The Civil Protection and Emergency Situation Services are responsible for coordinating the network and they run an annual quality control scheme.

Pharmaceuticals and medical equipment

The State Agency for Material Reserves, Public Acquisitions and Humanitarian Aid is the national body responsible for purchasing and stocking materials for crises situations including medical equipment and pharmaceuticals. They have four storage depots across the country, including refrigeration facilities. The composition of the list is confidential, but it includes hundreds of items, including 110 drugs. The list is constantly updated and the Ministry of Health advises on the drugs and medical items that are to be included. Expiry dates are closely monitored and the stocks are kept constantly up-to-date with the help of a computerized stock management system. However, they doubt that this stock management system could be used for managing incoming humanitarian assistance. The

[73] Assessment of health security and crises management capacity. WHO Report. 2008

The Agency has in fact three important, cross-cutting functions related to crisis management. These are:

1. maintenance of stocks of essential items for crisis response, including pharmaceuticals, medical equipment, fuel, generators, construction material and wheat;
2. procurement of central supplies (funded by the Government);
3. coordination of humanitarian aid.

While the State Agency is in charge of coordinating material humanitarian aid, the Interdepartmental Commission on Humanitarian Aid, currently chaired by the Deputy Minister of Economy, is in charge of the overall coordination of humanitarian aid. The Ministry of Health also has a commission that deals with health-related humanitarian assistance. All drugs must be registered with the National Drug Agency, which is subordinate to the Ministry of Health and responsible for the registration and quality control of pharmaceuticals. The National Emergency Medicine Centre also maintains drug reserves for all events (purchased from their regular budget) and issues guidelines to the subnational centres on what stocks they should keep for the treatment of 100 people in any particular situation. District hospitals also maintain limited stocks of drugs, the release of which requires the signature of the Chief Doctor. The Ministry of Health does not have its own reserve of drugs and equipment.

Features of medical-demographic processes in the Republic of Moldova

Birth is a phenomenon of biological, as well as social importance because it is influenced by interrelated factors, of which the most important are economic, political, demographic factors. Currently the Republic of Moldova is in transition featuring low standard of living. A large number of people migrate in search of jobs. Family, as a primary core element of society becomes less strong. According to official data of the past decades, the number of divorces increased essentially. In terms of the legal status, the percentage of children born out of wedlock is still high (22.9% in 2009). In rural areas the rate of births out of wedlock is increasingly higher (25% in 2009 versus 22.0% in 2000). In urban areas this co-relation is reversed (19.1% in 2009 versus 22.0% in 2000)[74].

An essential feature of the new century beginning is decreasing number of births. According to official statistics, over three decades (1970-2000) the birth rate reduced essentially from 19.4% to 10.2%. Until recent years it remained at 10.0% to 10.6 %. Currently it shows upward trend, surpassing the 2009 figure of 11.4 [75]. Being related to places of residence, figures are higher in rural areas and more modest in urban areas.

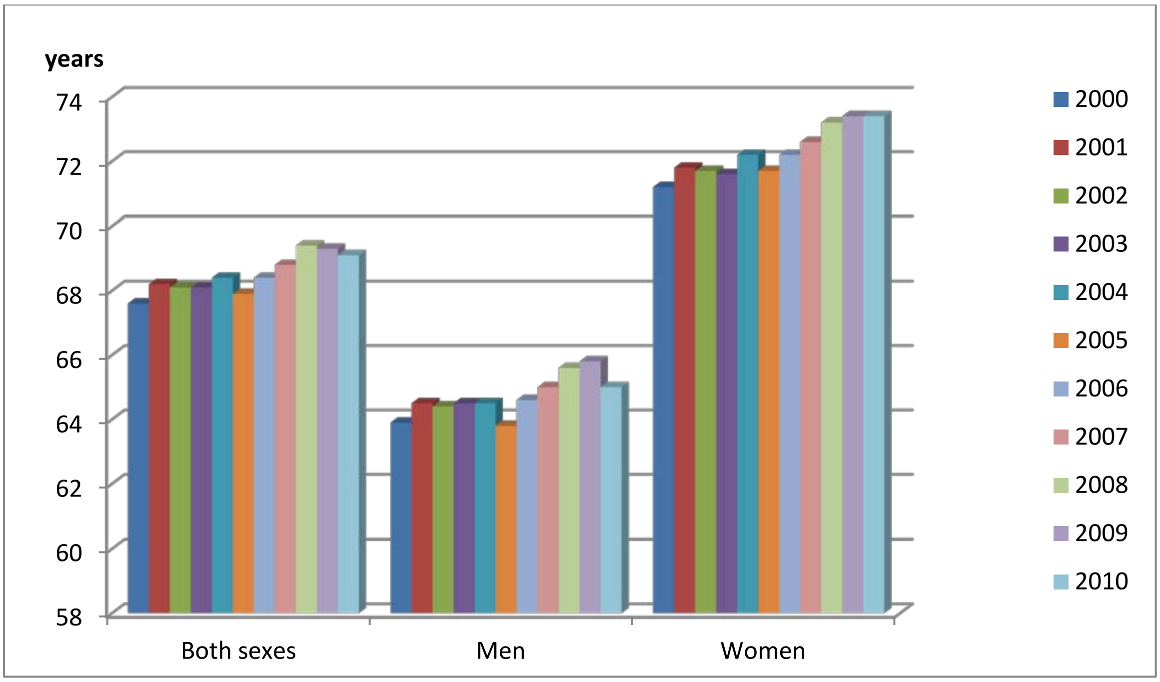

Fig. 3.3-12 Life expectancy at birth in the Republic of Moldova during 2000 – 2010 years.

[74] Statistical Yearbook, NBS, 2010
[75] Yearbooks, NBS

Life expectancy at birth in the Republic of Moldova is low, although in recent years it show a weak growing trend. In 2009 this indicator reached 69.3 years for the entire population, 65.3 years for men and 73.4 years for women (in 2005 life expectancy at birth was respectively 67.9, 63.8 and 71.7 years)[76].Being related to places of residence, each of these three indices are three years lower in rural areas compared to urban areas (fig.3.3-12).

All-cause mortality, which reflects all deaths that occur in population in one year, is determined by a whole range of factors, however, the primary one is worsening of the health status. Over the last decade this figure has not changed significantly, the average being 11 to 12 deaths per thousand population. In 2009 it was 12.3 ‰[77]. Being related to places of residence, the all-cause mortality is higher in rural areas (13.8 ‰ in 2009 compared to 9.0 ‰ in urban areas) and in relation to sex it is higher in males (1355.2 ‰) compared to that in women (1104.2 ‰)[78]. There is also a geographical difference. All-cause mortality in northern districts is higher than in Central and Southern districts.

In comparison with European Union and Europe integrally average, mortality in the Republic of Moldova is high, however it is somewhat lower than the NIS average (fig.3.3-13).

The analysis of ***specific mortality*** by specific causes of death reveals the fact that the most frequent causes of death are cardiovascular diseases, which over the years accounts for more than half of all deaths (2010 - 56.2% of the total deaths). In women it was by 1.1 times higher than in men (719.4 women in 100,000 population compared to 654.4 men). The second most frequent reason are deaths from tumors (in 2010 - 13.1%), which was by 1.4 times greater in men. The third reason is the diseases of the digestive system, the share of which in overall mortality was 9.8% (by 1.3 times greater in men). The fourth reason are injuries, which account for 8.3% deaths (in males – by 3.7 times more frequently than in women). The fifth reason is respiratory diseases, which account for 5.6% of all deaths. In this group of morbid conditions men also account for major share - men die of respiratory diseases by 2.1 times more often than women[79].

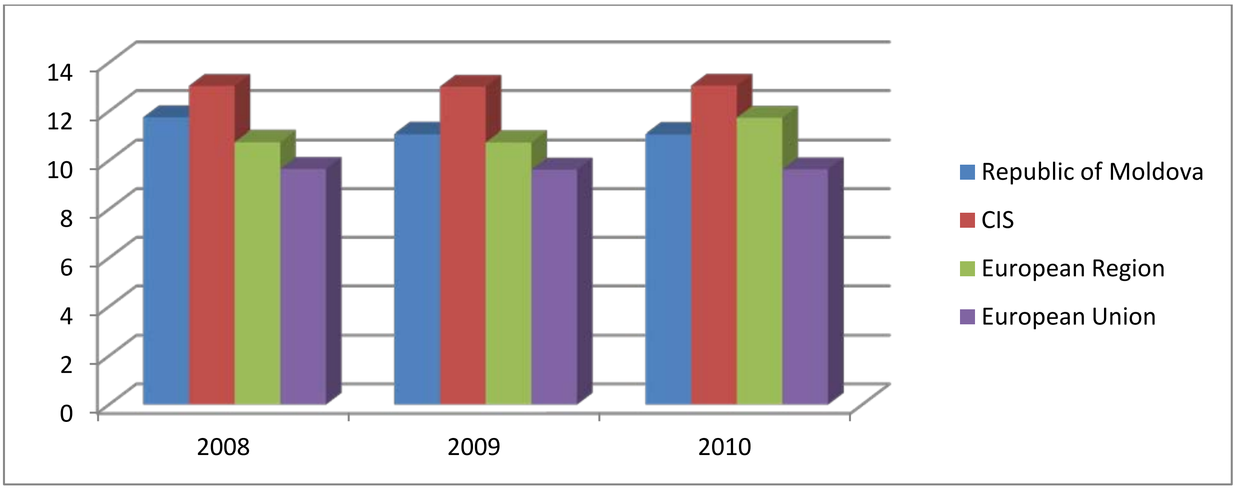

Fig.3.3-13 Mortality rate in the Republic of Moldova and in the countries of the region during 2008-2010 years (for 100 population).

It is important that specific mortality analysis takes into account the complexity of factors that determine differential exposure of population to risk of death. These factors depend on the person exposed to the risk of death (age, sex, nature of occupation, nutrition, etc.), quality of environmental factors and living conditions, as well as circumstances of death.

An essential feature of mortality in the Republic of Moldova is increased indicators of *mortality in population of active working age* (men - between 16 and 61 years, women - between 16 and 56 years). For both sexes the share mortality in active working age in the past five years varied from 44.2% to 45.5% from all-cause mortality. In men this figure is significantly higher than in women: in this time span it ranged between 58.8% and 62.8% for men and between 22.7 and 25.6% for women. It also shows an increasing trend of this indicator for men and a decreasing one for women.

[76] Report of the MH, 2010
[77] Statistical Yearbook, NCHM, 2011
[78] Statistical Yearbook, NBS, 2010
[79] Statistical Yearbook, NCHM, 2011

The analysis of the structure of causes of mortality in active working age in the past five years shows that cardiovascular diseases are ranked first (on average 24.7%, 25% in men and 23.9% in women). Injuries and intoxications rank second (on average 21.7%, 24.5% in men and 13.9% in women). The next come tumors (on average 18.3%, 15.8% in men and 25.1% in women), digestive diseases (on average 16.5%, 14.8% in men and 21.5% in women), respiratory diseases (on average 6.7%, 7.5% in men and 4.3% in women). Then come infectious and parasitic diseases, nervous system diseases, other diseases, the significance of which is more modest.

From the above it appears that the causes generated by external factors, including extreme phenomena due to climate change, have an important place among the causes of deaths in active working age, such as cardiovascular diseases, trauma, respiratory diseases, infections, etc. According to statistical data in 2010 trauma and intoxications class cover such causes as exposure to extreme cold of natural origin (9.3% of total) accidental drowning (7.7%), obstruction of airways with foreign bodies (7.3%), intoxications with carbon monoxide (7.3%) etc[80].

Morbidity of population. Illness in a community of population is the result of accrued action of a number of objective and subjective factors, with a macro-and micro social scope. In addition to inherited genetic factors, economic development, environmental factors, the level of knowledge, accessibility, level and quality of health care, an increasingly important role is frequently played by the consequences of globalization, including the extreme events due to climate change.

Morbidity can be assessed based on incidence and prevalence. *General incidence* in Moldova in the past five years is maintained at 3500-3600 to 10 thousand population. In 2010 the general incidence was 3468.5 to 10,000 population. The morbidity incidence in children is slightly more than two times higher than the general incidence in adults. In 2010 the general incidence in adults was 2755.8, while in children it was 6116.8 to 10,000 population of relevant age[81] (fig.3.3-14).

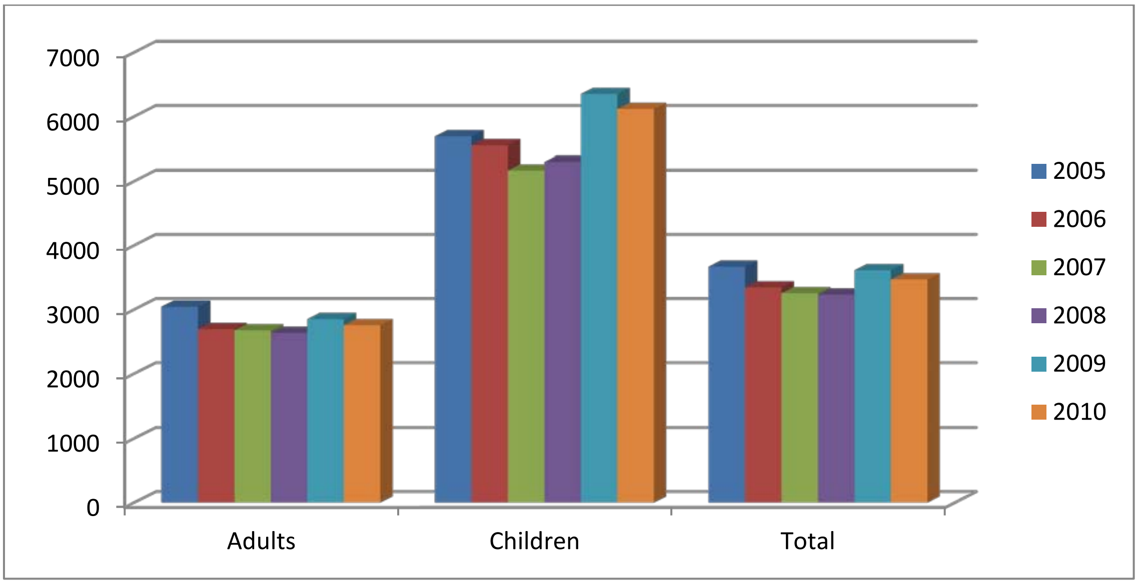

Fig.3.3-14 General incidence of morbidity by large age groups in the Republic of Moldova in the time series from 2005 to 2010 (for 10 thousand population) years.

The analysis of *specific incidence* shows that the incidence of respiratory diseases (1084.3 to 10,000 population) is the most frequent. It is followed by traumatic injuries, intoxications and other consequences of external causes (520.6 to 10,000 population), followed, significantly lagging behind, by infectious and parasitic diseases (281.4 to 10,000 population), digestive diseases (236.9 to 10 000 population), skin and subcutaneous tissues diseases (211.2 to 10,000 population), genital and urinary systems diseases (203.3 to 10,000 population). Cardiovascular diseases (154.1 to 10,000 population) rank seventh, osteoarticular system diseases, muscle and connective tissue diseases rank eighth (150.9 to 10,000 population), blood diseases, hematopoietic glands and some immune mechanism disorders (72.5 per 10 thousand population) rank ninth, etc.

[80] Statistical Yearbook, NCHM, 2011
[81] Statistical Yearbook, NCHM, 2011

General prevalence in 2010 was 7405.5 to 10,000 population (7274.5 for adults and 7891.9 for children in 10 thousand population of relevant age). Compared with previous years this indicator shows a moderate increase. Regarding *specific prevalence*, respiratory diseases rank first (1308.5 to 10,000 population). Circulatory diseases (1249.2 to 10,000 population)rank second, followed by digestive system diseases (931.1 to 10,000 population), traumatic injuries, intoxications and other external causes consequences (524.4 to 10,000 population), genital and urinary system diseases (498.0 to 10,000 inhabitants), mental and behavioral disorders (480.4 to 10,000 population). Infectious and parasitic diseases are ranked seventh (381.2 to 10,000 population), endocrine diseases, nutrition and metabolism (356.1 to 10,000 population) rank eighth, osteoarticular system diseases, muscle and connective tissue (338, 8 per 10 thousand population) rank ninth, tumors (262.5 to 10,000 population) rank tenth, etc.

The facts stated above can lead to the conclusion that morbid conditions, including those which may be conditioned by extreme events generated by climate change, are leading in the population morbidity structure.

Regarding smoking, this harmful habit is incidental in women (4.3% at 15-19 years of age, 9.8% at 20-34 years of age, 5.8% at 35-49 years of age), but more often in men (30.0% at 15-19 years of age, 59.1% at 20-34 years of age, 53.2% at 35-49 years of age). The survey conducted in 2008 also proves that in the near future we can expect an increase in the number of young women smokers. Multiple studies demonstrate the negative impact of smoking not only on the respiratory and cardiovascular systems, but on the reproductive function as well[82].

The health effects of drought could, for example, cause a decrease in food production and result in nutritional problems in the population, making them more vulnerable to disease. In a UNICEF survey conducted in the Republic of Moldova[83], local leaders anticipated that the most severe impact of the 2007 drought would be its effect on the health of the population. In fact, eight out of ten respondents (and 91% of the medical personnel interviewed) considered that it had already done so. However, the long-term effects of drought may be even more devastating. The increasing competition for arable land may eventually result in mass population movement and conflict as resources dwindle.

Climate change can have various (positive and negative) effects on the incidence of infectious diseases, such as malaria, tick-borne diseases and gastrointestinal disease.

So, at present there are increasingly many health problems, which in conditions of extreme events generated by climate change, serve as a negative background. Using the international[84];[85];[86] and national[87];[88];[89] sources of reference, one can conclude that being related to future climate change, the health problems in the Republic of Moldova may become more pronounced. Such dynamics is determined by the low quality of life of the population, persistence of multiple risks in the occupational, habitual and behavioral environment. This implies the need to strengthen the adaptation measures to extreme events generated by climate change and to enhance the health sector potential to reduce the serious consequences of these phenomena.

[82] National Report, 2008.
[83] Drought after-effects upon population of the Republic of Moldova. Chisinau, UNICEF Moldova, 2007
[84] Climate Change and Human Health, 2003
[85] Confalonieri U. et al. Human health. 2007. In: Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC. Cambridge, Cambridge University Press.
[86] Subbarao I. et al. 2008; 2(3): Applying yesterday's lessons to today's crisis: improving the utilization of recovery services following catastrophic flooding. Disaster medicine and Public Health Preparedness.-132-133.
[87] Opopol N., R. Corobov, 2010. Excess mortality in Kishinev during hot summer of 2007.
[88] National Health Policy, 2007
[89] Health System Development Strategy, 2008-2017.

Chapter 4. Technology prioritization for Agriculture Sector.

4.1 An overview of possible adaptation technology options in agriculture sector and their adaptation benefits.

A wide range of environmental technologies are required to bring about efficient processes in the Agriculture sector to increase Moldova's adapting capacity to climate change. The experts from Agriculture sector have proposed 33 adaptation technological options in the areas of Crop production, Agriculture Soils Management, Livestock Production, Biotechnology, Crop Insurance, Irrigation system.

In the table 4.1-1 is presented the Long List of proposed adaptation technologies in the Agriculture sector, categorized by their scale and term of availability.

In the current chapter proposed adaptation technologies will have the following main components: adaptation needs, technology option background, and mode of implementing the technology and adaption benefits. We consider appropriate to present them in this chapter as they are key component of TNA assess. Detailed information about technologies is presented in the annexed Technological Fact Sheet of each technology from the Final Long List of adaptation technologies.

Table 4.1-1 The Long List of technologies for adaptation identified and categorized for prioritized sector Agriculture.

		Adaptation Technologies	Scale of application	Short, medium, long term availability
AGRICULTURE		**Small scale/Short term**		
	1	Conventional tillage winter wheat	Small scale	Short term
	2	Conventional tillage sunflower	Small scale	Short term
	3	Conventional tillage sugar beet	Small scale	Short term
	4	Plants breeding based on anthers culture and *in vitro* pollen grain technology	Small scale	Short term
	5	High value genotype propagation using *in vitro* tissue culture	Small scale	Short term
	6	In depth fissuring 30-35 cm	Small scale	Short term
	7	Cultivation of agricultural crops in alternative strips (Alternative strips cultivation crops)	Small scale	Short term
		Small scale /Medium-Long term		
	1	Semi-intensive system of animal production	Small scale	Long term
	2	Intensive system of animal production	Small scale	Long term
	3	Introduction of 50 t/ha of manure with bedding to agricultural soils once in five years (agriculture fertilization with rother/manure)	Small scale	Long term
	4	Vetch field as green fertilizer into 5 year crop rotation	Small scale	Long term
		Large scale/ Short term		
	1	Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus	Large scale	Short term
	2	Conservation tillage with herbicides winter wheat	Large scale	Short term
	3	Conservation tillage with herbicides sunflower	Large scale	Short term
	4	Conservation tillage with herbicides sugar beet	Large scale	Short term
	5	Extensive system of animal production	Large scale	Short term
	6	Planning for Climate Change and Variability (Agricultural Insurance)	Large scale	Short term
	7	HEC-ResSim modeling technology	Large scale	Short term
	8	Earth Observation (EO) Technologies	Large scale	Short term
	9	Water Requirements Modeling Technologies at global and national levels: GEPIC (GIS-based Environmental Policy Integrated Climate Model	Large scale	Short term
	10	Vetch field as green fertilizer as successive into existing crop rotation	Large scale	Short term
	11	Conventional land cultivation system with moldboard plow in 5 fields crop rotation with a field of vetch used as green fertilizer (five	Large scale	Short term

AG	Adaptation Technologies		Scale of application	Short, medium, long term availability
		fields classic crop rotation)		
	Large scale/ Medium-Long term			
	1	Improved low pressure and water serving Sprinkler Irrigation technologies	Large scale	Medium term
	2	Construction of new and proper maintenance of existing dams and water reservoirs	Large scale	Long term
	3	Low-flow, low-pressure and water serving Drip Irrigation technologies	Large scale	Medium term
	4	Conservation tillage without herbicides wheat	Large scale	Long term
	5	Conservation tillage without herbicides sunflower	Large scale	Long term
	6	Conservation tillage without herbicides sugar beet	Large scale	Long term
	7	DHI Water & Environment Modeling Technologies (MIKE BASIN, MIKE SHE, MIKE 11, MIKE 21, MIKE FLOOD)	Large scale	Medium term
	8	GIS, HEC-RAS and HEC-GeoRAS technologies	Large scale	Medium term
	9	Technologies for breeding hybrids with high adaptation potential to meteo-indicators	Large scale	Medium term
	10	Mini-till system and vetch as successive plant	Large scale	Long term
	11	No-tlll system and vetch as successive plant	Large scale	Long term

Crop production technologies

Technology name:

a) Conventional system of soil tillage for winter wheat
b) Conservation system with herbicides of soil tillage for winter wheat
c) Conservation system without herbicides of soil tillage for winter wheat
d) Conventional tillage for sunflower
e) Conservation tillage with herbicides for sunflower
f) Conservation tillage without herbicides for sunflower
g) Conventional system of soil tillage for sugar beet
h) Conservation tillage with herbicides for sugar beet
i) Conservation tillage without herbicides for sugar beet

Adaptation needs: Higher adaptability to more frequent droughts. Higher adaptation to limited natural resources (water, non-renewable sources of energy, soil). Higher adaptation to prices vulnerability for agricultural products and resources (nonrenewable sources of energy) in globalized economy.

How this technology contributes to adaptation.

Moldboard plow for winter wheat has some advantages and disadvantages. Among advantages we can mention:

- possibility to control better weeds, especially perennial weeds
- better control of pests and diseases
- a deeper layer for root penetration etc.

Among disadvantages:

- higher vulnerability to wind and water erosion
- higher consume of fuel
- negative influence on earth warms etc.

Sowing of winter wheat after early harvested predecessors allows to accumulate more soil moisture, thus reducing the vulnerability to droughts.

Minimum tillage in crop rotation contributes to the reduction of soil erosion and uncompensated mineralization losses. By reduction of soil erosion and mineralization losses of soil organic matter we decrease global warming through increased carbon sequestration. By reducing the consumption of fuel as a result of replacing moldboard plow with minimum tillage it is possible to adapt to the limited sources of nonrenewable sources of energy, to the fluctuation of prices for nonrenewable sources of energy at the international level. By keeping mulch on the soil surface it is possible to reduce evaporation of soil moisture and to increase the stocks of soil moisture in the soil. So, the negative influence of drought can be reduced.

Background: The existing technology of growing field crops in Moldova includes moldboard plow as one of the most important technological operation. Immediately after this operation we need to wok soil with disks and after this with cultivator. In the spring we are working soil with fifth harrows and after cultivation it is possible to drill crops.

By using the conservation system of soil tillage we can avoid using moldboard plow by replacing it with chisel plow in aggregate with disks. So, three technological operations are replaced by one. For winter cereal crops we can use combinatory for direct sowing of crops. Minimum tillage system (conservation tillage) is studied in long-term field experiments at the Research Institute of Field Crops „Selectia" (Balty, Republic of Moldova).

Research results are available for farmers through publications of books, recommendations, articles, TV, radio. Farmers are visiting the experimental plots of the institute with different systems of soil tillage. Each year we are organizing seminars for farmers – at least two times (in the spring, before sowing spring crops and in the fall before sowing winter cereal crops). During these seminars farmers can see the equipment in operation for minimum tillage in crops rotation.

Implementation assumptions.

Conventional system of soil tillage, which supposes moldboard plowing, is used on large scale in the Republic of Moldova, including for winter wheat, sugar beet and sunflower. Moldboard plow has a lot of negative consequences on soils and the environment, not only for the above mentioned crops, but for all other crops in crop rotation. The imperfect structure of sowing area doesn't allow respecting crop rotations and simultaneously doesn't allow respecting a good (optimal) system of soil tillage, which suppose reduction of moldboard plowing.

Unfortunately soil tillage very often is discussed in the lack of connections with the other components of farming system (crop rotations, soil fertilization, crop protection etc.).The lack of a whole farming system is compensated by the excess of soil tillage, mainly by moldboard plowing.

We are proposing a system of minimum (conservative) soil tillage for the above mentioned three crops-winter wheat, sugar beet and sunflower. Such system is based on using chisel plow instead of moldboard plow. Chisel plow in combination with a good crop rotation and an optimal system of soil fertilization allow restoring soil fertility. We are studding different variants of minimum soil tillage in combination with different crop rotations and fertilization systems in a long-term field experiment at the Research Institute of Field Crops "Selectia"(Balti, Republic of Moldova).

The experimental results are proving a real possibility to minimize soil tillage in crop rotation. During the last period of time we are using also cover crops in crop rotations as a tool for reducing soil erosion and for the improvement of soil quality. Farmers have real possibilities to see such experiments.

The obtained results are demonstrated at different seminars organized in different regions and districts of Moldova. They are published also in scientific magazines and advertised through mass media (newspapers, radio, TV). The economic, energetic and ecologic advantages of such systems of soil tillage relatively to moldboard plow are evident.

They allow also to increase carbon sequestration, which is reducing the negative influence of global warming.

a) Conventional technology

	Fuel, l/ha	Salary, lei/ha
1. Moldboard plow (MTZ-80 + PLN 3-35)	25.0	41.3
2. Disks, MTZ-80 + BDT-3	6.0	10.9
3. Cultivation, MTZ-80 + KPG-4	6.0	10.9
TOTAL	37.0	63.1

b) Alternative variant for spring sowed crops

	Fuel, l/ha	Salary, lei/ha
1. Chisel plow + disks (T-150 + PC-2,5)	20	26.9
TOTAL	20	26.9

c) Alternative variant for winter cereal crops

	Fuel, l/ha	Salary, lei/ha
1. Combinator T-150 + Sunflower, CN3-3	10	13.0
TOTAL	10	13.0

The economy of fuel by using chisel plow instead of moldboard plow is 17 l/ha, and the economy for salary – 36.2 lei/ha. For the total area of spring sown crops the economy of fuel consists 17400 ton, and for salary 43.4 M mdl.

The economy of fuel by using combinatory for winter cereal crops instead of moldboard plow consists 15 l/ha, and the economy for salary – 50.1 mdl/ha. For the total area of winter cereal crops the economy of fuel consists 6750 ton, and the economy of salary – 22.5 M mdl. All together the economy of fuel for the whole area under field crops consists 24150 ton and for salary – 65.9 M mdl.

Benefits:

Economic

- Increasing the sustainability of agricultural sector, including profitability
- Reducing the dependence from nonrenewable sources of energy and their derivatives (mineral fertilizers and pesticides) which Republic of Moldova has to import at the moment and in the future
- Creating conditions for the development of small and medium enterprises

Environmental

- Achieving a more sustainable use of natural resources through preventing soil degradation, soil and water pollution, preservation of biodiversity etc.

By implementing a conservative system of soil tillage it would be possible to increase the environment benefits through:

- higher carbon sequestration which allows to reduce global warming
- reduction of soil erosion and better storage of the soil moisture
- reduction the pollution of ground water with nitrates
- reduction of GHG emission as a result of lower amount of burned fuel

Social

- Maintaining the fertility of soil as the basis for maintaining and increasing productivity for achieving economic stability for the wellbeing of people
- Improving health of people as a result of increased soil functionality and decreased inputs (mineral fertilizers, pesticides), which are leading to better quality of water and food
- More people remaining in rural communities

Costs calculations are provided in the annexed TFSs.

Irrigation technologies

Technology name: Operational Irrigation Scheduling Technologies at farm and field scale using real time electronic instruments monitoring: Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus.

Adaptation needs: Reducing of water consumption for irrigation at farm and field scale using real time soil moisture monitoring.

How this technology contributes to adaptation: Irrigated agriculture generally uses large volumes of water compared to cities and industries, and competition for good water quality is really high in many regions. It is recognized that improved water management practices in agriculture can lead to important benefits in terms of water availability for expanded agricultural activity and for other uses, and can reduce many environmental problems.

However, it is difficult to successfully implement efficient practices without field measurements and analytical tools that allow water managers to have a good estimation of crop water use, situation which is constraining water management. Regular feedback of information from the field into water management decision making can substantially improve the performance of water delivery services. However, obtaining repeated objective evaluations about actual field conditions is difficult so that operational tools are needed to facilitate water managers to take right decisions about crop water use and water deliveries.

Within the new technologies currently used for irrigation scheduling and crop water use is Operational Irrigation Scheduling Technologies at farm and field scale using real time electronic instruments monitoring, in particular, Real time wireless soil moisture monitoring system.

Background: Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus.

This soil moisture monitoring system is based on the application of electronic technologies TDR (Time Domain Reflectometry) and consists of the following components:

- Wireless Station for measuring of the soil moisture with receiver-transmitter of the 1-st level DL1-10RT model, with its components (see TFS)
- Controller of the 2-nd level with wireless receiver-transmitter universal DL2-24RTR model with its components (see TFS).
- Controller of the 3-th level with wireless receiver-transmitter universal DL3-4SAT model with its components (see TFS):
- Wireless device URL- 4RT for solenoid valves operation.
- IrrigationLink software for personal computer that allows real-time display of information obtained in graphic or tabular forms, as well as setting up the electronic devices and management operations of the irrigation system, both manually and automatically.
- The developer and manufacturer of Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus, including software IrrigationLink is "Iristar-Com" Company (Moldova).

The Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus awarded a gold medal and diploma of the Ministry of Agriculture and Food Industry of Moldova at the XXI International Exhibition ' MOLAGROTECH -2011 ' in Chisinau.

Implementation assumptions:

- To introduce this technology in building codes as a mandatory step in the irrigation systems design. In the existing Construction Legislation and Standards for irrigation system design it is proposed to introduce a statement, which would make mandatory the application of Electronic System Monitoring of soil humidity for all newly built and reconstructed irrigation systems.
- Each irrigating system again entered into operation should be equipped by monitoring system IRISTAR Pro2 Plus

Support of local scientists on the implementation of "Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus.", developed in Moldova

Benefits:

Economic:

- High value agricultural development
- Impacts on water supply
- Decreasing of irrigation water consumption
- Increasing of crop yields

Environmental:

- Decreasing of impact to the irrigated soils
- Prevention of "over-water"
- Prevention of rising groundwater level
- Prevention of secondary soil salinization

Social

- Increasing of the population incomes from guaranteed high yields
- Educational and scientific development
- Increased community welfare

Technology's costs are presented in the annexed TFS

Technology name: Improved low pressure and water serving Sprinkler Irrigation technologies.

Adaptation needs:

- Guaranteed yields of agricultural crops in an increasingly dry climate
- Reducing of water and energy consumption for irrigation needs in agriculture

How this technology contributes to adaptation:

- Irrigation is an essential tool for getting guaranteed yields in conditions increasingly dry climate of Moldova when lack of natural moisture of the soil will only grow in the future.

- Irrigation is the most climate-sensitive use of water. The yields and profitability of irrigated land relative to dryland farming tend to increase as conditions become hotter and drier. Consequently, in areas with available and affordable water supplies, hotter and drier conditions would increase both the land under irrigation and the amount of water applied per irrigated area. Increased water use efficiency attributable to higher atmospheric CO2 levels would tend to counter the tendency to apply more water as temperatures rise (Kenneth Frederick, 1997).
- In these conditions, to reduce consumption of energy and water for irrigation is a major challenge to adapt to climate change.

Background: At sprinkling irrigation, water on the field is usually served on pressurized pipelines, and then sprayed it in the form of artificial rain over the irrigated area by sprinkling machines and installations.

The principles of creating energy and resource-saving irrigation systems

Depending on the method of irrigation, irrigation system must meet the following principles:

- High-altitude location of irrigation lot should not exceed 30 m and 50 m in exceptional cases in relation to the source of irrigation;
- Agricultural lands irrigated by sprinklers should have surface slope not more than 5% to prevent irrigation soil erosion;
- Application low-pressure sprinkler irrigation devices with diameter of drops not more than 1.5 mm and average rain intensity does not exceed the intensity of the absorption of water into the soil (0.2 …0.3 mm/min);
- Application of low-flow (local) irrigation methods to reduce the irrigation water consumption;
- Eliminating losses of irrigation water from irrigation canals and pipelines and its flow into the groundwater;
- Minimization of the impact of irrigation on soil through the use of irrigation regime based on the principle of additional moisture to natural rainfall;
- Using of information-measuring systems for:
  -continuous recording and processing of agro-meteorological data on irrigation site: air temperature, relative humidity, rainfall, wind speed and direction, solar radiation, ultraviolet radiation, evapotranspiration, irrigation terms and forecast weather conditions;
  -continuous monitoring of the soil moisture movement;
- Using of alternative energy sources for water supply: solar energy, wind energy, gravitational energy of the water in case the water source located higher on irrigated area.

Improved Sprinkler Systems and Practices:

Improved center pivots have been developed that reduce both water application losses and energy requirements. Older center pivots, with the sprinklers attached directly to the pipe, operate at relatively high pressure (4.0-5.5 bar), with wide water-spray patterns. Newer center pivots usually locate the sprinklers on tubes below the pipe and operate at lower pressures (1.0-3.0 bar). Existing center pivots have to be retrofitted with system innovations to reduce water losses and energy needs.

Linear or *lateral-move* systems are similar to center-pivot systems, except that the lateral line and towers move in a continuous straight path across a rectangular field. Water may be supplied by a flexible hose connected to the pressurized underground pipe or from a concrete-lined ditch along the field edge.

LEPA (Low-energy precision application) is an adaptation of center pivot (or lateral-move) systems that uses drop tubes extending down from the pipeline to apply water at low pressure below the plant canopy, usually only a few inches above the ground. Applying water close to the ground cuts water loss from evaporation and wind and increases application uniformity. On soils with slower infiltration rates, furrow dikes are often used to avoid runoff.

Implementation assumptions:

At present, Moldova has already implemented several projects contributing to the reconstruction and improvement of old and creation of new modernized irrigation systems:

- Transition to High Value Agriculture (THVA) Project funded by the Millennium Challenge Corporation (MCC) of the United States (*Centralized Irrigation System Rehabilitation Activity (CISRA), Irrigation Sector Reform Activity (ISRA)).*

- RISP – II Program (For installation / improvements of irrigational systems the soft loan at a rate of up to \$100.000 from fractions of the grant at a rate of up to 20 % is provided to farmers).
- Rural Financial Services and Marketing Program – The Consolidated Unit for the Implementation of IFAD Programs.
- Moldova – Japan 2KR Project.

It is necessary to increase the number and the budgets of projects that will stimulate farmers to use advanced resource-saving irrigation systems.

Creation and Government support of Water Use Associations to increase the purchasing capacity of farmer's communities to acquire modern irrigation systems and promote their sustainable use.

Benefits
Economic

- High value agricultural development
- Impacts on water supply
- Decreasing of irrigation water consumption

Environmental

- Decreasing of impact to the country environment

Social

- Increasing of the population incomes from guaranteed high yields
- Educational and scientific development
- Increased community welfare

Other considerations and technology costs provided in the annexed TFS

Technology name: Low-flow, low-pressure and water serving Drip Irrigation technologies

Adaptation needs: Reducing of water and energy consumption for irrigation needs in agriculture

How this technology contributes to adaptation: The main advantage of drip irrigation is that water comes directly into the root zone of the plants. It provides high irrigation uniformity, optimal soil moisture; more than 50% reduced consumption of irrigation water and reduced water losses to evaporation from the soil surface. Fundamentally new going on fertilizer. Fertilizers are supplied in dissolved form, along with irrigation water directly into the root zone of each plant. Thus, no weeds are fed between the rows, but only cultivated crops. Application rates of mineral fertilizers in drip irrigation are reduced to 3 - 4 times.

At drip irrigation water does not reach the leaves of fruit and vegetables, hence the plant is less exposed to disease. Drip irrigation systems are designed for the cultivation of various crops in outdoor and indoor conditions. These systems show particularly effective when used in orchards, vineyards and vegetables, ensuring the growth of their yield to 50% and more. By its design and working principle the drip irrigation system best meet the environmental, energy-efficient and resource-saving requirements. For example, the main element of the drip irrigation system - drip tube most modifications works under the pressure not more than 0.8 bar, while working pressure of even low-pressure sprinkler irrigation devices is not less than 2.5 – 3.0 bar.

Additional advantages of drip irrigation include:

- Drip systems are adaptable to oddly shaped fields or those with uneven topography or soil texture; these specific factors must be considered in designing the drip system. Drip systems also can work well where other irrigation systems are inefficient because parts of the field have excessive infiltration, or runoff.
- Drip irrigation can be helpful if water is scarce or expensive. Because evaporation, runoff, and deep percolation are reduced and irrigation uniformity is improved, it is not necessary to "over-water" parts of a field to adequately irrigate the more difficult parts.
- Precise application of nutrients is possible using drip irrigation. Fertilizer costs and nitrate losses can be reduced. Nutrient applications can be better timed to meet plants' needs.
- Drip irrigation systems can be designed and managed so that the wheel traffic rows are dry enough to allow tractor operations at any time. Timely application of herbicides, insecticides, and fungicides is possible.

- Proven yield and quality responses to drip irrigation have been observed in onion, broccoli, cauliflower, lettuce, melon, tomato, and cotton.

Background: To low-flow irrigation systems *(*sometimes called as *local irrigation systems)* include *drip* (*trickle)* and micro-sprinkler irrigation systems. Water and nutrients enter the soil from the emitters, moving into the root zone of the plants through the combined forces of gravity and capillary. In this way, the plant's withdrawal of moisture and nutrients are replenished almost immediately, ensuring that the plant never suffers from water stress, thus enhancing quality, its ability to achieve optimum growth and high yield.

The classic drip irrigation system consists of the following elements:

- water source;
- pumping station;
- fertilizers application device;
- water filtration plant;
- main pipeline;
- sub-main pipelines of various levels;
- drip lines.

Improved drip irrigation system must also be equipped with a measuring-information system to provide continuous monitoring of soil water regime. The main element of the drip irrigation system is drip line which may be of various types in their design and methods of manufacturing: drip tube or drip tape with drippers (emitters).

Drip tube of the Drip - In type. Drip tube of Drip-In type is a rigid polyethylene tube wall thickness of 1.1 - 1.2 mm and diameter of 12, 16 or 20 mm with built-in emitters (drippers) inside. Drippers are available in two forms: pressure compensated and non-pressure compensated.

Drip tube of the Drip - On type. Represent the plastic pipe wall thickness of 1.1 - 1.2 mm, and diameter 16 or 20 mm, outside of which various types and modifications of Drippers are installed. Any distance between drippers depending on the needs of various plants may be chosen. The service life of the drip tube is not less than 8 years, so it is mainly used for irrigation of orchards, vineyards and berry fields.

Drip tape, in contrast to the Drip tube, is a flexible polyethylene tube wall thickness from 100 to 400 microns (4 to 16 mil), and diameter of 12 to 22.5 mm with built-in dripper. Another distinctive feature of drip tape is the drippers are also designed as the flexible labyrinth. Invention of the drip tape made a revolution in drip irrigation. Its use has reduced the cost of irrigation systems in about 5 times, improve the performance of laying strips in 8 times, reduce the material consumption of irrigation systems in 10-12 times.

Currently being developed and produced drip tape of various types and designs, each of which has its own advantages and disadvantages.

Implementation assumptions:

At present, Moldova has already implemented several projects contributing to the reconstruction and improvement of old and creation of new modernized irrigation systems:

- Transition to High Value Agriculture (THVA) Project funded by the Millennium Challenge Corporation (MCC) of the United States (*Centralized Irrigation System Rehabilitation Activity (CISRA), Irrigation Sector Reform Activity (ISRA)).*
- RISP – II Program (For installation / improvements of irrigational systems the soft loan at a rate of up to $100.000 from fractions of the grant at a rate of up to 20 % is provided to farmers).
- Rural Financial Services and Marketing Program – The Consolidated Unit for the Implementation of IFAD Programs.
- Moldova – Japan 2KR Project.

It is necessary to increase the number and the budgets of projects that will stimulate farmers to use advanced resource-saving irrigation systems.

Creation and Government support of Water Use Associations to increase the purchasing capacity of farmer's communities to acquire modern irrigation systems and promote their sustainable use.

Benefits:

Economic

- High value agricultural development
- Impacts on water supply
- Decreasing of irrigation water consumption

Environment

- Decreasing of impact to the country environment

Social

- Increasing of the population incomes from guaranteed high yields
- Educational and scientific development
- Increased community welfare

Costs are provided in the annexed TFS.

Technology name: Construction of new and proper maintenance of existing dams and water reservoirs

Adaptation needs: Increasing of seasonal and multiannual volume of water storage

How this technology contributes to adaptation. Dams and reservoirs represent the main option for adaption to climate change in the water sector in Europe. Being deficient in natural lakes and with abundant intermittent streams, Moldova has already developed a large network of ponds and reservoirs for inter-seasonal and inter-annual redistribution of water. Proper maintenance of existing dams and reservoirs, as well as construction additional ones could help in redistributing precipitation between seasons, serving as an important object for both water storage and diminishing flash flood risk. Moldova needs till 2020 to increase volume of the water accumulated to 50 million $м^3$

Background. The main source of water for agricultural irrigation in Moldova is the surface water of rivers, lakes and artificial reservoirs. An increase in the accumulated amount of water would reduce the risks associated with climate change. Construction technology of dams and water reservoirs is not new for Moldova. These works have been executed earlier and continue to be carried out now. Almost all of the previously constructed dams are earthen dams, equipped with concrete or earthen discharge structures. The most widespread and approved method of their construction in Moldova is layer-by-layer stacking of an earthen body of the dam by scrapers with simultaneous compacting by compacting machines. To reduce the filtration of water through the dam body are various impervious options, including the device impervious screens in the dam body, upland slope facing concrete slabs, and others.

Implementation assumptions. The state program of dams and water basins building across territory of Moldova should be developed. Construction of water basins of long-term redistribution on the small rivers of Moldova being between the rivers Nistru and the Prut should be made.

Benefits

Economic

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

Environmental

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

Social

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

Technology costs provided in the annexed TFS.

Breeding technologies

Technology name: Technologies for breeding hybrids with high adaptation potential to meteoindicators

Adaptation needs: Climate change which is a feature of the last three decades, causes not only high temperatures (annual, seasonal), but also other frequent natural extreme events (droughts, floods, etc.). The past 62 years (1945-2007) featured: 12.7% annual droughts with reduced crop productivity levels to 16.9%, spring droughts with respectively 24.6% and 32.8%, and summer droughts: 20.9% and 14.8%. The annual average losses (62 years) are estimated at 220 million Lei at prices of 2009-2011. In the years when extreme phenomena occurred (2003, 2007) the amount of losses can be estimated at $ 130-170 million.

How this technology contributes to adaptation: For each crop (following the analysis of biological systems) "weak indicators" of modern genotypes to changing the existing and projected meteorological parameters have been identified. For winter crops (wheat, barley, canola, etc.) - resistance to frost and winter, spring crops - drought and extremely high temperatures during critical stages of development of agricultural plants, resistance to (tolerance of) the new pest species and diseases. Modification of improvement programs (aimed at developing such features in new genotypes) after their implementation will enable agriculture to reduce losses of these crops yields.

Background: The technologies aimed at improving varieties and hybrids with a high potential to adapt to climate change include the following steps:

- analysis (assessment) of the adaptive level of approved varieties (hybrids) and identify "weaknesses" in the studied genotypes;
- supplementing the collections with original material having blocks of genes needed to further include them into the improvement (selection) programs;
- testing and selection of new genotypes created naturally and artificially (cold rooms, fitotrones, etc.)
- inquiring into the level of compliance with bio-economic and ecological capacities in selected genotypes, assessing the new varieties potential for reproduction of seeds and implementation in real production conditions.

Implementation assumptions:

The original seeds will be produced by the research institutions (private companies) from which seeds originate, while super elite varieties partially will be produced in the research institutions and/ or seed experimental stations of these institutions. The I-III reproductions elite seeds are produced by the seed agriculture farms contracted by originated institutions. The research institutions from the Republic of Moldova have a 50year successful background of crop seed production. The State Commission for Evaluation of new varieties evaluates and registers new varieties (hybrids) despite the breeding methodology. Existing seeds and hybrids system is approved by the commission of Ministry of Agriculture and Food processing of the Republic of Moldova, while the monitoring is performed by the Department of Seed Production that investigates (approves) plant fields (all generations) and issues the certificates. For efficient production of high quality seeds of new hybrids there are no special technological requirements (traditional growing plants equipment, yield harvesting and post-harvesting machinery: ventilation, pealing, sorting, and packing). Special technical requirements are needed for developing and improving the initial steps of breeding process in the research institutions, where new, original self-pollinating genotypes are bred along with plants parental cross fertilising lines. These special requirements are needed for efficient generation and selection of genotypes, possessing the set of original (high performance characteristics) genes for their further involvement in the breeding process.

The production of seeds of new varieties (hybrids) will lead toward setting up of efficient production in the seed growing agricultural farms, due to their high performance characteristics, with increased demand on the market based on their higher adaptive potential to new climate. Crop production agricultural farms will receive increased yield of crops due to the implementation of new varieties and hybrids, their advantage being yield stability (by years) and ensuring reduction in economic fluctuations

- Implementation of newly created varieties (hybrids) in real production conditions can be accomplished through traditional methods producing the seeds of newly created varieties on the premises of research institutions (seeds of the highest categories (basic, super-elite seeds)
- testing under the system of the State Commission for testing and registration of new genotypes with the registration of the most promising ones;
- continuous multiplication (after the registration of varieties) of seeds at the seed farms specialized conditions (elite seeds, I-III reproductions, hybrid seeds (F1));
- Use of new varieties (hybrids) seeds in farming to produce agricultural commodities.

Benefits:

Economic. Reducing the fluctuation of agricultural commodities amounts, as well as of risk, is a key condition for financial and economic situation stabilization in rural areas, accumulation of equity, and for attracting credit resources, including foreign investment. Implementation of modern growing and processing technologies in agribusiness can serve as the next step to building upon the scientific and technical progress in the rural sector.

Environmental. Economic wellbeing of rural businesses, increased capital investment in new businesses (for agricultural production processing, new branches of industrial enterprises, service companies, etc.) will form the need (demand) for different highly skilled specialists, and thus stimulate intensive development of rural infrastructure (energy supply, business communications, roads, etc.).

Social. Strengthening rural businesses, increasing the tax base will drive stimulate growth of local budgets, as well as financial opportunities to improve rural infrastructure (schools, hospitals, cultural objects, etc.). Creating new jobs will decrease the motivation for massive migration of rural population, as well as the sustainability of the demographic decline.

Technology name: Application of anthers culture and "in vitro" isolated pollen methods to obtain and use double haploid lines in plant breeding.

Adaptation needs:

- Better adaptation to low temperatures during sowing and early vegetation season of plants.
- Adaptation to drought conditions.
- Adaptation to vulnerable prices in the process of first generation hybrid seed production.

How this technology contributes to adaptation:

- Enhancement of plant breeding for resistance to different stress factors (low temperatures during the first growing season, drought, etc.) by obtaining by "in vitro" method of "pure" or inbred, absolutely homozygous lines.
- The possibility to detect valuable mutations at the level of haploid and further - diploid cell may facilitate obtaining of lines resistant to drought, low temperatures, various pathogens, with many valuable features.
- The possibility to remove certain inappropriate individuals at early stages of selection, due to the *hemizygot* state of haploids that allow expression of all genes, including unfavorable recessive genes.
- The possibility to rapidly create, by method of androgenesis, of *androsterile* analogues - female genitor lines in the process of first generation hybrid seed production.
- The possibility of fixing the heterocyst revealed in the first and further hybrid generations.
- Reducing the costs for human and financial resources while creating varieties of pollinated plants and obtaining the initial material for improving cross-fertilized plants.

Background: The current system of production of hybrid seed of first generation (F1) is based on development of inbred lines, which, by using a conventional method, are obtained as a result of controlled self-pollination of the original form (variety, population, hybrid) for 5-8 consecutive generations.

The genetic research carried out in early '60s of the last century have demonstrated the possibility of obtaining "pure" or double haploid inbred lines in a number of species, including maize, by androgenesis in "in vitro" culture.

Androgenesis is the transformation of a haploid cell of the male gametophyte into a mature plant with a gametal number of chromosomes. Androgenesis may be induced through "in vitro" culture of anthers or pollen at a certain stage of development. In order to obtain normal plants, perfect homozygote, haploids diploidize. The fact that the double haploid lines, which are absolutely homozygotic, can be obtained during two generations, while using conventional methods inbred lines are obtained in at least 6-8 generations justify the increased interest of breeders to haploid method. So, the haploid method determines an important reduction of the selection process duration.

Implementation assumption: The technology of valuable varieties by "in vitro" culture multiplication can be used by the Institute of Horticulture Crops and Food Technology, Institute of Genetics and Plant Physiology of the ASM, the Moldova State Agricultural University, Research Institute for Field Crops "Selection", Institute of Botany of the ASM. These institutions have the experience working with in vitro" culture” products. The pedoclimatic conditions in Moldova are quite favorable for the growth of a large ranges of crops that include about 80 species of plants, including sps resistant to water stress, high and low temperatures. The technological process has been tested in the lab conditions of State Agrarian University of Moldova following the main steps:

1. selection of donor plants, isolation of explants and obtaining a sterile well-bred culture.
2. micro-propagation itself, when maximum amount of micro-clones is achieved.
3. rooting of multiplied shoots with their further adaptation to field conditions and, if necessary – depositing of regenerated plants at low temperatures (+2^{o} - 10^{o}C).

4. Growing plants in greenhouses and preparing them for selling or planting in the field, and if necessary – depositing at low temperatures (2^o - 10^oC).

The final product of the technology:

a) double haploid lines valuable from agronomic point of view can be used directly in production, as commercial varieties in self-pollinated plants and plants with vegetative reproduction.

b) haploid lines derived from heterozygotic plants of cross-fertilized species, which necessarily originate from a single gamete, will have a completely different genotype due to re-combinations and large number of genes.

c) first generation hybrid seeds will be used by farmers to obtain high yields of crops.

The expected scientific results will be published in scientific papers, radio and television, so that farmers, PhD candidates, students will be informed and will make efficient use of knowledge gained from practical implementation.

Benefits:

Economic

- Stimulate economic activities with environmental impact
- Enhance financial support in the agricultural sector, and subsequently the income of rural population.
- Expanding the market to sell agricultural production.

Environmental

- Increase biodiversity and avoid erosion of germplasm.
- Improve human health by excluding harmful effects of fertilizers, pesticides and even the allergic effect of pollen on human health.
- More rational use of farm land (by reducing the areas used for research as experimental plots and implementation of highly productive corn hybrids.

Social

- More people will be engaged in research and innovation
- Increased interest for the implementation of modern biotechnology methods and cultivation of other species and varieties of plants important to the national economy.
- Reduce poverty.

Costs calculation other consideration, up-scaling are provided in the annexed TFS.

Technology name: Micro-propagation of valuable genotypes by "in vitro" cultivation of plant cells and tissues

Adaptation needs:

- Adaptation of agrophytocenoses to environmental changes.
- Adaptation of seeds reproduction to the adverse impact of biotic and abiotic factors.
- Adaptation to vulnerable prices in the seed production process.

How this technology contributes to adaptation:

- Possibility to reproduce a large number of descendants having valuable features and properties specific to the initial forms (parent body) in short time and on a very limited areas.
- Selection and reproduction of new plant varieties resistant to drought, diseases and pests.
- Revealing varieties with enhanced capacity to assimilate carbon dioxide and respectively, with higher productivity.
- Obtaining virus-free plants in a series of species (potato, tomato, strawberry, tobacco, vine, fruit and floriculture).
- Reducing costs for human resources and financial expenditures for the process of seeds and planting material reproduction.

Background: Many species of plants (vine, fruit trees, bushes, strawberries, carnations, etc.) reproduce both sexually-by seeds, and by vegetative propagation (by cuttings, tubers, bulbs, buds, rhizomes, etc.). Reproduction by seeds in these species is limited, expensive, takes a long time (getting a generation by seeds takes 3-10 years), and causes a high genetic diversity of offspring. This mode of reproduction, now is used more frequently in theoretical research and process improvement only. In case of vegetative propagation the descendants feature great genetic uniformity and stability and the juvenile period (the period between germination and blooming) is much shorter. In terms of genetics, identical plants can be obtained only through cloned propagation. Unlike multiplication by seeds, which are usually healthy, vegetative propagation is disadvantaged by the fact that different pathogens (viruses, viroids, fungi, etc.), are transmitted in the course of the cells division. In order to obtain faster a large number of genetically stable, resistant to biotic and abiotic factors descendants, plant cells and tissues "in vitro" cultivation technique was developed in the 50-60-s of the last century. This method allows regeneration "in vitro" of plant organs (root, apex, reproductive organs) from an initial cell of the whole and even mature body, genetically similar to the one from which they descended.

Thus, the "in vitro" culture allows multiplication of valuable genotypes in a relatively short period of time and in a limited space. This method is used in areas that can be grouped according to the three complexes of research tasks aimed at improvement:

- broadening the genetic base of improvement by creating new original material,
- industrial cloned micro-multiplication of precious genotypes
- obtaining virus-free planting material.
- selection of donor plants, isolation of explants and obtaining a sterile well-bred culture.
- micro-propagation itself, when maximum amount of micro-clones is achieved.
- rooting of multiplied shoots with their further adaptation to field conditions and, if necessary – depositing of regenerated plants at low temperatures (+2 ^{o} - 10^{o}C).

Growing plants in greenhouses and preparing them for selling or planting in the field, and if necessary – depositing at low temperatures (+2 ^{o} - 10^{o}C).

Implementation assumption: The technology of valuable varieties by "in vitro" culture multiplication can be used by the Institute of Horticulture and Food Technology, Institute of Genetics and Plant Physiology of the ASM, the Moldova State Agricultural University, Research Institute for Field Crops "Selection", Institute of Botany of the ASM.

The final product of this technology: Obtaining of genetically identical clones of elite plants to be used for improvement and plant breeding; Rapid and effective multiplication of new varieties of valuable plants; Advantageous multiplication of highly productive genotypes of wood crops, wood decorative plants or vine rootstocks, as well as vine and fruit crops; Multiplication in sterile conditions aimed at obtaining virus free planting material: Preservation and multiplication of valuable genotypes, separated as initial form for specific improvement purposes; Achieving energy savings compared to greenhouse crops. The crop obtained on 2500 sq.m, can be obtained on 10 sq.m if in vitro culture technique is employed.

Benefits:

Economic

- Reduced costs for human resources and energy resources related to organization and maintenance of seed plantations.
- Reduce financial costs related to storage of seeds.
- Stimulate economic activities with environmental impact
- Increase financial support for the agricultural sector, the income of rural population inclusively.
- Expand the market for selling agricultural products.

Environmental

- Increase biologic diversity and avoid erosion of germplasm.
- Improving human health by excluding harmful effects of fertilizers, pesticides, as well as allergic effect of pollen.
- More rational use of land (by reducing areas occupied by fields used for growing and multiplication of seeds.
- Reduce GHG emission and global warming effect.
- Maintain soil fertility and reduce erosion.
- Reduce water and air pollution.

Social

- More people in rural areas will be employed.
- Improve health, increase birth rate and reduce mortality.
- Increasing interest for implementation of modern biotechnologies and cultivation of other species and varieties of plants important to the national economy.
- Reduce poverty

Animal breeding technologies

Technology name: Extensive system of animal husbandry.

Adaptation needs: Adaptation of animals to higher temperatures

How this technology contributes to adaptation: The absolute majority of animals raised in Moldova is now accommodated to environmental conditions, have a better adaptability, are less vulnerable than the breeds of high yield animals, but have low production indicators and breeding them is economically not cost-efficient. In this respect it should be noted that low quality is a factor that generally do not allow to penetrate into the European market.

***Background*:** Currently the extensive system of animal husbandry is the most common in the Republic of Moldova. Approximately 96% of livestock are raised in the private sector, mostly in households with few animals (e.g., 1-2 cows) in primitive conditions, without observance of sanitary and veterinary requirements. At the same time it should be noted that only about 1% of the overall population is breeding animals, the other 99% are crossovers with no known origin and productive qualities. For these reasons the animal yields obtained under such circumstances in all species (cattle, swine, sheep, goats, poultry) are small and their quality is low.

Implementation assumptions: Currently used technologies in the livestock sector in Moldova, except for a few large farms, do not imply mechanization and automation of livestock industry processes. Along with the introduction of such procedures is necessary to improve the gene pool by implementing high yield breeds and creating such animals maintenance conditions that would ensure the possibility to control the parameters of the microclimate, including the temperature, in order to mitigate the environmental impact on animals.

Benefits:

Economic. Increased food security. Dependence of the livestock sector on feed produced by crop husbandry branch.

Environmental. Grazing outdoors means less accumulation of ammonia in manure. Extensive animal husbandry entails reduced environmental pollution. Construction of manure storing platforms. Fermented manure is a valuable organic fertilizer.

Social. Acquiring knowledge for compliance with veterinary animal welfare and environmental requirements. Along with the disappearance of large livestock farms, ammonia emissions significantly reduced. Use of best practices. Identification and selection of genotypes with high potential for adaptation to climate change. Conservation of endangered gene pools.

Costs details provided in the annexed TFS.

Technology name: Semi-intensive system of animal husbandry. Intensive system of animal husbandry.

Adaptation needs: Adaptation of animals to higher temperatures

How this technology contributes to adaptation: Along with best genotypes of indigenous breeds, some world renown breeds may be raised at such mini-farms. They can be grown in optimum conditions and therefore will be less prone to unfavorable environmental conditions and, being fed with proper feed, are more likely to yield better production.

Background: The semi-extensive system of animal breeding implies breeding of animals at mini-farms. For example, dairy cattle - at farms of 10-20-50 heads, provided such farms are model farms meeting the basic maintenance requirements of breeding technologies (areas, number of stock, microclimate), employment of mechanized milking, etc.

Under the intensive animal breeding system, animals are permanently kept in paddocks, thus a high degree of technicality being ensured: skilled staff, operationally advanced livestock breeding equipment and technologies.

High value breeds and hybrids can be grown based on scientific reproduction, breeding and selection programs, ensuring maximum genetic progress. Animal feeding can be done differentially, taking into account the age, category of animals, the production level

Implementation assumptions: The mini-farms may employ modern technologies allowing mechanization of many processes, both in terms of fodder preparation, as well as milking cows, sheep or goats, manure disposal; installation of some biogas plants. The animals will be milked inside the barn.

Under the intensive animal breeding system, virtually all farm activities are mechanized, and some of them even automated. Animals are kept in several barns and are milked in special rooms. The milk obtained is cleaner, and of better quality.

This system allows for the concentration and specialization of livestock and its rapid improvement. Switching from traditional animal breeding systems in the intensive ones allows to meet the growing demand for food products of animal origin, but at the same time, they are incompatible with animal health and entail a number of diseases: pneumopathies favored by the microclimate, stress, illness of hoofs, mastitis, behavior disorders (cannibalism, coprophagy, etc.)

Benefits:

Economic. The semi-intensive animal breeding system is economically more superior to the extensive one. In case of farms, the livestock sector depends on crop production to a larger extent than in case of extensive animal breeding. More diverse feed contribute to increased productions. Makes it possible to improve the breeds. Ensures labor productivity. Allows to increase production in economically efficient way. Concentration of large herds of livestock on small areas. The workforce used is skilled and specialized. Scientific organization of production and work based on economic efficiency indicators. High quality breeding material, technical equipment, feeding of animals with combined, scientifically substantiated rations, employment of state-of-the-art technologies allow to get high production and good economic results.

Environmental. In case of mini-farms, construction of manure storage platforms will be required, what will lead to a reduction in environmental pollution. It will become possible to set biogas plants which will ensure the energy needs of the farm. Manure fermentation will produce valuable organic fertilizer.

Concentration of a large number of animals on small areas entails accumulation of essential quantities of manure, which presents great danger to environment. Accumulation in large amounts of manure increases the amount of ammonia, carbon dioxide, carbon released into the atmosphere. It is possible to build big facilities to produce biogas from manure.

Social. Use of best practices. Compliance with sanitary and veterinary requirements and obtaining animal products of higher quality. Ensuring human health. The animal breeding process can be computerized along the entire flow. Facilitates the work of people milking cows, milking rooms can be equipped with robots. There is a well-established and rhythmic sales flow throughout the year. Production is certified and complies with HACCP, SSOP.

Agriculture Soils Technologies

Technology name: Cultivation of agricultural crops in alternative strips

Adaptation needs: Adaptation to increased desertification of agricultural lands situated on slopes, occurring due to increased erosion generated by climate change. In Moldova the lands on slopes with a gradient greater than 2° account for 57 percent of the total area. Eroded soils on agricultural lands pedologically evaluated occupy 878 thousand ha. The crops harvested from eroded arable lands (400 thousand hectares) are by 20% smaller in comparison with crops from non-eroded lands. Based on the average yield of cereal crops of 3 t / ha on non-eroded soils, crop losses are 0.6 t / ha / year, or 240 tons / year units of cereals on all eroded areas, which in terms of money is 46 million euro / year. Climate change is expected to generate aridization, increased frequency of torrential rains and, consequently increased erosion (Annex 1). This will lead to increased fertile soil losses and water from the arable soils on slopes, increased pedological drought and crop reduction. To facilitate adaptation to climate change two simple, inexpensive and effective soil erosion control technologies are proposed.

How this technology contributes to adaptation: Reduces erosion by 50-60 percent.

Proposed technology has the effect of alternation on slopes of high protective characteristics crop strips that provide and erosion protection up to 70-90 % (wheat, barley, perennial grass) with strips planted with low protection indices crops (maize, sunflower, other). The width of the strip is calculated based on diagram[90] depending on the peculiarities of planted crop and varies from 20-30 m up to 150-200m. This technology is efficient in all pedoclimatic zones. Technology efficiency increases when on planted crop strips is applied soil slotting technique between rows at the beginning and at the end of the summer.

[90] Titus Neamțu. Eroziune, Ecologie şi Protecție Antierozională. Bucureşti: Cereş, 1996. P. 131-136.

In combination with field operations proposed for lands requiring cultivation, it practically stops the erosion on up to 8° gradient slopes. Minimization of soils degradation processes and improvement of the slopes soils moisture regime decrease the risk of desertification of arable soils eroded as a result of climate change.

Background: The technology is based on the principle of differential protection provided to soil by the crop foliage and variable crop density, which according to the degree of protection are divided into the following groups:

- Very good protective crops - perennial grasses and legumes after the first year of growth, provide 90-95 percent protection;
- Good protective crops - cereal grains, legumes and perennial grasses in the first year of vegetation, annual high density fodder plants, provide 70-90 percent protection;
- Medium protective crop - annual legumes, provide 50-70 percent protection;
- Weak protective crops - low density of weeding crops requiring cultivation (corn, sunflower, beets, vegetable crops), provide 20-50 percent protection.
- Anti-erosion effect on the slopes is ensured by alternating strips of very good and good protective crops, and medium and poorly protective ones.

Implementation assumptions: Can be implemented without limitations. The optimal width of the strips shall be determined based on very simple special diagrams (Annex 12), depending on the slope. This technology shall be implemented by agricultural businesses on their own land. The initial location of the strips will require appropriate topographical work by a surveyor.

Benefits:

Economic. The yields on arable eroded soils (about 400 thousand ha) will increase by 5 percent or 1q grain units generating a benefit of about 20 € / ha / year, and a total benefit for all arable eroded soils (400 thousand ha) will be 8 million per year.

Environmental. The erosion-caused soil degradation processes will be minimized. The risk of roads, ponds, rivers, valleys salination and groundwater pollution will decrease.

Social. The socio-economic effect from the implementation of this technology will be the following: increased turnover and quality of agricultural production on eroded soils will increase well-being and decrease migration of rural population.

Technology Name: In depth fissuring (30-35 cm)

Adaptation needs: Results in erosion reduction by up to 70-80% on slopes with 2-5° gradients, used for growing weeding crops. In combination with the growing crops on alternative strips ensures reduction of erosion up to 90%. It reduces the risk of soil deterioration and desertification of arable soil eroded as a result of climate change.

Background: The deep loosening of soil increases water permeability, thus decreasing liquid and solid leaking from the slopes. Virtually total absorption of the water from precipitations by soil, stops the erosion and ensures more effective use of water by plants and provides for their better development. Losses of topsoil from the slopes are decreased by on average 5 t / ha.

Implementation assumptions: This technology shall be implemented by agricultural businesses on their eroded lands, occupied by weeding crops. The total area of such lands in the country is about 200 000 ha. Implementation will require a PRVH -2.5 type aggregate with arrow type rippers and a tractor).

Benefits:

Economic. The weeding crops on eroded soils (about 200 thousand ha), will increase yields by 10 percent or 2q cereal units. It will generate an additional gross income of about 40 € / ha / year (net income 20 € / ha / year), the total gross for all weeding crops on eroded soils (200 thousand ha) - 8 million euro per year, the net economic benefit - 4 million euro per year. The cost of one tone of washed away black soil from the slopes is about 8 euro. Loosening reduces soil losses by 5 t / ha, the calculated benefit based on the cost of prevented soil losses is 40 € / ha or 8 million per year.

Environmental. The erosion-caused soil degradation processes will be minimized. The risk of roads, ponds, rivers, valleys salination and groundwater pollution will decrease. The ecologic stability of agricultural landscape will improve.

Social. Socio-economic effect from implementation of this technology will be the following: increased turnover and quality of agricultural production on eroded soils will increase well-being and decrease migration of rural population

Technology Name:

a) Applying of 50 t/ha manure with bedding to agricultural soils once in five years;
b) Vetch field as green fertilizer into 5 year crop rotation;
c) Vetch field as green fertilizer as successive into existing crop rotation.

Adaptation needs: Adaptation to increasing desertification by dehumification, dissolution and secondary compaction of the soil arable layer. Climate aridization along with classic cultivation lead to dehumification of agricultural soils, soil structure damage and strong secondary compaction of the arable layer. Currently the arable layer of agricultural soils lost its natural ability to compaction resistance. Dehumification, dissolution and secondary arable soil compaction is a global problem, but particularly acute in Moldova where 80 percent of soils are characterized by fine texture. These soils have a high production capacity only if their structure is agronomically favorable and contributes positively to regulate air-fluid and nutrients regimes, ensuring optimal conditions for plant growth and development. In a compacted layer of soil moisture reserves are almost by 2 times less accessible than in the same loose layer with agronomical favorable structure. Therefore, soils with high content of humus, agronomically favorable structure and loose arable layer are more adapted to climate change. To adapt to increasing desertification due to dehumification, dissolution and secondary compaction of the arable layer of soil generated by climate change, 6 technologies described below are recommended.

How this technology contributes to adaptation: This technology helps maintain a stable content of organic matter in the soil. The content of nutrients increases, and the soil structure improves. The arable layer becomes more loose, more resistant to compaction, better provided with reserves of water accessible to plants. This increases crop resistance to drought.

Background:

a) The technology implies the return of the biophil elements contained in dung, urine and vegetal waste of cattle bedding, in the biological circuit. One tone of manure with bedding at 50-55% humidity contains about 15-16 kg of nitrogen, phosphorus and potassium.

b) The technology is based on the fact that green mass of vetch is very rich in nitrogen, which leads to fertilization of soil on account of symbiotic nitrogen. A good quality green mass contributes to rapid synthesis of organic matter in soil. The root system of vetch is well developed and contributes to the structuring of the arable soil layer. Given the two harvests of vetch per year, the arable layer of the soil becomes biogenic, structured, loose, and permeable for water and roots.

c) This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.

Implementation assumptions:

a) Currently there are no large farms and cattle herd is concentrated in rural households. To use manure as fertilizer, municipalities have to organize the collection, storage, fermentation and storage of manure on special platforms. Technologies for processing and introduction of manure in the soil are provided in specially developed recommendations.

Realistically possible reserves of manure collection in the country do not exceed 2 - 3 million tons, which would be sufficient to fertilize only 200 thousand ha of agricultural lands annually, provided this amount is indeed collected (regretfully the amount collected is tens times smaller). The amount of manure possible to collect is 9 times lower than required.

b) This technology can be successfully implemented on all agricultural lands of farmers. It can be implemented under any land cultivation system. In order to implement this technology, it is necessary to create the autumn and spring vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September and spring vetch – in early May of the next year after incorporation of autumn vetch mass into soil.

c) Technology can be successfully implemented on the entire surface of agricultural soils under any soil tillage system. Vetch as a successive crop used as green fertilizer, shall be sown once in two years after harvesting spiked cereals.

Implementation of this technology requires autumn and spring vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September.

Benefits:

Economic

a) The total increase of crop through the entire period of action of the 50 t of manure / ha is 1t/ha/year grain units in 5 years or - 200 € / ha/year in money terms. Total (gross) benefit over 5 years is 1000 € / ha or 200 €/ ha annually. If this technology is applied regularly, it contributes to developing carbon balance in soil, and practically excludes CO_2 emissions from agricultural soils.
b) The total crop growth over the whole period of vetch green mass action (5 years) is 4t/ha cereal units or 800 € /ha/year in monetary terms. The net benefit is € 191/ha/year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO_2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.
c) The total crop growth over the whole period of vetch green mass action (2 years) is 2.0 t / ha grain units or - 400 €/ha in monetary terms. The net benefit is 315 €/ha/year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO_2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.

Environmental. This technology stops the accelerated degradation of soils, it reduces the risk of nitrate pollution of water in wells in villages, improves sanitary conditions in villages and health of population, makes the humus and soil carbon balance positive or well-balanced, cardinally improves the soil biota status, increases resistance of soil to pollution and of plants to drought.

It stops soil degradation, makes the humus and soil carbon balance positive or well-balanced, cardinally improves the soil biota status, increases resistance of soil to pollution and of plants to drought.

Social. The social - economic effect of these technologies implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, decrease migration, and increase the earnings for social infrastructure development.

Technology Name:

a) Conventional land cultivation system with moldboard plow in 5 fields crop rotation with a field of vetch used as green fertilizer;
b) Mini-till system and vetch as successive plant;
c) No-tlll system and vetch as successive plant.

***Adaptation needs*:**

a) Due to specifics of some crops (sugar beet and fodder, vegetables, etc..), the classical soil cultivation system can be replaced with a system aimed at soil conservation on only 80 percent of arable lands. Based on this, it is proposed to improve the classical cultivation system that will still be used for 20 percent of lands, by including a "vetch field as green fertilizer" into a 5 fields crop rotation, or using the vetch as successive green fertilizer crop.

b) The classical soil cultivation system generated the phenomena of soil features degradation. Excessive plowing favored dehumification, damage of the soil structure, increased compaction, danger of erosion. It became necessary to develop new tillage systems known as “soil conservation works systems, SCWS". Mini-till and No-Till systems turned out to be the most effective. It is proposed to improve these two systems by including vetch as successive crop for green fertilizer.

c) The existing soil cultivation systems entail intensive physical, chemical and biological degradation of soil. The classical soil cultivation system generated the phenomena of soil features degradation. Excessive plowing favored dehumification, damage of the soil structure, increased compaction, danger of erosion. It became necessary to develop new tillage systems known as "soil conservation works systems, SCWS". Mini-till and No-Till systems turned out to be the most effective.

How this technology contributes to adaptation:

a) A crop of vetch (about 6 t/ha of dry weight containing 4% of nitrogen), and roots (about 4 t/ha dry weight containing 2% of nitrogen) accumulates about 10 tons of organic matter in soil, which ensures synthesis of about 2.5 t/ha of humus containing about 200kg of nitrogen. This amount of humus is sufficient to create a positive carbon and nitrogen balance in soil during 2 years. The arable layer will become structured, loose, will contribute to a favorable air-fluid and nutrients regime and will increase the plants resistance to drought.

b) A crop of vetch (about 6 t/ha of dry weight containing 4% of nitrogen), and roots (about 4t/ha dry weight containing 2% of nitrogen) accumulates about 10 tons of organic matter in soil, which ensures synthesis of about 2.5 t/ha of humus containing about 200kg of nitrogen. This amount of humus is sufficient to create a positive carbon and nitrogen balance in soil during 2 years. The arable layer will become structured, loose, will contribute to a favorable air-fluid and nutrients regime and will increase the plants resistance to drought.

c) It is proposed to improve these two systems by including vetch as successive crop for green fertilizer.

A crop of vetch (about 6 t/ha of dry weight containing 4% of nitrogen), and roots (about 4t/ha dry weight containing 2% of nitrogen) accumulates about 10 tons of organic matter in soil, which ensures synthesis of about 2.5 t/ha of humus containing about 200 kg of nitrogen. This amount of humus is sufficient to create a positive carbon and nitrogen balance in soil during 2 years.

The No-till soil cultivation system means that the sowing is done directly on the stubble field or field containing vegetal waste of the previous crop. The main mechanism for No-Till is the sowing machine. The main element of the sowing machine is the cutter. Recently, the cutters are combined with corrugated disc type blades in combination with chisel type blades. Gradually, the topsoil will become biogenic, well structured, and loose, will contribute to a favorable air-fluid and nutrients regime and will increase the plants resistance to drought.

Background

a) This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.

b) This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.

c) This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.

Implementation assumption. This technology can be successfully implemented on 20 percent of agricultural lands, on which for various reasons it is not possible to implement the soil conservation system. On the "occupied field" vetch shall be sown and applied to soil twice a year (the soil accumulates about 20t/ha of organic matter that maintains the balance of nitrogen and carbon during 4 years). Vetch as a successive crop used as green fertilizer, shall be sown once in two years after harvesting spiked cereals. Implementation of this complex technology requires vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September.

b) This technology can be successfully implemented on 50 percent of agricultural lands. Vetch, as a successive crop used as green fertilizer, shall be sown once in two years after harvesting spiked cereals. Implementation of this complex technology requires vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September.

c) This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.

Benefits:

Economic

a) The total crop growth over the whole period of vetch green mass action (5 years) is 4t/ha cereal units or 765 € / ha / year in monetary terms. The net benefit is € 20 / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.

b) The crop growth over the whole period of vetch green mass action (2 years) is 1t/ha cereal units or 200 € / ha / year in monetary terms. The net benefit is € 115 / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.

c) The annual crop growth over the whole period of vetch green mass action (2 years) is 1t/ha cereal units or 200 € / ha / year in monetary terms. The net benefit is € 115 / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent

Environmental. Applications of these technologies stop soil degradation, makes the humus and soil carbon balance positive or well-balanced, cardinally improve the soil biota status, increases resistance of soil to pollution and of plants to drought.

Social. The social - economic effect of these technologies implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, and decrease migration.

Technology Name: Climate Insurance (CI): named-peril (NPCI) and multi-peril crop insurance (MPCI), and Index-based Insurance (II).

Adaptation needs. Moldova is highly vulnerable to climate variability and change[91]. According to a range of studies, including Moldova's Second National Communication (SNC) under the United Nations Framework Convention on Climate Change (UNFCCC)[92] and the National Human Development Report (NHDR, 2009)[93], the impacts of climate change are expected to intensify as changes in temperature and precipitation affect economic activity. Furthermore, socio-economic vulnerability to these changes is high. Moldova is one of the least advanced countries in the region – in 2005, Moldova had the fourth lowest Human Development Index out of 20 countries in the region[94]. The economy was in decline before 1991, a process that was intensified with separation from the USSR, and Moldova's economy suffered during the recent economic crisis.

The impacts of climate change on agriculture are of particular concern – agriculture is a major source of income in Moldova, where more than half the population lives in rural areas and about one third of the labor force is employed in agriculture.

The socio-economic costs of climate related natural disasters such as droughts, floods and hail are significant and both their intensity and frequency are expected to further increase as a result of climate change. During the period 1984-2006, Moldova's average annual economic losses due to natural disasters were about US$61 million, or 2.13 percent of national GDP. More recent events have had a significant impact: the 2007 drought caused estimated losses of about US$1.0 billion; the 2008 floods cost the country about US$120 million.[95] The most recent floods in 2010 are estimated to have had an adverse economic impact on GDP of about 0.15 percent, with total damage and losses estimated at approximately USD 42 million. The floods primarily affected rural and agricultural regions of the country[96].

How this technology contributes to adaptation. Climate has become an urgent issue on the development agenda. There is a high degree of interest in the potential role of CI in agricultural adaptation to climate change. Climate change is expected to give rise both to changes in the average agro climatic conditions for growing different crops and to increases in the variability of weather, with more frequent or extreme weather events. Adaptation to these changes is built on actions to increase resilience and reduce risk (e.g. appropriate crops, varieties and cropping patterns; irrigation; and soil and farm management techniques). In spite of these actions, risks remain or will increase (particularly to extreme weather events). CI can support appropriate climate change strategies, but it should not be seen as a way to avoid taking proper adaptation measures; nor should CI be seen as replacing other measures that address the effects of climate change.

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[91] UNDP/Ministry of Environment (2011), Draft National Climate Change Adaptation Strategy of the Republic of Moldova. Chisinau, 2011. 73 p. (see it available on: http://www.clima.md/lib.php?l=en&idc=237)..

[92] UNEP/Ministry of Environment and Natural Resources (2009), Second National Communication of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Chisinau, 2009. – 316 p.

[93] UNDP (2010), National Human Development Report, 2010/2011. Republic of Moldova from Social Exclusion towards Inclusive Human Development. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf).

[94] Namely 20 Central and Eastern European (CEE) and Commonwealth of Independent States (CIS) countries.

[95] World Bank, "Project Appraisal Document on a Proposed Credit to the Republic of Moldova for a Disaster and Climate Risk Management Project", July 6, 2010.

[96] Government of the Republic of Moldova. "Post Disaster Needs Assessment, Floods 2010." Supported by the European Union, the United Nations, and the World Bank, with the support of the Global Facility for Disaster Reduction and Recovery (GFDRR), 2010.

Republic of Moldova

Background. Moldova was a part of the Soviet Union until 1991. The subsidized agricultural insurance system was available in the whole country. Agricultural insurance was offered on mandatory basis by the state Insurance company "Gosstrakh". After the independence of the country, the agricultural insurance almost stopped.

In 2004 the national parliament adopted a Law on Agricultural Insurance. Subsidized agricultural insurance was implemented in 2005. The law defines the basic features of the subsidized agricultural insurance, including the premium subsidies. The farmers pay only their share of the premium due on the insurance policy. The rest is paid by the government directly to the insurance companies.

In practice the insurers receive the subsidized share of the premiums from the government within 2 to 3 weeks after the sales of the contracts (4-week term is established by the Law on Agricultural Insurance). The government subsidizes premiums on most crops, fruits, vegetables, and grapes. Livestock insurance is also subsidized.

Agricultural Insurance Products Available. The Republic of Moldova's insurance companies at the moment offer named-peril (NPCI) and multi-peril crop insurance (MPCI) products for additional information and description see (Annex A: Table 1 and Box 1). Farmers can choose the perils to be covered by the subsidized MPCI contract. The MPCI product differs from the traditional understanding of MPCI insurance because the farmer can select the list of perils covered.

MPCI that indemnifies yield losses on an individual farm basis is subject to problems of adverse selection (the highest risk farmers insuring) and moral hazard (farmer influence over yield-based loss assessment, which is difficult for the insurer to control). High administrative and loss adjustment costs are incurred in operating MPCI. It requires significant investment in monitoring farm yields to prevent higher payments than those losses actually incurred by the farmer. Furthermore, MPCI has large correlated risks, so it is exposed to extremely high potential claims in adverse years. International reinsurers are reluctant to provide reinsurance for MPCI, particularly for new and unproven programs, and if available**,** costs are high. Experience internationally indicates that it is technically extremely difficult to insure farm-level crop yields from losses caused by any number of natural perils. Massive and unsustainable levels of government subsidies may be needed to support multiple peril crop insurance[97].

Implementation assumptions

Agricultural Insurance Market Structure
Subsidized agricultural insurance is offered only by private insurance companies. Currently, two companies participate in the program, but the biggest market share for last 5 years (about 75%) belongs to the MOLDASIG insurance company (Annex A: Figure 1). The insurers offer both crop and livestock insurance services. Data on voluntary unsubsidized agricultural insurance is insignificant.

Delivery Channel
Insurance agents are the main delivery channels. Insurance brokers are the second most important delivery channel. Banks and other finance institutions as delivery channels are marginal. There are no specific organizations in the Republic of Moldova for delivering agricultural insurance services to small and marginal farmers.

Voluntary vs. Compulsory Insurance
Crop and livestock insurance in the Republic of Moldova is voluntary. There are no mandatory requirements on agricultural insurance though the financial institutions might require insurance policy as collateral**.**

Types of Public Support for Agricultural Insurance

The Government of the Republic of Moldova subsidizes agricultural insurance premiums. The premium subsidy in 2011 was 60% of the OGP premium for perennial crops, sugar beet and vegetables. For insurance of other crops as winter wheat, barley, sunflower, maize, soybean, winter rape and livestock premium subsidies were 50%. The farmer should pay his share of the insurance premium when the insurance contract is signed. The rest of the premium is paid by the Government directly to the insurance company. The insurance premium paid on agricultural insurance contracts is exempt from taxes.

Benefits

Economic. Crop insurance is additional mechanism for the management of the risks associated with random yield shocks once all cost-effective risk mitigation strategies have been implemented; and disaster assistance effort. Although, as a rule insurance multi-peril schemes are not sustainable without heavy government subsidies

[97] WB Report, 2007. Rural Productivity in Moldova – Managing Natural Vulnerability. 23 May 2007, p.107.

Environmental. "Resilient is the flip side of vulnerability - a resilient system or population is not sensitive to natural hazards, climate variability and change and has the capacity to adapt"[98] ;[99]. or more precisely: "Resilience is the capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures." [100]

Assist to constructing a resilient to climate change social-environmental system capable of anticipating, adapting to and coping with uncertainties and unexpected extreme events without losing its sustainable stability, performance and regenerative ability.

Social. Access to formal risk financing instruments, such as insurance, can help farmers transfer excessive losses to a third party (such as an insurance company), thus stabilizing household income, facilitating their access to credit, and ultimately enhancing their livelihoods.

Other considerations and costs provided in the annexed TFS.

4.2 Criteria and process of technology prioritization

The technology prioritization was done according to the guidance provided during Bangkok training workshop (8-11 August, 2011), also using TNA Handbook and Multi-criteria analysis manual[101] and applying **Multi Criteria Decision Analysis.** During technology evaluation, the working group panel led by team leader applied the main 8 steps of MCDA (table 4.2-1).

Table 4.2-1 MCDA steps applied in technology assessment in Agriculture sector.

1	**Establish the decision context.**
	1.1 Establish aims of the MCDA, and identify decision makers and other key players.
	1.2 Design the socio-technical system for conducting the MCDA.
	1.3 Consider the context of the appraisal.
2	**Identify the options to be appraised.**
3	**Identity objectives and criteria.**
	3.1 Identify criteria for assessing the consequences of each option.
	3.2 Organise the criteria by clustering them under high-level and lower-level objectives in a hierarchy.
4	**'Scoring'. Assess the expected performance of each option against the criteria. Then assess the value associated with the consequences of each option for each criterion**
	4.1 Describe the consequences of the options.
	4.2 Score the options on the criteria.
	4.3 Check the consistency of the score on each criterion.
5	'**Weighting'. Assign weights for each of the criterion to reflect their relative importance to the decision.**
6	**Combine the weights and scores for each option to derive an overall value.**
	6.1 Calculate overall weighted scores at each level in the hierarchy.
	6.2 Calculate overall weighted scores.
7	**Examine the results.**
8	**Sensitivity analysis.**
	8.1 Conduct a sensitivity analysis: do other preferences or weights affect the overall ordering of the options?
	8.2 Look at the advantages and disadvantages of selected options, and compare pairs of options.
	8.3 Create possible new options that might be better than those originally considered.
	8.4 Repeat the above steps until a 'requisite'model is obtained.

[98] IPCC, 2001

[99] Thywissen, K. (2006): Components of Risk. A Comparative Glossary. SOURCE No.2/2006. UNU-EHS, Bonn.

[100] UN/ISDR (United Nations International Strategy for Disaster Reduction) (2004): Living with Risk. A Global Review of Disaster Reduction Initiatives. 2004 version. United Nations, Geneva, p. 430.

[101] Multi-criteria analysis: a manual. Department for Communities and Local Government, UK. 2009

Establishment of the decision context

The process of criteria and indicators identification was highly participatory, involving all TNA working group participants: stakeholders and experts. Stakeholders from governmental institutions, NGOs and private sectors, national consultants participated in the development of national criteria and their components (set of indicators) used in technological appraising.

As a result of expert judgment and key-stakeholders consultation process, it was agreed that the main considerations against which the criteria would be judged and included in the evaluation matrix are:

a) to correspond to National Development Priorities;

b) to correspond to Republic of Moldova MDGs;

c) to maximize country's social, economic and environmental benefits;

d) to contribute to the enhancement of sector's adaptation potential to climate change;

e) to contribute to sector's resilience to drought as one of the main aggressive climate factor affecting Moldova.

Identification of the criteria and indicators

A number of indicators have been proposed by experts and discussed with stakeholders during the two meetings and virtual sessions, e-mails exchanging. A final set of criteria and indicators was developed for each Agriculture criteria for ranking technology options.

During the meetings and discussions on the identification and selecting of the indicators, participants presented their arguments when proposing the criteria. The team leader assured each working group member to expresses his opinion, brings arguments, justification for proposed criteria. During these discussions both experts' and stakeholders' opinions, their judgmental arguments were considered. A focus aspect during technological prioritization was consideration of national development priorities, along with specific aspects of the sector.

Each proposed criterion and indicator was analyzed in the context of specific challenges the sector has to face during climate change time. Participants have discussed the problems of drought, floods, soil erosion, crop breeding, livestock breeding and other issues imposed by climate variability and climate change and each indicator significance in the context of a specific issue.

Participants in the adaptation technologies prioritization have paid attentions to all criteria built into the Performance Matrix: costs, that are of major importance in the current context of Moldova's economy, and benefits, that are important nowadays, but most important for building sustainable environment in a future changing climate. Experts and stakeholders came to the agreement the following criteria and indicators to be used in the current technology assessment with supportive arguments:

a) **Costs**. Implementation of one technology or multiple technologies whether at a large or even at a small scale, involves significant expenditures. Initial investments costs necessary to set up the system and then the expenses to operate and maintain the system make this criterion highly important. The costs vary widely depending on the magnitude and complexity of technology, estimating the total cost of implementing a particular technology is complicated by differences in the types and available features of the systems now being sold. The working group commonly agreed, that costs (broken into capital costs and O&M costs) is a criterion of a major importance for technological implementation in the current economic conditions of Republic of Moldova.

b) **Economic benefits.** Introduction of new crops, livestock, improved irrigation system, land resources management; other technical measures are seen as new opportunities for economic growth of the sector, along with employment opportunities, possibilities to extend agri-prodcuts market. Economic development is of paramount importance for country's resilience to climate change.
The set of indicators considered under criteria economic benefits consists of: *climate resilience and market potential, employment and poverty alleviation, higher value agricultural development.*

c) **Environmental** benefits were considered in relation to specific climatic impact on Agriculture sector of Moldova. Working group members have stressed the need to take immediate actions in order to address current environmental problem facing the sector in order to increase whole country adaptive capacity to future climate change. After proposing a large number of environmental indicators that could be considered under criteria environmental benefits, the group came to the agreement the following set of indicators is relevant to the specific problems country faces in relation to climate change impact: enhancing soil quality, decreasing natural resources consumption, reducing negative impact to local environment.

d) **Social benefits** were identified after considering possible impact of future technical options implementation and social levels where environmentally sound technologies will bring the highest benefits. Working group members took into account country's specific social problems such as unemployment, poverty, particularly among rural communities and came to the conclusion to have the following set of indicators included: ***contribution to national development priorities, increased community well fare, increased labor efficiency.***

e) **Adaptation potential.** Technology assessment participants have brought up the importance of improving soil quality, soil management, water use efficiency and changing crop varieties as top adaptive measures in Agriculture sector. Extensive breeding and testing programs may be necessary to identify cultivars and breeds appropriate to changing local conditions.

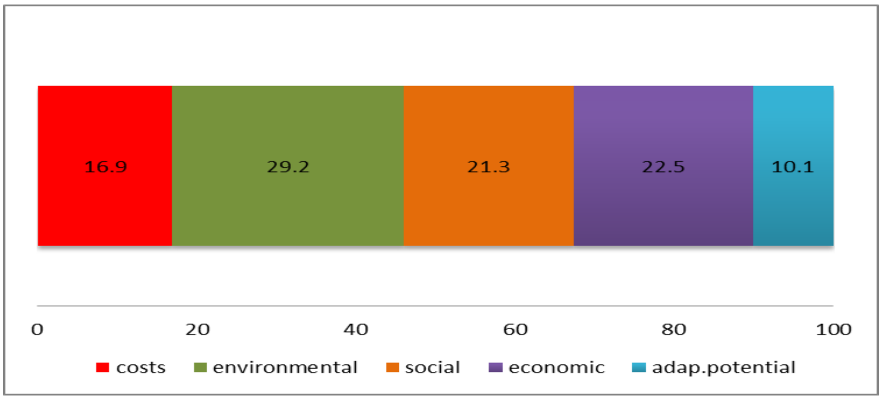


Fig. 4.2-1 By weight criteria contribution chart bar in the technology prioritization of the Agriculture sector

By weight criteria contribution char bar (fig.4.2-1) indicates a balanced contribution of each criterion, with more attention paid by sectoral working group to environmental benefits.

The objective, criteria and indicators were organized by clustering them under different levels of hierarchy as presented in the Hierarchy Value Tree (fig 4.2-2), this way facilitating the scoring of technological options. The objective has been clustered under top level hierarchy, costs as main inputs and benefits as main outputs, one level lower separated one versus another. Under benefits were placed criteria, each criterion broken down into indicators. The whole process was open, transparent and group members driven.

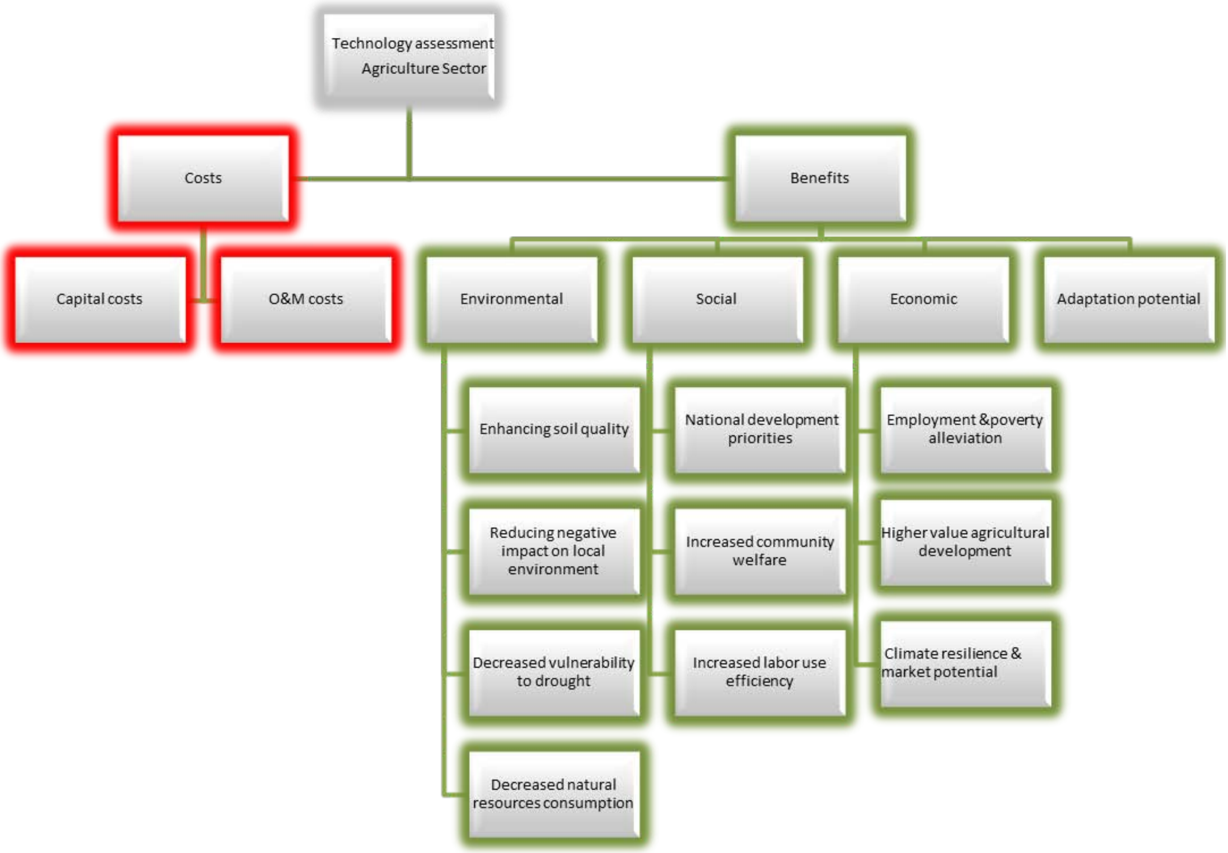


Fig. 4.2-2 Hierarchy value tree of Agriculture sector in the technological assessment

Technology prioritization

Technology options have been elaborated as Technological Fact Sheets format (provided during Bangkok training workshop 8-11 August, 2011) and their e-versions circulated among working group members. This way the stakeholders and experts (other than the one elaborating technology), acquired information about the potential technologies. During the working group meetings, each technology has been characterized by the expert and unknown details clarified and discussed with stakeholders. For some technologies the authors presented many details such as technology efficiency, technical measurements, capacity factors and lifetime, degree of technical sophistication required for manufacturing, installation and operation, information on reliability.

For the Agriculture sector, the technologies were assessed separately, according to each category: a) small scale/short term; b) small scale/medium-long term, c) large scale/short term; d) large scale/medium -long term. This categorization assured a correct approach in comparing different scales and implementation time framework technologies.

After reaching the common sense regarding the set of criteria and indicators, each technology from the Long List was considered. Some technologies have been rejected by the working group, the main reason being not sufficiently elaborated and not convincingly presented, the expert giving preferences to other technologies. Several rounds of discussions, intensive e-mails exchanging took place until the Final Long List of selected technologies within each category was established. These technologies were organized into Performance Matrixes and during the working group meeting assessed against each indicator, giving the points, based on 1-10 sale to convert qualitative judgment into quantitative.

Scale used: 1,2-weakly important; 3,4-less important; 5,6-moderately important; 7,8-important; 9,10-extremely important.

The technologies were ***evaluated using preference scores*** method, giving 0 (zero) value to the least preferred option and 100 to the most preferred one. The other options are scored relative to them. This exercise was used for each indicator, in four Scoring Matrixes.

After all options have been scored, the next step was ***assigning weight*** for each of the criteria indicator to reflect its relative importance to the decision. The scale of 0-100 was applied. Almost each criterion was discussed again when given the weight considering its contribution to climate change adaptation. There were no big disagreements in assigning the weight; the team leader negotiated the final value of the indicator, considering each member’s opinion. The stakeholder’s opinion was under special consideration at all stages of the assessment.

Overall weighted score was calculated for each technological option, as a result having the overall value of benefits for each technology. The process of scoring and weighting was repeated for each category, the results presented in the Scoring Matrix.

Costs/benefits analysis was used to find the least costly adaptation technologies in each category, as in Moldova’s economic constrain the implementation of new technologies are preferred to be done at the lowest costs.

In accordance with methodology provided during Bangkok training workshop, the **total costs** were broken down into **capital costs and operational & maintenance costs.** The final value was taken based on costs-to –benefits ratios of the technology options. The costs/benefits graph of each category was the final output of the calculation based on original inputs of working group members.

For the category Small Scale/Short Term we will provide the main three components of evaluation techniques:

1) Performance Matrix (table 6.3-1); 2) Scoring Matrix (table 6.3-2), 3) Costs/Benefits analysis table (4.3-3), costs-benefits relationship between ranked technologies (fig. 6.3-2) and criteria contribution chart bar (fig.4.3-3). Because of the similarity in the procedure, for other categories, we will present only the final step of evaluation -Costs/Benefits analysis graphs and criteria contribution chart bars. The names of adaptation technologies would be shortened in the matrixes and graphs with the purpose of reducing their length.

4.3 Results of technology prioritization, Agriculture Sector

Table 4.3-1 Performance Matrix of Small Scale/Short Term category technologies

Performance Matrix

			Costs			Benefits										
						Environmental				Social			Economic			Adaptation potential
No.	Technology Option	Taken for scoring	Total costs	Capital Costs (Infrastrures, Vehicles, etc.)	O & M Costs (plus fuel costs)	Enhancing soil quality	Decreased vulnerability to drought	Decrease natural resources consumption	Reducing negative impact to local environment	Contribution to national development priorities	Increased community wellfare	Increased labor use efficiency	Employment and poverty alleviation	Higher value agricultural development	Contribution to climate rezilience and market potential	Adaptation potential/Reduction of vulnerability
			euro	euro	euro											
1	Conventional tillage winter wheat	Yes	255,645,000	31,129,000	224,516,000	5	5	4	4	5	6	5	5	6	5	6
2	Conventional tillage sunflower	Yes	69,292,000	13,858,400	55,433,600	5	4	4	5	6	5	4	4	4	4	4
3	Conventional tillage sugar beet	Yes	51,975,000	10,395,000	41,580,000	6	6	5	6	6	7	6	6	7	6	6
4	Anthers culture and *in vitro* pollen grain technology	Yes	24,000	19,000	5,000	7	6	6	6	7	6	7	7	9	8	8
5	Genotype propagation using *in vitro* tissue culture	Yes	34,965	27,315	7,650	7	8	6	6	6	6	7	6	6	7	8
6	Alternative strips crop cultivation	Yes	1,200,000	800,000	400,000	7	6	5	6	6	6	4	5	7	7	7
7	In depth fissuring at 30-5 cm		9,800,000	5,800,000	4,000,000	7	7	4	6	6	6	5	6	6	6	7
	Lowest value Preferable **(Y or N)**		Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N

1,2-Weakly important; 3,4-less important; 5,6-moderately important; 7,8-important; 9,10-extremely important

Republic of Moldova

Table 4.3-2 Scoring Matrix of Small Scale/Short Term category technologies, Agriculture Sector

Scoring Matrix

No.	Technology Option	Total costs	Costs: Capital Costs (Infrastrures, Vehicles, etc.)	Costs: O & M Costs (plus fuel costs)	Benefits – Environmental: Enhancing soil quality	Benefits – Environmental: Decreased vulnerability to drought	Benefits – Environmental: Decrease natural resources consumption	Benefits – Environmental: Reducing negative impact to local environment	Benefits – Social: Contribution to national development priorities	Benefits – Social: Increased community wellfare	Benefits – Social: Increased labor use efficiency	Benefits – Economic: Employment and poverty alleviation	Benefits – Economic: Higher value agricultural development	Benefits – Economic: Contribution to climate rezilience and market potential	Benefits – Adaptation: Adaptation potential/Reduction of vulnerability	Total
	Normalized Weights		9.0	7.9	7.9	9.0	5.6	6.7	10.1	5.6	5.6	7.9	6.7	7.9	10.1	100.0
1	Conventional tillage winter wheat		0.0	0.0	0.0	25.0	0.0	0.0	0.0	50.0	33.3	33.3	40.0	25.0	50.0	19.3
2	Conventional tillage sunflower		55.5	75.3	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	19.3
3	Conventional tillage sugar beet		66.6	81.5	50.0	50.0	50.0	100.0	50.0	100.0	66.7	66.7	60.0	50.0	50.0	63.1
4	Anthers culture and in vitro pollen grain technology		100.0	100.0	100.0	50.0	100.0	100.0	100.0	50.0	100.0	100.0	100.0	100.0	100.0	92.7
5	Genotype propagation using in vitro tissue culture		100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	100.0	66.7	40.0	75.0	100.0	83.5
6	Alternative strips crop cultivation		97.5	99.8	100.0	50.0	50.0	100.0	50.0	50.0	0.0	33.3	60.0	75.0	75.0	66.5
7	In depth fissuring at 30-5 cm		81.4	98.2	100.0	75.0	0.0	100.0	50.0	50.0	33.3	66.7	40.0	50.0	75.0	65.6

Swing Weighting

	Total costs	Capital Costs	O & M Costs	Enhancing soil quality	Decreased vulnerability to drought	Decrease natural resources consumption	Reducing negative impact to local environment	Contribution to national development priorities	Increased community wellfare	Increased labor use efficiency	Employment and poverty alleviation	Higher value agricultural development	Contribution to climate rezilience and market potential	Adaptation potential/Reduction of vulnerability	Total	
Most preferred option	Anthers culture and in vitro pollen grain technology	Anthers culture and in vitro pollen grain technology	Anthers culture and in vitro pollen grain technology	Anthers culture and in vitro pollen grain technology	Genotype propagation using in vitro tissue culture	Anthers culture and in vitro pollen grain technology	Conventional tillage sugar beet	Anthers culture and in vitro pollen grain technology	Conventional tillage sugar beet	Anthers culture and in vitro pollen grain technology	Anthers culture and in vitro pollen grain technology	Anthers culture and in vitro pollen grain technology	Anthers culture and in vitro pollen grain technology	Anthers culture and in vitro pollen grain technology		
Least preferred option	Conventional tillage winter wheat	Conventional tillage sunflower	Conventional tillage winter wheat	Conventional tillage winter wheat	Conventional tillage sunflower	Conventional tillage winter wheat	Conventional tillage winter wheat	Conventional tillage winter wheat	Conventional tillage sunflower	Conventional tillage sunflower	Conventional tillage sunflower	Conventional tillage sunflower	Conventional tillage sunflower	Conventional tillage sunflower		
Weight		80	70	70	80	50	60	90	50	50	70	60	70	90		890

Table.4.3-3 Costs benefits analysis of Small Scale/Short Term category technologies

No.	Technology Option	Costs (euro)	Development benefits
1	Conventional tillage winter wheat	255,645,000	22
2	Conventional tillage sunflower	69,292,000	9
3	Conventional tillage sugar beet	51,975,000	57
4	Anthers culture and în vitro pollen grain technology	24,000	85
5	Genotype propagation using in vitro tissue culture	34,965	75
6	Alternative strips crop cultivation	1,200,000	56
7	In depth fissuring at 30-35 cm	9,800,000	57

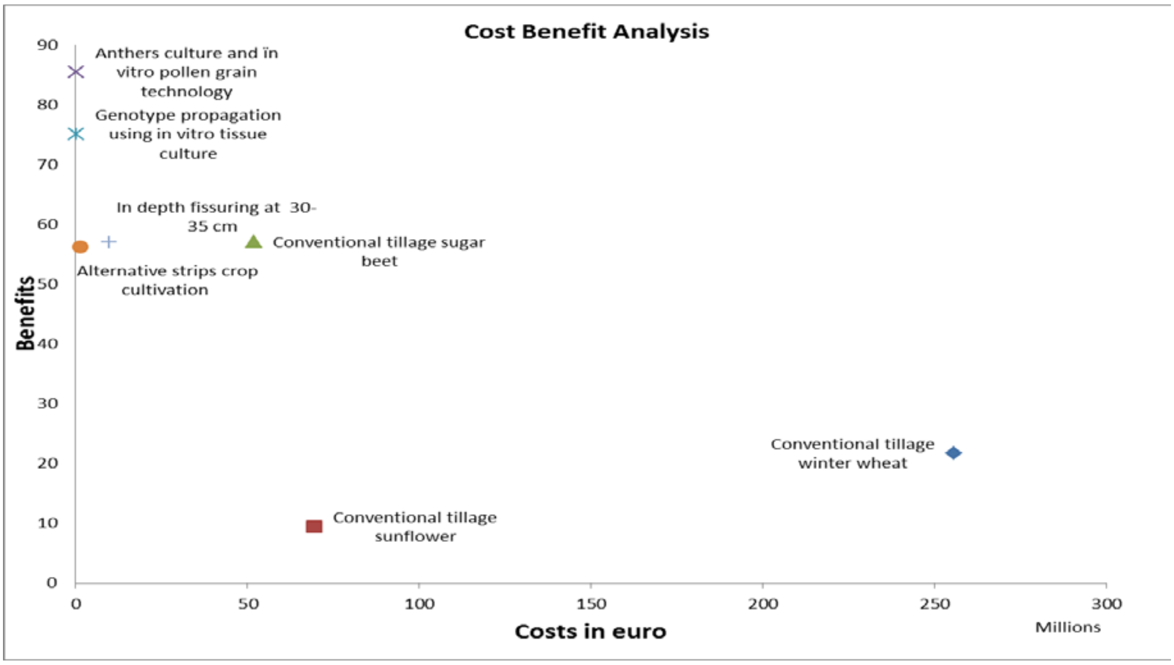


Fig. 4.3-2 Costs benefits ranking of Small Scale/Short Term category technologies

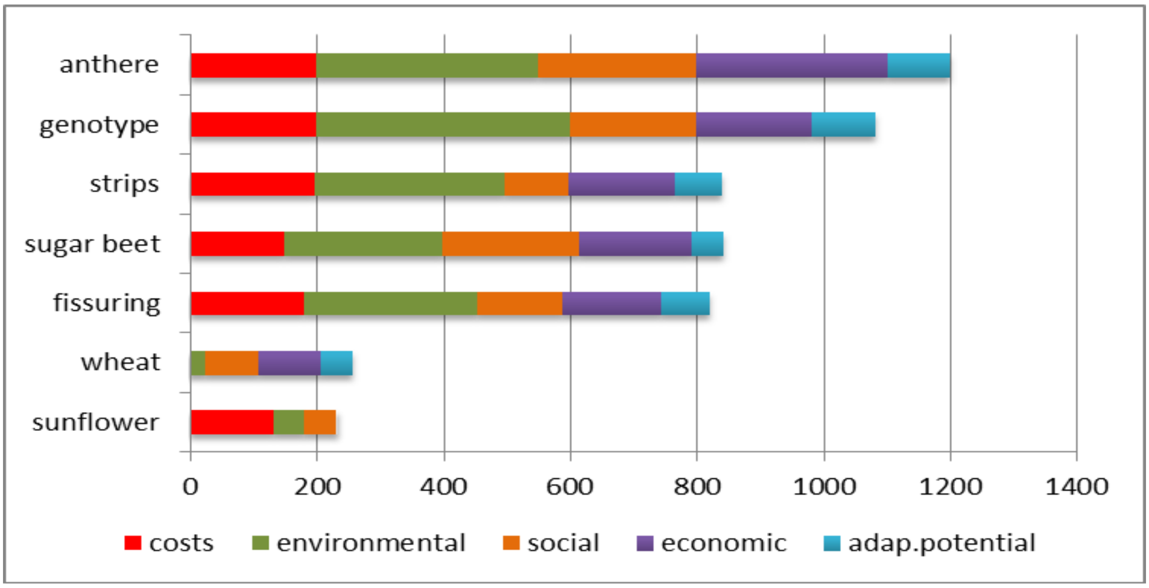


Fig. 4.3-3 By scoring criteria contribution chart bar in technology prioritization of Agricuture sector, Small Scale/Short Term category.

Table 4.3-4 Costs benefits analysis of Small Scale/Medium-Long Term category technologies

No.	Technology Option	Costs (euro)	Development benefits
1	Semi-intensive system of animal production	5,500,000,000	17
2	Intensive system of animal production	7,500,000,000	53
3	Agriculture soils fertilisation with manure	24,404,000	34
4	Vetch field into 5year crop rotation	9,800,000	28

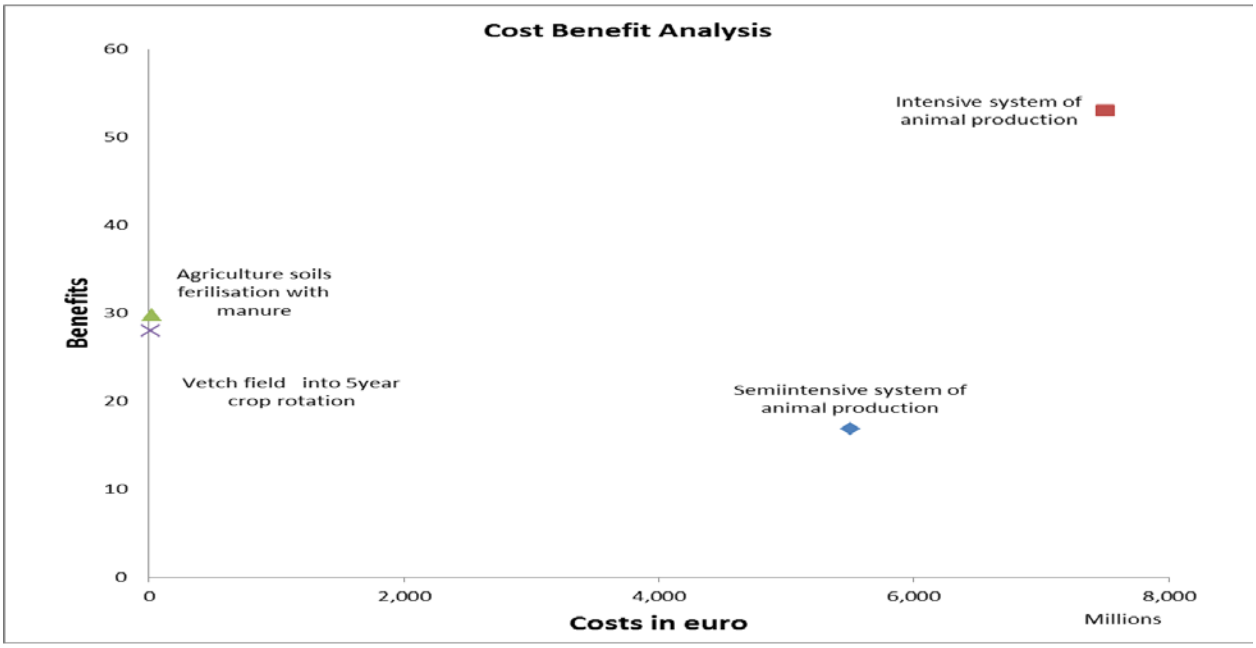


Fig. 4.3-4 Costs benefits relationship of Small Scale/Medium-Long Term category technologies

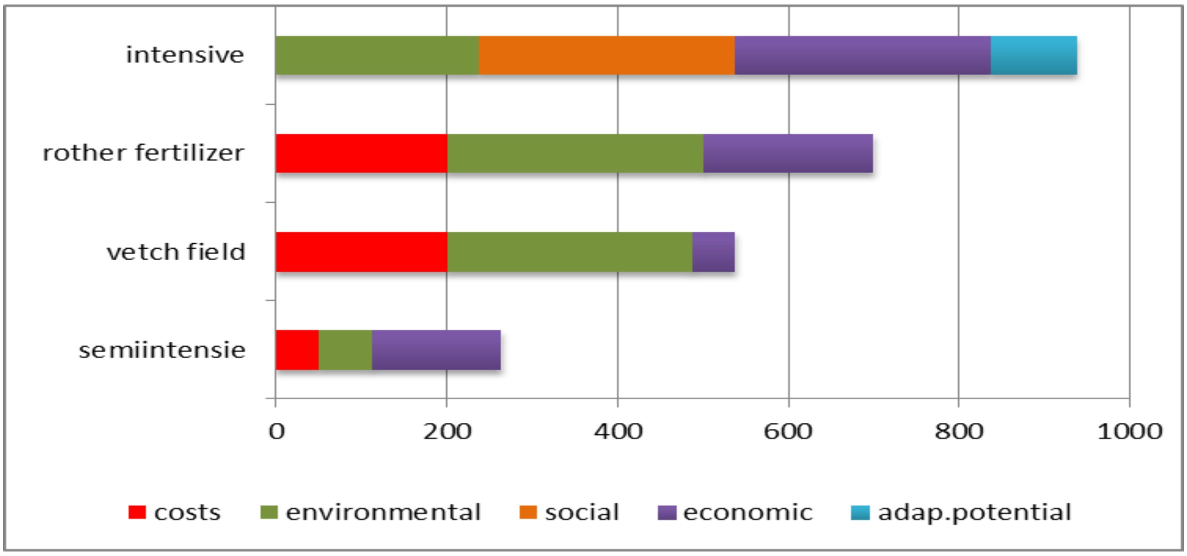


FIg. 4.3-5 By scoring criteria contribution chart bar in technology prioritization of Agricuture sector, Small Scale/ Medium-Long Term category

Table 4.3-5 Costs benefits analysis of Large Scale/ Short term category technologies

No.	Technology Option	Costs (euro)	Development benefits
1	Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus	6,709,375	92
2	Conservation tillage with herbicides winter wheat	132,685,000	38
3	Conservation tillage with herbicides sunflower	60,809,000	35
4	Conservation tillage with herbicides sugar beet	50,764,000	43
5	Extensive system of animal production	2,000,000,000	15
6	Agricultural Insurance	6,625,000	45
7	Vetch field as successive green fertilizer in crop rotation	11,620,000	40
8	Five fields classic crop rotation +vetch	34,020,000	8

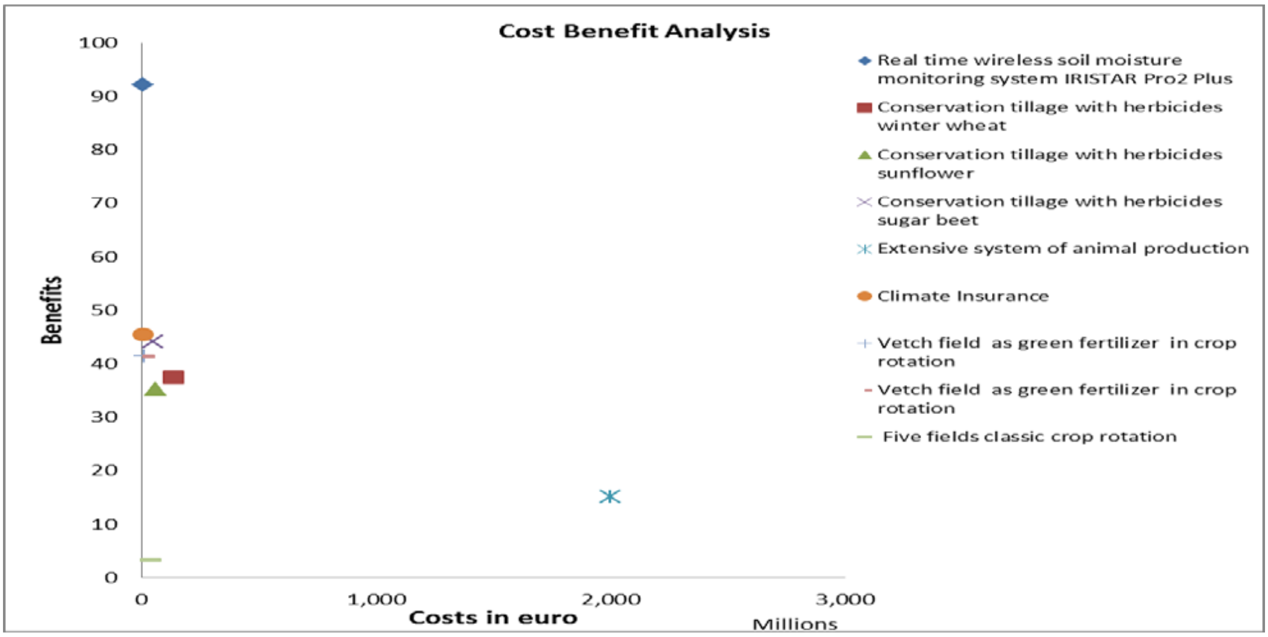


Fig. 4.3-6 Costs benefits relationship of Large Scale/ Short term category technologies

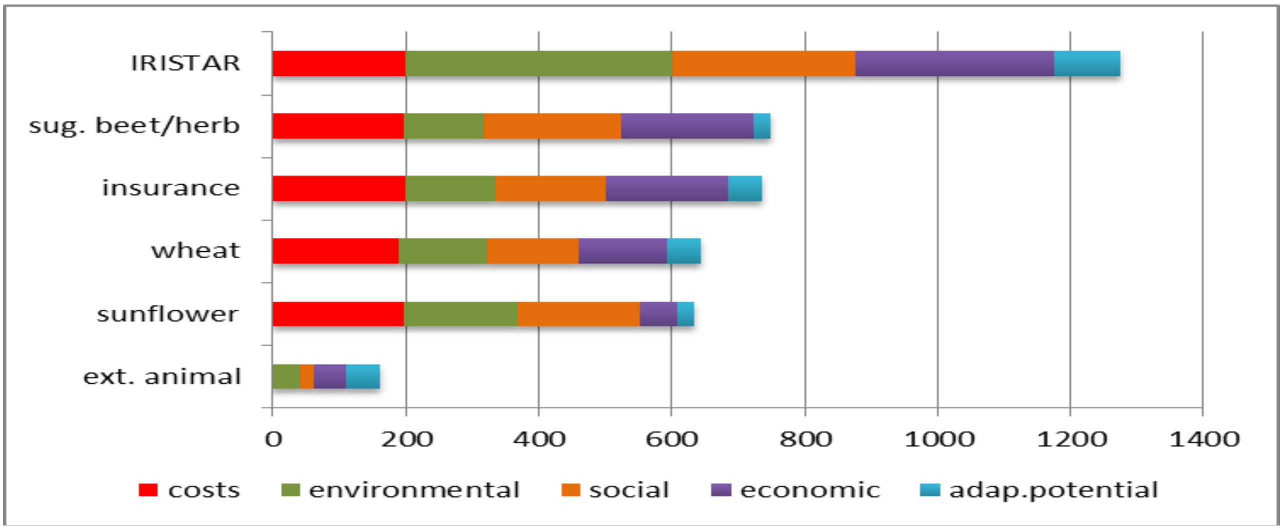


Fig. 4.3-7 By scoring criteria contribution graph in technology prioritization of Agricuture sector, Large Scale/ Short Term category

Table 4.3-6 Costs benefits analysis of Large Scale/ Medium-Long term category technologies

No.	Technology Option	Costs (euro)	Development benefits
1	Improved low pressure and water serving Sprinkler Irrigation technologies	219,780,000	60
2	Construction of new and proper maintenance of existing dams and water reservoirs	182,500,000	44
3	Low-flow, low- pressure and water serving Drip Irrigation	169,880,000	64
4	Conservation tillage without herbicides wheat	110,565,000	75
5	Conservation tillage without herbicides sunflower	60,690,000	13
6	Conservation tillage without herbicides sugar beet	50,729,000	56
7	High adaptation potential hybrids technologies	319,000	38
8	Mini-till system and vetch as successive plant	32,670,000	32
9	No-till system and vetch as successive plant	32,400,000	34

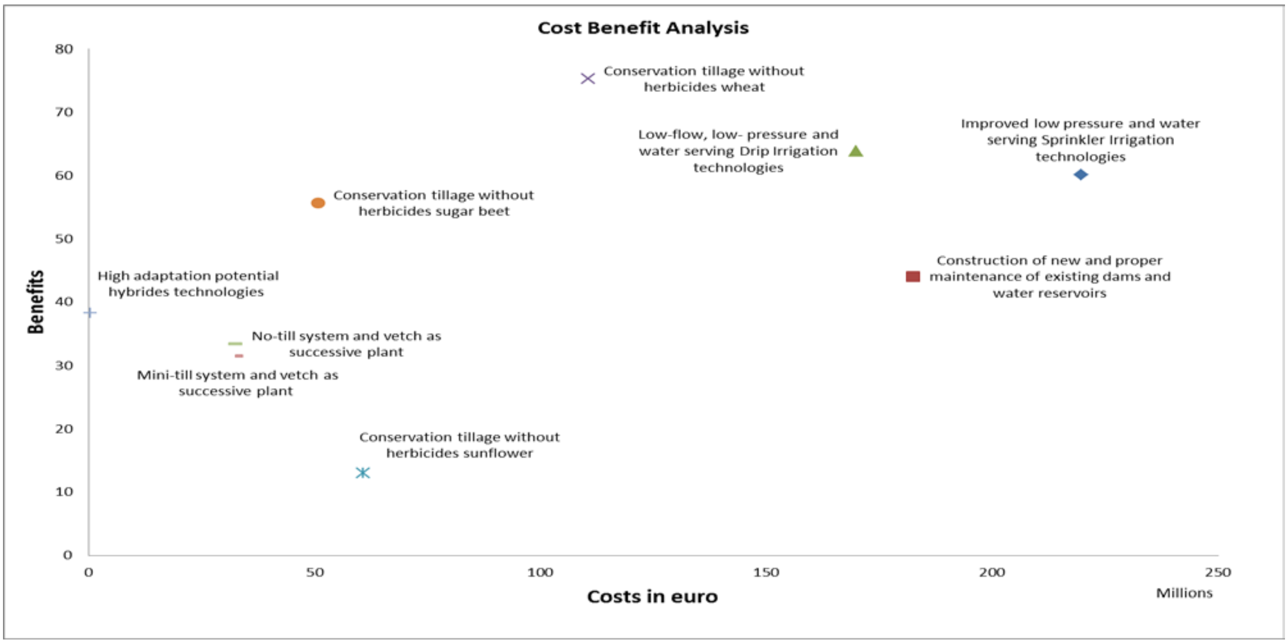


Fig. 4.3-8 Costs benefits relationship of Large Scale/ Medium-Long term category technologies

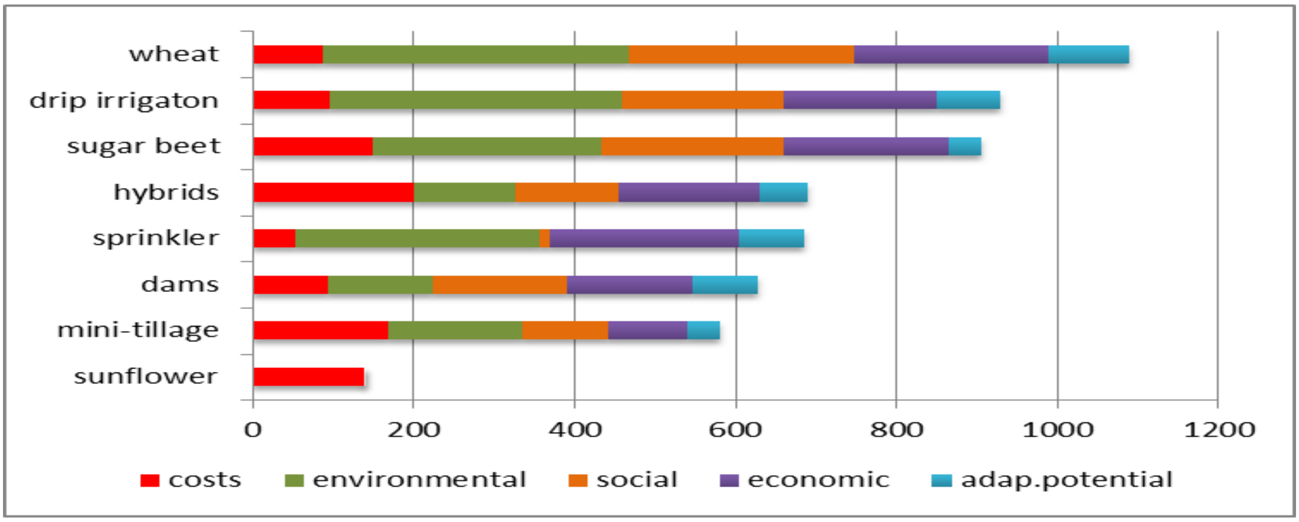


Fig. 4.3-9 By scoring criteria contribution chart bar in technology prioritization, Large Scale/ Medium-Long Term category

Costs/benefits analysis was carried out for each technology option. The outputs from costs/benefits analysis are the four graphs, one per each category of technology. The working group members have expressed their opinions in relation to ranked technological options and agreed on the Short List of technologies. Costly technologies are to be implemented only if climate change damages turn out to be extremely high. Excluding animal breeding technologies from the Short List does not make them less important.

Table 4.3-7 The Short List of adaptation technologies identified and categorized for Agriculture sector

		Adaptation Technologies	Scale of application	Short, medium, long term availability
AGRICULTURE		**Small scale/Short term**		
	1	Plants breeding based on anthers culture and *in vitro* pollen grain technology	Small scale	Short term
	2	High value genotype propagation using *in vitro* tissue culture	Small scale	Short term
		Small scale /Medium-Long term		
	1	Applying of 50 t/ha of manure with bedding to agricultural soils once in five years (Agriculture fertilization with manure)	Small scale	Long term
	2	Vetch field as green fertilizer into 5- year crop rotation	Small scale	Long term
		Large scale/ Short term		
	1	Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus	Large scale	Short term
	2	Agricultural Insurance	Large scale	Short term
		Large scale/ Medium-Long term		
	1	Conservation tillage without herbicides wheat	Large scale	Long term
	2	Technologies for breeding hybrids with high adaptation potential to meteo-indicators	Large scale	Medium term

The shortlisted technologies of the Agriculture sector are in line with national sustainable development priorities of Republic of Moldova and government plans and policies in agriculture development. The portfolio of prioritized technologies in the Agriculture sector consists of eight technologies, two per category: the favored technology and the next to favored technology. The results are sown in the table 4.3-7.

In the **Small scale/Short term** category the two top technologies are in Plant Biotechnology area, one of the most needed but not well developed in the Republic of Moldova. Implementation of these technologies should have scientific support, yet, their implementation would bring economic, environmental and social benefits in the sector.

In the category **Small scale /Medium-Long term** the two selected technologies are from Agriculture Soils area, one of the most vulnerable areas of Agriculture sector. As mentioned in the description of these technologies, they may bring many benefits within medium term time.

In the category **Large scale/ Short term the** three top technologies are from the areas: Agriculture Irrigation, Climate Insurance domain and Crop production. It was decided to include three adaptation technologies due to the fact that the last two differ only by 1 point, with little significance. Considering drought as one of the main climate threat for Moldova, irrigation technologies in the Agriculture sector are crucial and their implementation highly needed. The second technology is related to climate insurance and proposes to implement named-peril (NPCI) and multi-peril crop insurance (MCPI) and index based insurance. The implementation of crop and livestock insurance would be of great support to local farmers in the adverse years. The third technology relates to the production of one of the main crop in Moldova, sugar beet. Improvements in this technology would bring considerable social and economic benefits.

In the category **Large scale/ Medium-Long term** the top technology refers to Crop Production area and Soil improvement, conservation system of soil tillage without herbicides for winter wheat technology based on whole farming system, using environmentally friendly technology with high contribution to environment sustainability. The second technology is in Crop selection area and proposes improvements in the breeding programs of the most spread crops in Moldova for selecting hybrids with high adaptation potential to meteo-indicators.

Sensitivity analysis

The results of prioritizing process were sent to all working group members in order to review the assessment. In the sensitivity analysis exercise the working group did not change assessment criteria, considering them correctly identified and elaboratelly constructed by apropriate indicators. Presumably, due to te fact that both criteria and indicators have been largerly disussed, there were no disagrements during sensytivity analisys.

The working group has been asked to come with propositions regarding uncertainties in the inputs: given points in the scoring exercise and weights to criteria indicators and comments regarding changes. Their opinions have been discussed during the meeting of the working group.

In the sensitivity analysis was proposed to adopt the model of **reducing weight given to costs**, as most plausible situation. Considering Moldova's potential for economic growth, we can adopt the scenario, when the country has rapid or medium pace of economic development. In the current assessment costs were of high importance, as country has limited economic potential, that is why the stakeholders and experts commonly agreed to give the weight of 80% to capital costs and 70% to operational and maintenance costs on 0-100% scale. This weight was considered in the costs/benefits analysis and ranked the technological options in the ways presented in the costs/benefits graphs for each category. In the sensitivity analysis exercise the group has reduced the weight by 50% from original value, giving to capital costs 40% and O&M costs 35% however, this reduction did not bring significant changes in the ranking of technological options of any category. Further reduction of costs to 20% and respectively 10 % had no impact on the technological ranking for any of categories.

The plot of the graph represents the ranking of the technologies of Small Scale /Short Term category with 20% to capital costs and 10% to O&M costs, which is not radically different form the original graph.

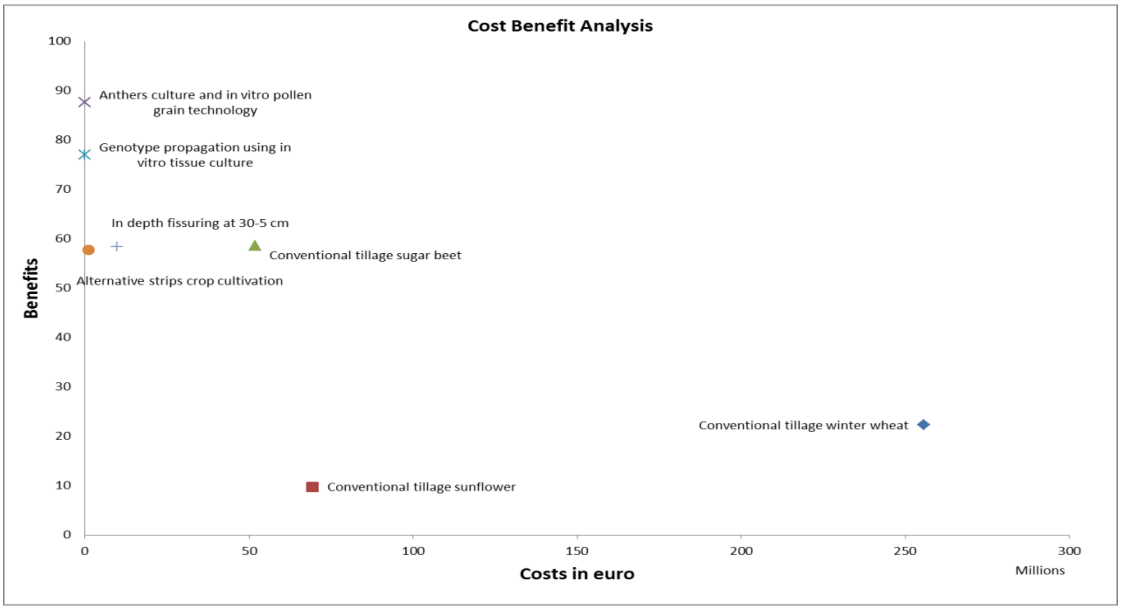


Fig. 4.3-10 Cost-benefits analysis of Small Scale/Short Term category, Agriculture sector with reduced capital costs to10% and O&M costs to 20%

The templates used in the assessment have on the costs side only two indicators for adaptation technologies: capital costs and O&M costs, which are 16.9 % from the total 100% (fig.6.2-1). On the benefits side there are 11 indicators constituting 83.1% from the total. Even drastic changes of the costs weight cannot influence the ranking of appraised technologies, thus proving the rigidity of the system under a large variation of given weights.

Assigning **different points to benefits criteria** the working group adopted the optimstic scenario for some technologies, setting them higher values, assuming that there is potential for their improvement. The example bellow refferes to ***Vetch field as green fertilizer in crop rotation*** technology, from Large scale/Short term category. Considering the many benefits of applying green manure for maintaining and enhancing soil quality in Moldova, the working group has changed the original giving score to indicators as follows:

Enhancing soil quality 7→9
Decrease natural resources consumption7→9
Reducing negative impact to local environment 6→9
Contribution to national development priorities 6→8
Increased community welfare6 →7
Higher value agricultural development 6→9
Contribution to climate resilience and market potential6→9
Adaptation potential/Reduction of vulnerability7→8

Setting higher score to benefits criteria (41 →72) to *Vetch field as green fertilizer in crop rotation* technology, ranked it as next to the most preferred technology. This optimistic approach exercise was applied to all 4 categories for technologies identified with potential for improvement from climate change viewpoint.

Table 4.3-8 Costs benefits analysis of Large Scale/ Short term category technologies

No.	Technology Option	Costs (euro)	Development benefits
1	Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus	6,709,375	82
2	Conservation tillage with herbicides winter wheat	132,685,000	33
3	Conservation tillage with herbicides sunflower	60,809,000	31
4	Conservation tillage with herbicides sugar beet	50,764,000	39
5	Extensive system of animal production	2,000,000,000	13
6	Agricultural Insurance	6,625,000	40
7	Vetch field as green fertilizer in crop rotation	11,600,000	**72**
8	Five fields classic crop rotation	36,800,000	3

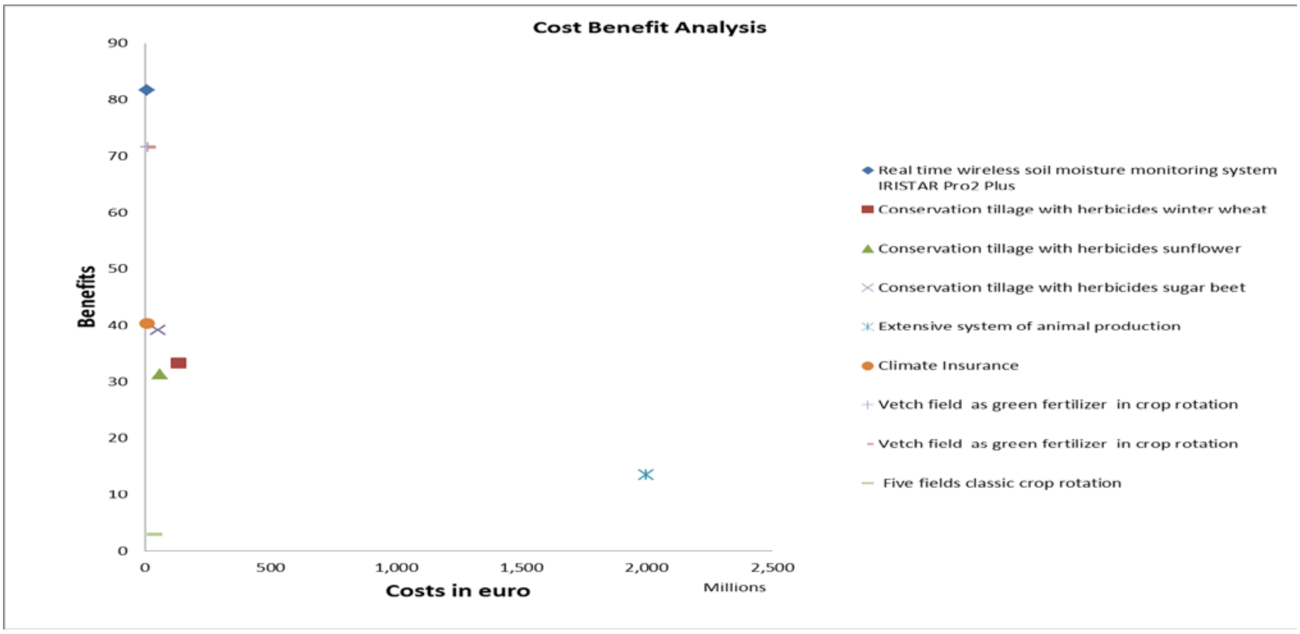


Fig.4.3-11 Costs-benefits relationship of Large Scale/ Short Term category technologies, optimistic scenario for technology #7

The example bellow (table 4.3-10) is the "optimistic scenario" for *Construction of new and proper maintenance of existing dams and water reservoirs* (Large scale/Long term category, table 4.3-11, fig 4.3-12) technology, the 44 benefit points in the original→51 benefit points in optimistic scenario. In this case, increasing the value of benefit scoring, moved up the technology on higher region of the benefits on the graph plot, but it was not enough to impact the ranking of technologies.

Table 4.3-9 Costs benefits analysis of Large Scale/ Medium-Long term category technologies

No.	Technology Option	Costs (euro)	Development benefits
1	Improved low pressure and water serving Sprinkler Irrigation technologies	219,780,000	59
2	Construction of new and proper maintenance of existing dams and water reservoirs	182,500,000	51
3	Low-flow, low-pressure and water serving Drip Irrigation technologies	169,880,000	64
4	Conservation tillage without herbicides wheat	110,565,000	75
5	Conservation tillage without herbicides sunflower	60,690,000	44
6	Conservation tillage without herbicides sugar beet	50,729,000	54
7	High adaptation potential hybrids technologies	319,000	35
8	Mini-till system and vetch as successive plant	32,600,000	29
9	No-till system and vetch as successive plant	32,400,000	31

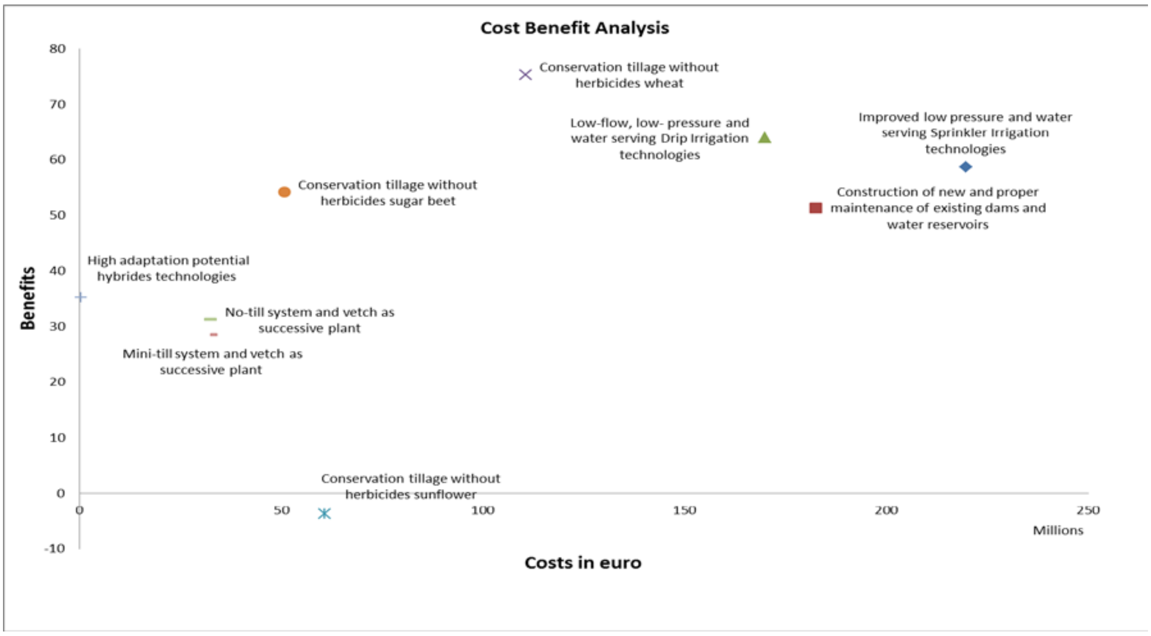


Fig.4.3-12 Costs-benefits relationship o Large Scale/ Medium-Long Term category technologies, optimistic scenario for technology #2

There were not many disagreements on giving higher scores; there were more discussions on which technology would have the potential for improvement, what advantages and disadvantages would be in future conditions of a new climate, other economic development, other circumstances then those considered originally.

The ranking graphs show a fairly consistent robustness under a large variation of given weights. When optimistic or pessimistic values of benefits substitute the original values for considered technology, the situation may change yet, not dramatically. Applying cost-benefits analysis in technological evaluation is appealing because it is possible to compare and/or aggregate many different categories of benefits or costs into a single value. However, because of the time within present TNA Project did not allow discussing more options, e.g. a mixture of optimistic and pessimistic scenario for considered technological options and their feasibility in the context of climate change scenario, economic and social development for Republic of Moldova.

If a software simulation of MCDA (including costs-benefits analysis) in conjunction with climate change scenario model could be applied, with more inputs considered, as outputs would be a more complex picture, including both advantages and disadvantages of each technology in concrete conditions of a particular climate change scenario.

The sensitivity analysis as part of MCDA used in the technological appraising for Agriculture sector is a way to test some perspectives that may occur under different climate scenario. This approach gives the opportunity to consider a multitude of options, not to be focused only to one relationship between technologies, as the environmental and social circumstances change, the importance of each technology may change too. It is a tool worth to be considered in the context of different climate change scenarios. In our case it helped us to identify robust performers for each category of technologies.

In the table 4.3-11, are presented the costs of the proitized technologies for 4 categories of Agricuture sector, along with their benefits measured in given points during scoring exercise. For some of them, the expets gave percentage of upscaling potential, while for other options was difficult to estmiate.
The chart bar of criteria contribution gives the understanding of signifiance of each criterion in the total score (fig.4.3-13).

Table 4.3-10 Summarizing table of prioritized adaptation technologies for Agriculture sector

	Technology	Costs	Benefits output from MCDA assessment	Up-scaling potential of the technology
	Small scale/Short term	euro	points	
1	Plants breeding based on anthers culture and *їn vitro* pollen grain technology	24 000	65	100% per year
2	High value genotype propagation using *in vitro* tissue culture	34 965	65	Up to 5 times
	Small scale /Medium-Long term			
1	Applying of 50 t/ha of manure with bedding to agricultural soils once per five years.	24 404 000	74	Depending on livestock sector development.
2	Vetch field as green fertilizer into 5 year crop rotation.	9 800 000	78	Significant
	Large scale/ Short term			
1	Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus.	6 709 375	62	24 th ha per year, up to 237.6 th ha in 2020 y.
2	Agricultural Insurance.	6 625 000	45	30%
	Large scale/ Medium-Long term			
1	Conservation system of soil tillage without herbicides for winter wheat.	11,565,000	85	20%
2	Technologies for breeding programs hybrids with high adaptation potential to meteoindicators.	319 000	63	50-67%

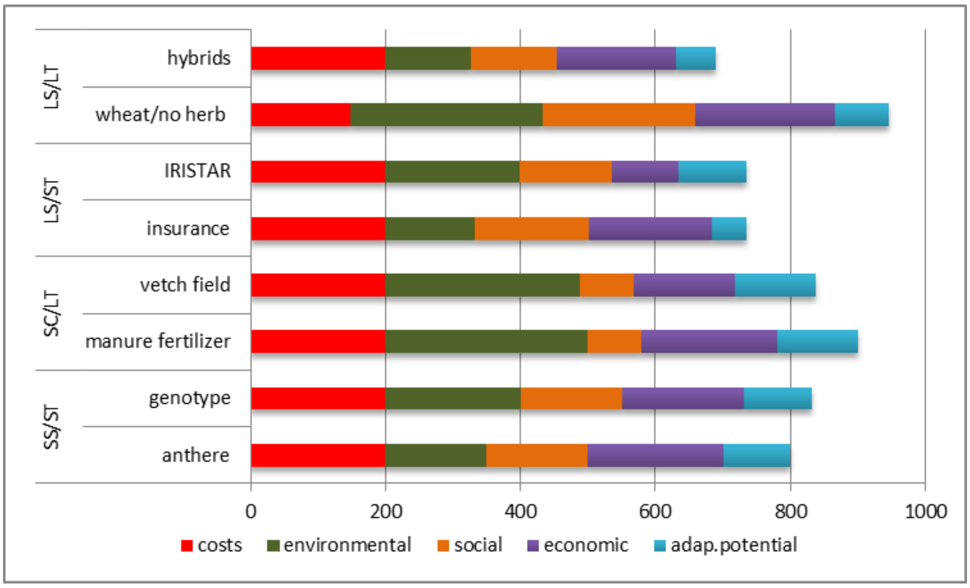


Fig 4.3-13 By scoring criteria contribution chart bar in the technology prioritization for shortlisted technological options of the Agricuture Sector.

The top rated technologies represent the basis of portfolio of environmentally sound technologies in the Agriculture sector of the Republic of Moldova. Implementation of these adaptation technologies/measures would have a significant contribution to enhancing sectorial adaptation to future climate change.

The shortlisted technologies of Agriculture sectors are in line with national sustainable development priorities of the Republic of Moldova and government plans and policies in agriculture.

According to Report reviewers' suggestion to make the following phases of the Project (barrier analysis and policy frameworks) more manageable and focus on 2-3 technologies, the working group has met in a meeting. During this meeting all 8 technologies from the summarizing table 4.3-11 have been reconsidered. The stakeholders (Ministry of Agriculture) have pointed out, that the technology *Vetch field as green fertilizer into 5 year crop rotation* has realistic perspectives from implementation viewpoint, it has no dependency on other agricultural areas, this technology can be piloted at the community level, it is replicable, that would facilitate the diffusion of the technology, with high benefits for environment and community management. The arguments were convincing and the working group members after exchanging their views toward this particular issue agreed upon selecting 3 top technologies for Agriculture sector with highest impact on country's adaptation potential and capability to diffuse the technologies throughout the country.
This sensitivity analysis ended with selection of:

- **Conservation system of soil tillage without herbicides for winter wheat;**
- **Applying of 50 t/ha of manure with bedding to agricultural soils once per five years;**
- **Vetch field as green fertilizer into 5 year crop rotation.**

Chapter 5 Technology prioritization for Human Health Sector

5.1 An overview of possible adaptation measures in Human Health sector and their adaptation benefits.

The Long List of the prioritization technologies/measures for Human Health sector consisted of 11 technologies (table 5.1-1).

Table 5.1-1 The Long List of technologies for adaptation identified and categorized for prioritized sector Human Health

		Adaptation Measures	Scale of application	Short, medium, long term availability
		Small scale/Short term		
HUMAN HEALTH	1	Energy conservation measures, measures aimed at maintaining optimal temperature in homes and public places and reducing the adverse effects of extreme temperatures (heat waves and low temperature) on health and quality of life of population.	Small scale	Short term
	2	Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves (Medical units).	Small scale	Short term
	3	Organization of social centers for homeless persons.	Small scale	Short term
	4	Organization of postgraduate training of physicians in management of disasters caused by climate change and mitigation of consequences for public health.	Small scale	Short term
	5	Development of a National Action Plan on adaptation and health protection during heat wave.	Small scale	Short term
	6	Construction of passive houses in conditions of the Republic of Moldova (pilot project).	Small scale	Short term
	7	Guide ”The adverse effects of improper administration of medicals”.	Small scale	Short term
	8	Recommendations regarding humidity regime during hot time of the year.	Small scale	Short term
	9	Guide ”Reducing the risks for vulnerable groups of populations during heat waves and adaptation measures”.	Small scale	Short term
	10	Guide ”Maintaining optimal temperature in the house”.	Small scale	Short term
	11	Supply rural population with drinking water of guaranteed quality. Building of local water supply systems.	Small scale	Short term

Adaptation measure name: Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves.

Adaptation needs: In the recent decades deaths and morbid conditions caused by heat waves become more frequent and pronounced. They turned into a new problem in the region and in the country. Development of modalities to adapt to heat waves is becoming more and more vital, especially for vulnerable groups of population. Increased access to emergency medical care and provision of prompt simple and effective rehabilitation services contribute greatly to saving lives and adapting of population to extreme temperatures generated by climate change.

How this measure contributes to adaptation: Prolonged exposure to high temperatures is an obvious risk for the population, especially for the urban population. Heat stress, which develops as a result of prolonged exposure of the body to high temperatures in the environment, is a pathophysiological state which affects health and may entail sudden death. Certain inexpensive, timely and sufficient measures prove to be effective to reduce heat stress and its consequences. Also, these measures are essential in the process of adapting to climate change, first of all for population in urban areas.

Background: Proposed measure is as a short term measure and is part of the national health policy. This measure is accomplished by inexpensive, but efficient methods employed during critical periods of heat waves. The experience of many European countries shows that the organization and operation of provisional health posts in public places during critical periods allow to prevent many complications generated by heat stress. In the Republic of Moldova is proposed that temporary health posts to be supplemented by prompt rehabilitation procedures, which ensure more efficient adaptation of the body to high temperatures.

Benefits

*Economic****.*** Support to vulnerable groups of population in critical periods of natural disasters is a very effective measure in terms of the national economy as it allows maintaining the human potential of the country.

Social. Social benefits are obvious due to health care measures, respectively, significant spending cuts for the rehabilitation of people affected.

Environmental. In terms of environmental development it is an indisputable priority, as it creates a better environment for human population during critical periods of heat waves.

Adaptation measure name: Construction of passive houses in conditions of the Republic of Moldova (pilot project)

Adaptation needs: Buildings built up to date do not sufficiently isolate the internal environment from the external one, do not ensure energy conservation during the cold season, do not prevent overheating during heat waves and do not contribute to maintaining optimal temperatures in rooms unless with significant expenditures for energy. The term *passive house* refers to observance of a rigorous energy efficiency standard for buildings, also called Passivhaus standard (in German). The results of observance of this standard are buildings with ultra-low energy consumption for heating or cooling. In addition, the concept of passive house is based on the principle of reducing long-term investment through energy efficient house design. Passive houses provide a comfortable indoor climate, whatever the season, practically without the need to employ a conventional heating source. Such constructions meet the adaptation requirements under the extreme events generated by climate change.

How this measure contributes to adaptation: Perfect insulation of living premises not only essentially reduces energy costs during the cold and warm seasons, but also contributes to ensuring optimal habitat conditions (below 32oC during the day and below 24° C at night). These measures are essential for adaptation to climate change, first of all, for population in urban areas.

Background: Buildings built up to date do not sufficiently isolate the internal environment from the external one, do not ensure energy conservation during the cold season, do not prevent overheating during heat waves and do not contribute to maintaining optimal temperatures in rooms unless with significant expenditures for energy. A long-term measure is proposed, which is a part of the global climate change adaptation and energy consumption reduction policy, and along with fuel consumption, of reduced emissions into the atmosphere. This measure is accomplished by the new way of designing buildings in the residential areas, on the basis of the principle of a *passive house*, i.e. buildings with ultra-low consumption of energy for heating or cooling. In addition, the concept of passive house is based on the principle of reducing long-term investment through energy efficient house design. *Passive houses* provide a comfortable indoor climate, regardless

Benefits:

Economic. Conservation of internal temperature entails high economic efficiency. It should significantly reduce heating costs during the cold season and air-conditioning costs in summer. Building of experimental passive houses in Chisinau and Cahul cities aim to demonstrate the economic efficiency of such buildings in the Republic of Moldova.

Environmental. Passive houses are ecological. Reducing heating costs in winter and air conditioning costs during summer will contribute to environmental development due to fuel (gas and solid fuel) and electricity savings. Thus, reducing heating costs in winter and air conditioning costs during summer will contribute to sustainable environmental development through energy saving.

Social. Social benefits are obvious due to significant spending cuts for heating during winter and air conditioning during summer. The resources saved could be channeled to other needs: healthier diets, cultural needs, etc.

Adaptation measure name: Organization of social centers for homeless persons

Adaptation needs: In recent decades deaths and morbid conditions caused by low temperatures are becoming more frequent and pronounced. Under the climate change circumstances the situation has become a new problem for the country and the region. Low temperatures increasingly affect the health of homeless people, as well as those who live in temporary dwellings with no heating, in tents or cars. During strong frosts such persons are at risk of major trauma, disease, death. The statistics on the number of people with injuries and deaths as a result of low-temperatures serve as convincing argument for the need of the state's involvement in social support of vulnerable groups of population in extreme conditions.

How this measure contributes to adaptation: This measure is crucial for adaptation of the homeless, who are part of vulnerable population, primarily in urban areas. During the cold season and, in particular, when the temperature falls below 15 °C the number of people with frostbites and deaths due to total hypothermia grows.

Background: It is part of national health care and social assistance policy with regard to vulnerable strata of population. This measure shall be accomplished by organizing social centers for the homeless and people living in temporary housing without heating, in tents or cars, in Chisinau and Balti municipalities. Under such conditions social centers for the homeless is the only and the most effective measure to prevent injuries and premature death in case of low temperatures. Social centers for the homeless can be operated jointly with other similar institutions or attached to such, for example, together with the for Children Placement Center.

Benefits:

Economic. Supporting vulnerable groups of population is one of the organic components of the country's economic development.

Social. Social benefits are essential, because the society supports one of the most vulnerable groups of population.

Environmental. Supporting vulnerable groups, society creates a better environment for human population.

Adaptation measure name: Development of a national action plan on adaptation and health protection during heat wave.

Adaptation needs: The frequency and intensity of heat waves, which are becoming more pronounced, has an apparent impact on all branches of national economy, lowers the quality of life and affects health. In management of emergencies, which occur along with the extreme events generated by climate change, central public administration authorities should take the lead in developing a relevant policy, developing and implementing certain measures. A national action plan would be of essential help for central government authorities.

How this measure contributes to adaptation: A national action plan on adaptation and health protection measures during heat waves, related to economic and human potential of the state and coordinated with all relevant ministries will contribute to the adaptation and health protection during critical periods of heat waves. The plan shall provide for essential measures for adaptation of population to climate change, primarily, urban population.

Background: Heat waves are increasing in frequency, intensity, and duration throughout the world. The nature of heat waves is also affected by climate change. Nighttime temperatures have been climbing twice as fast as average temperatures since 1970, meaning less relief at night. In addition, the warmer atmosphere holds more water vapor -- seven percent more for each one-degree Celsius warming -- raising humidity levels, thus heat indices, which determine how we feel during a heat wave. The combination of factors make heat waves today all the more lethal, and the consequences include cardiorespiratory illness, and dehydration and diarrhea in children.

Development of an action plan on adaptation and health protection measures during heat waves is a short-term measure, while implementation of actions included in the plan – a long-term measure. Both are part of the overall policy of adaptation to climate change. This measure shall be implemented by mobilizing the population to better adapt to events generated by climate change

Benefits:

Economic. Economic benefits will be high, given that many public health emergency will be prevented, while dealing with consequences of such emergencies imply significant expenditures

Social. Social benefits are obvious due to health care measures, respectively, significant spending cuts for the rehabilitation of people affected.

Environmental. Development and implementation of the national action plan on adaptation and health protection measures during heat waves will contribute, to a certain extent, to biodiversity conservation.

Adaptation measure name: Energy conservation measures, measures aimed at maintaining optimal temperature in homes and public places and reducing the adverse effects of extreme temperatures (heat waves and low temperature) on health and quality of life of population.

Adaptation needs: In the recent decades deaths and morbid conditions caused by heat waves become more frequent and pronounced in Central Europe, including in the Republic of Moldova. They turned into a new problem in the region and in the country. The frequency and intensity of heat waves, strong frosts, abundant precipitations and flooding, which are more pronounced from year to year, worsen the quality of life and health of population.

The basic characteristics of buildings, built until now do not ensure energy conservation during the cold season, do not provide sufficient insulation of internal environment from the external one during heat waves, and do not contribute to maintaining optimal temperatures in rooms unless significant energy costs are incurred.

How this measure contributes to adaptation: Perfect insulation of housing and public premises, production and training areas not only essentially reduces energy costs during the cold and warm season, but also contributes, on the one hand, to assuring optimal habitual conditions and, on the other, ensures optimal conditions for professional activities, education and training (below 32oC during daytime, and below 24 °C at night). These measures are essential to adaptation of population to climate change, primarily, in urban areas

Background: Poor indoor environmental quality resulting from insufficient air circulation, poor lighting, mold build up, temperature variances, carpeting and furniture materials, pesticides, toxic adhesives and paints, and high concentration of pollutants contribute widely to respiratory problems, allergies, nausea, headaches, and skin rashes.

This measure is part of the overall policy of adaptation to climate change, reducing energy consumption and subsequently reducing greenhouse gases in the atmosphere. This measure shall be accomplished by a more efficient thermal insulation of all residential, industrial and administrative buildings, by conserving energy and reducing energy spent for heating.

Benefits:

Economic. Economic benefits will be higher since it heating costs in winter and internal air conditioning costs in summer will be significantly reduced.

Social. Social benefits are obvious due to significant savings in spending for heating in wintertime and internal air conditioning during summer. The resources saved could be channeled to other needs: healthier diets, more decent living conditions, cultural needs, etc.

Environmental. Reducing heating costs in winter and air conditioning costs in summer will contribute to environmental development due to fuel savings (natural gas and solid fuel), and electricity.

Adaptation measure name: Organization of postgraduate training of physicians in management of disasters caused by climate change and mitigation of consequences for public health.

Adaptation needs: In the recent decades deaths and morbid conditions caused by heat waves become more frequent and pronounced in Central Europe, including in the Republic of Moldova. They turned into an new problem in the region and in the country. The frequency and intensity of heat waves, strong frosts, abundant precipitations and flooding, which are more pronounced from year to year, worsen the quality of life and health of population.

Effectiveness of adaptation measures and consequences for human health, including sanitary and epidemiological well-being during the outbreak and during the liquidation of consequences of extreme events largely depends on the actions taken by professionals who provide preventive care services, as well as emergency and primary health care services. Training of such professionals plays an important role in policy development in this area (including local action plans), preventive health measures and primary health care, etc.

How this measure contributes to adaptation: The professional activity of the specialists of the State Public Health Surveillance Service plays an important role in the organization and implementation of sanitary-epidemiological measures during the outbreak of extreme events generated by climate change. Family doctors also have an important role as they provide primary health care and undertake preventive measures in the areas served. Awareness of these professionals about the regularities of epidemics outbreaks, intoxications, trauma, mental and behavioral disorders, etc. is a prerequisite for preventing epidemiological complications and mitigating the consequences for public health in case of medical emergencies

Background: The professional activity of the specialists of the State Public Health Surveillance Service plays an important role in the organization and implementation of sanitary-epidemiological measures during the outbreak of extreme events generated by climate change. Family doctors also have an important role as they provide primary health care and undertake preventive measures in the areas served. Awareness of these professionals about the regularities of epidemics outbreaks, intoxications, trauma, mental and behavioral disorders, etc. is a prerequisite for preventing epidemiological complications and mitigating the consequences for public health in case of medical emergencies

Benefits

Economic. The benefits of economic development will be high, provided that sanitary-anti-epidemic and primary health care measures will be undertaken at a high professional level and efficiently.

Social. Social benefits are obvious due to more efficient public health protection measures.

Environmental. Improved sanitary-epidemiological measures have a significant contribution to maintain a healthy environment for human population. Improved management during epidemical outbreaks is an effective measure for reducing the danger on environmental contamination.

Adaptation measure name: Provision of high guarantee quality water to rural population. Construction of local water pipe system (aqueducts).

Adaptation needs: In recent decades deaths and morbid conditions along with deaths caused by extreme phenomena of climate change are more persistent in the Central Europe, including Republic of Moldova. They became an urgent regional and country issue. Among most difficult situations are heat waves, floods, other climate phenomena, which increasingly affect the quality of life and health of a continuously increasing number of population.

In the conditions of the Republic of Moldova the situations becomes stringent due to the depletion of phreatic resources, as the water is taken by more than 150 thousand local sources. During summer time, particularly during heat waves, the water is evaporating, causing depletion of the water sources.

One of the most efficient adaptation solutions to extreme weather events would be the construction of water pipes in rural communities.

How this measure contributes to adaptation: This measure is crucial for adaptation of rural population to climate change. Building up a sustainable source of high quality water will prevent waterborne diseases, improved health of rural population. Reducing the water stress and water scarcity in rural areas would bring improved life standards and reduced migration out of these communities

Background: Droughts are increasing in frequency, intensity, duration, and geographic extent. Drought and water stress are major killers in developing nations, and are associated with disease outbreaks, including water-borne cholera. Droughts and dead stands from forest pests, plus more unstable wind patterns from altered temperatures and pressures, all contribute to the rising incidence and toll of forest fires.

It is an adaptation measure that corresponds to global politics of adaptation to climate change. Despite the eventual goal of providing safe, sustainable supply of drinking water at home to whole people, the World Health Organization and other international bodies have recognized the benefit of targeted, interim approaches for those with unsafe drinking water.

There is a priority need in decreasing the risks caused by deficiency of high quality drinking water in rural communities of the Republic of Moldova. In the recent years, this measure is implemented with international contribution, donations of foreign investors. In spite of this help, more than 500 rural communities suffer from shortage of high quality drinking water. They don't have access to improved source of drinking water

Benefits:

Economic. The economic benefits would be high, due to the fact, that rural population would have accesses to high standards water, thus reducing morbidity caused by viral hepatitis A, other diarrhea diseases and chronic diseases.

Environmental. Reducing the use of phreatic water would bring environmental benefits, such as improved management of water use, reduced consumption of natural resources.

Social. Drinking water supply via pipes incorporates source water protection and centralized treatment. Preventing of waterborne diseases can lead to increased social life, school attendance, more tie spent and gainful activities in childcare and less financial resources to pay for medical care.

5.2 Criteria and process of technology prioritization

The approaches used in the adaptation measures prioritization for Human Health sector were similar to the Agriculture sector, applying **Multi Criteria Decision Analysis.** We consider unnecessary to describe the whole process, but the steps specific to this sector.

In the prioritization of adaptation measures of Human Health sector the following criteria have been selected: **costs**, **and benefits**: **environmental, social, economic and adaptation potential.**

The main considerations against which the criteria were judged and included in the evaluation matrix are:

a) corresponding to National Development Priorities;
b) corresponding to Republic of Moldova's MDGs;
c) to maximize country's social, economic and environmental benefits;
d) to reduce sector's vulnerability and contribute to the enhancement of adaptation potential to climate change.

After establishing the evaluation framework, each criterion has been desegregated into constituent indicators and discussed amongst working group members.

a) **Costs** for implementing adaptation measures in Human Health sector are not less important as in Agriculture sector, mainly from the same reasons stated in the Chapter 4.3. The working group members have emphasized, that besides investment costs, at the starting phase of implementing adaptation measures in the Human Health sector, there is a major organizational commitment in particular if the measure is to be adopted by all health units of the sector. These and other important considerations make costs **(capital and O&M costs**) an absolutely important criterion to be considered when assessing proposed adaptation measures.

b) **Economic benefits** were an important criterion considered by Human Health sector working group. Moldova's population consists of 58% of rural populations, settled in various sizes communities with a strong link between economic prosperity and climate. The decline in the quality of life has adverse changes to mental and social health. The health of both rural and urban communities depends on the provision of reliable infrastructure and services. The implementation of measures that would increase the income of primary producers is highly needed. The working group included under economic benefits the following indicators: ***employment and poverty alleviation, infrastructure development, avoided costs by improved health care.***

c) **Environmental criterion** was analyzed in relation to the improved management in the Human Health sector -from improving hospital design to reducing and sustainably managing waste, using safer chemicals, sustainably using resources such as water and energy, and purchasing environmentally-friendly products. Local hospitals may serve as units, where small –scale renewable energy projects can be implemented at low cost. The working group has selected the following indicators as component of environmental criteria: ***human population improved environmental habitat, decreased natural resources consumption, environmental sustainability***.

d) **Social benefits** were of special consideration of working group, in the context of improved health and life conditions for whole population of the Republic of Moldova. Of particular consideration was population particularly vulnerable to many of the potential health impacts of climate change such as: aged, young, disabled, homeless and those with compromised health. The social criterion consists of indicators: ***improved dignity and quality of life, nation health improvement, protection for the most vulnerable groups.***

a) **Adaptation potential.** The working group discussed the coping capacity of health system in the context of what could be implemented now to minimize the negative health impacts of climate change that may arise in the future and maximize any positives that may occur. This approach is especially important in relation to rural population, which needs an improved access to essential health services.

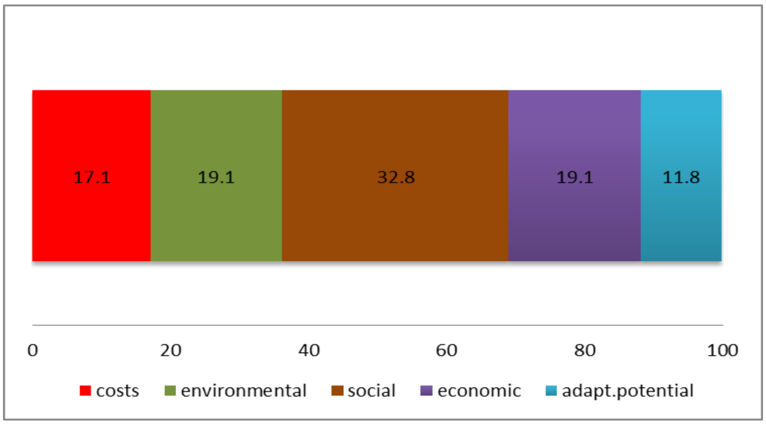


Fig. 5.2-1 By weight criteria contribution chart bar in the technology prioritization of the Human Health sector

By weight criteria contribution chart bar (fig. 5.2-1) indicates a high contribution of social benefits, which is important in relation to measure impact on country's population health and life.

The objective, criteria and indicators were organized by clustering them under different levels of hierarchy as presented in the Hierarchy Value Tree of the Health Sector (fig 5.2-2).The adaptation measures of the Human Health sector have been elaborated as Technology Fact Sheets (TFS), e-versions circulated among working group members, presented for discussion, and then assessed similarly to Agriculture sector methodology assessment.

For the Human Health sector, the adaptation measures were classified under one category: Small Scale/Short Term, as they fit by time and implementation scale.

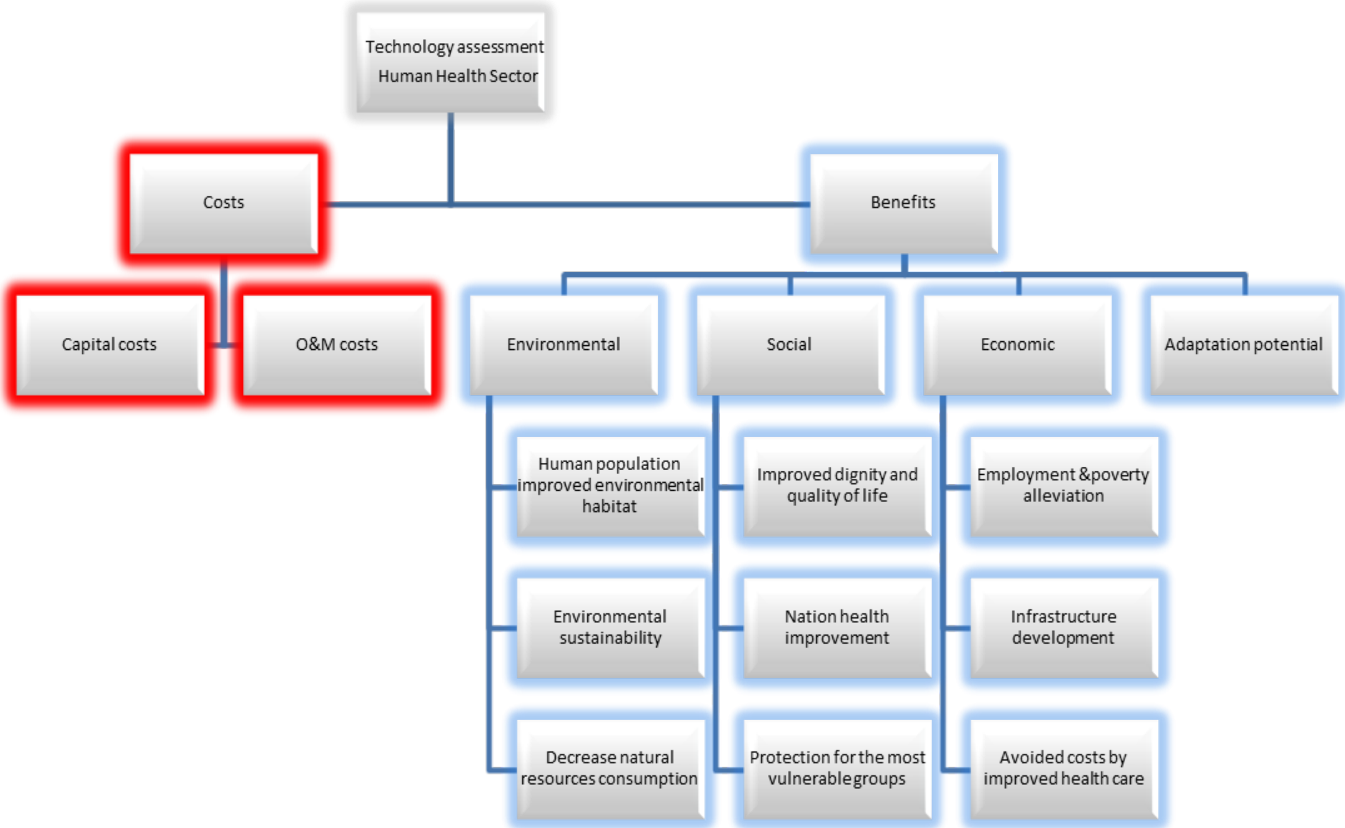


Fig. 5.2-2 Hierarchy value tree of Human Health sector in the technological assessment

The Long List (table 5.1-1) comprised of 11 adaptation measures addressing identified needs of Human Health sector of Moldova in relation to climate change. One of the specific aspects of the sector was the proposition of experts to write guidance on a number of climate change related issues, while the stakeholders opted for other types of measures, with more tangible outputs, with a proactive focus on prediction and prevention. That is why some adaptation measures have been rejected by the working group (adaptation measures 7,8,9,10), considering guides not enough efficient adaptation measure, as in Human Heath sector, adaptation measures should focus on more pragmatic approaches. During the meeting of sectorial working group members regarding adaptation measures in the Health sector, there were less disagreements comparing to Agriculture sector, the final Long List (table 5.2-3) of adaptation measures consisting of 7 adaptation options.

The adaptation measures from the Final Long List were organized into one Performance Matrix and during the meeting of working group assessed against each indicator, giving the points based on 1-10 scale thus, converting qualitative judgment into quantitative. The eight MCDA steps were followed, including scoring procedure using preference scores, assigning weight to each criterion, the overall weighted score calculated.

The adaptation measures classified under Small Scale/Short Term category have the main three components of evaluation techniques: 1) Performance Matrix (Final Long List of adaption measures (table 5.3-1), 2) Scoring Matrix (table 5.3-2), 3) Costs/Benefits analysis presented in the Tables 5.3-3 and 5.3-1 graph and criteria contribution chart bar on 5.3-2 figure bellow.

In Moldova's economic constrains the implementation of new adaptation measures are preferred to be done at the lowest costs, therefore the ***Costs/benefits analysis*** was performed. The results helped to understand the likely efficiency of an adaptation investment for each proposed measure for Human Health sector. In accordance with methodology provided during Bangkok training workshop (8-11 August, 2011), the **total costs** were broken down into **capital costs and operational & maintenance costs.** The final value was taken based on costs-to –benefits ratios of the technology options. The costs/benefits graph of evaluated adaptation measures was the final output of the calculation based on the original inputs of the sectoral working group members.

The names of adaptation measures would be shortened in the Matrixes and graphs with the purpose to avoid text overlapping.

Table 5.2-3 The final Long List of adaptation measures identified and categorized for prioritized sector Human Health

		Adaptation Measures	Scale of application	Short, medium, long term availability
HUMAN HEALTH		**Small scale/Short term**		
	1	Energy conservation measures, measures aimed at maintaining optimal temperature in homes and public places and reducing the adverse effects of extreme temperatures (heat waves and low temperature) on health and quality of life of population	Small scale	Short term
	2	Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves (Medical units)	Small scale	Short term
	3	Organization of social centers for homeless persons	Small scale	Short term
	4	Organization of postgraduate training of physicians in management of disasters caused by climate change and mitigation of consequences for public health.	Small scale	Short term
	5	Development of a National Action Plan on adaptation and health protection during heat wave.	Small scale	Short term
	6	Construction of passive houses in conditions of the Republic of Moldova (pilot project).	Small scale	Short term
	7	Supply rural population with drinking water of guaranteed quality. Building of local water supply systems.	Small scale	Short term

5.3 Results of technology prioritization, Human Health Sector

Table 5.3-1 Performance Matrix of Small Scale/Short Term category adaptation measures.

Performance Matrix (Final Long List of Adaptation Measures)

				Costs		Benefits									
						Environmental			Social			Economic			Adaptation
No.	Technology Option	Taken for scoring	Total costs	Capital Costs (Infrastrures, Vehicles, etc.)	O & M Costs (plus fuel costs)	Human population improved environmental habitat	Environmental sustainability	Decreased natural resources consumption	Improved dignity and quality of life	Nation health improvement	Protection for the most vulnerable groups	Employment and poverty alleviation	Infrastructure development	Avoided costs by improving health care per year	Adaptation potential/Reduction of vulnerability
			euro	euro	euro									euro	
1	Constructions isolation	Yes	551,000	550,000	1,000	8	1	2	10	9	10	4	9	500,000	9
2	Medical units for temporary assistance	Yes	25,000	15,000	10,000	10	2	3	9	10	10	8	8	200,000	9
3	Social centers for houseless persons	Yes	250,000	200,000	50,000	9	2	2	8	10	9	8	8	200,000	8
4	Training in climate change disaster management	Yes	30,000	10,000	20,000	8	8	5	9	10	10	7	2	100,000	10
5	Development of National Action plan on adaptation	Yes	25,000	10,000	15,000	9	8	7	7	10	10	3	2	300,000	10
6	Passive buildings	Yes	2,005,000	2,000,000	5,000	10	10	10	10	10	9	10	10	2,000,000	8
7	Rural water pipe	Yes	705,000	700,000	5,000	10	10	9	10	10	10	10	10	500,000	9
	Lowest value Preferable **(Y or N)**		Y	Y	Y	N	N	N	N	N	N	N	N	N	N

1,2-Weakly important; 3,4-less important; 5,6-moderately important; 7,8-important; 9,10-extremely important

Table 5.3-2 Scoring Matrix of Small Scale/Short Term category adaptation measures, Human Health Sector

Scoring Matrix

		Costs			Benefits										
					Environmental			Social			Economic			Adaptation	
No.	Technology Option	Total costs	Capital Costs (Infrastrures, Vehicles, etc.)	O & M Costs (plus fuel costs)	Human population improved environmental habitat	Environmental sustainability	Decreased natural resources consumption	Improved dignity and quality of life	Nation health improvement	Protection for the most vulnerable groups	Employment and poverty alleviation	Infrastructure development	Avoided costs by improving health care per year	Adaptation potential/Reduction of vulnerability	Total
	Normalized Weights		9.2	7.9	7.9	5.9	5.3	10.5	10.5	11.8	3.9	5.3	9.9	11.8	100.0
1	Constructions isolation		72.9	100.0	0.0	0.0	0.0	100.0	0.0	100.0	14.3	87.5	21.1	50.0	50.1
2	Medical units for temporary assistance		99.7	81.6	100.0	11.1	12.5	66.7	100.0	100.0	71.4	75.0	5.3	50.0	67.4
3	Social centers for houseless persons		90.5	0.0	50.0	11.1	0.0	33.3	100.0	0.0	71.4	75.0	5.3	0.0	34.3
4	Training in climate change disaster management		100.0	61.2	0.0	77.8	37.5	66.7	100.0	100.0	57.1	0.0	0.0	100.0	64.1
5	Development of National Action plan on adaptation		100.0	71.4	50.0	77.8	62.5	0.0	100.0	100.0	0.0	0.0	10.5	100.0	61.9
6	Passive buildings		0.0	91.8	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0	66.5
7	Rural water pipe		65.3	91.8	100.0	100.0	87.5	100.0	100.0	100.0	100.0	100.0	21.1	50.0	81.8
8															

Swing Weighting

Most preferred option	Development of National Action plan on adaptation	Development of National Action plan on adaptation	Constructions isolation	Medical units for temporary assistance	Passive buildings	Passive buildings	Constructions isolation	Medical units for temporary assistance	Constructions isolation	Passive buildings	Passive buildings	Passive buildings	Training in climate change disaster management		
Least preferred option	Passive buildings	Passive buildings	Social centers for houseless persons	Constructions isolation	Constructions isolation	Constructions isolation	Development of National Action plan on adaptation	Constructions isolation	Social centers for houseless persons	Development of National Action plan on adaptation	Training in climate change disaster management	Training in climate change disaster management	Social centers for houseless persons		
Weight		70	60	60	45	40	80	80	90	30	40	75	90		760

Table 5.3-3 Costs benefits analysis of Small Scale/ Short Term category technologies

No.	Technology Option	Costs (euro)	Development benefits
1	Buildings isolation	550,000	36
2	Medical units/posts for temporary assistance	25,000	52
3	Social centers for houseless persons	250,000	26
4	Training in climate change disaster management	20,000	50
5	Development of National Action Plan on adaptation	15,000	47
6	Passive buildings	2,000,000	59
7	Rural water pipe	700,000	69

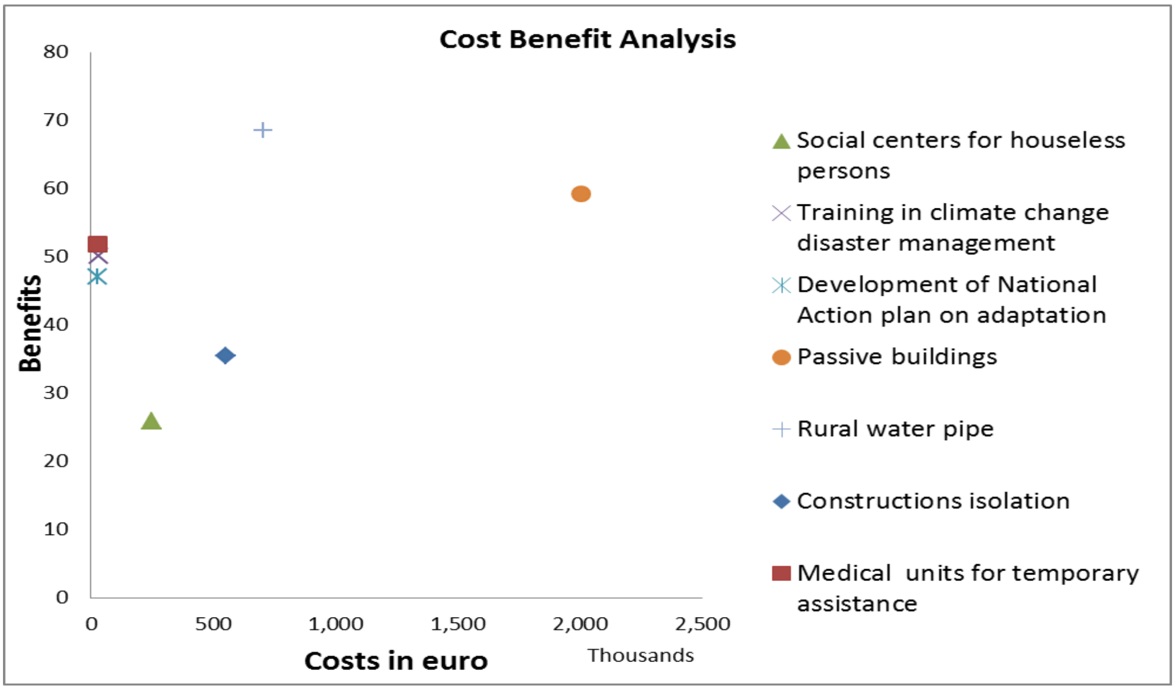


Fig 5.3-1 Costs benefits relationship of Small Scale/ Short Term category adaptation measures, Human Health sector

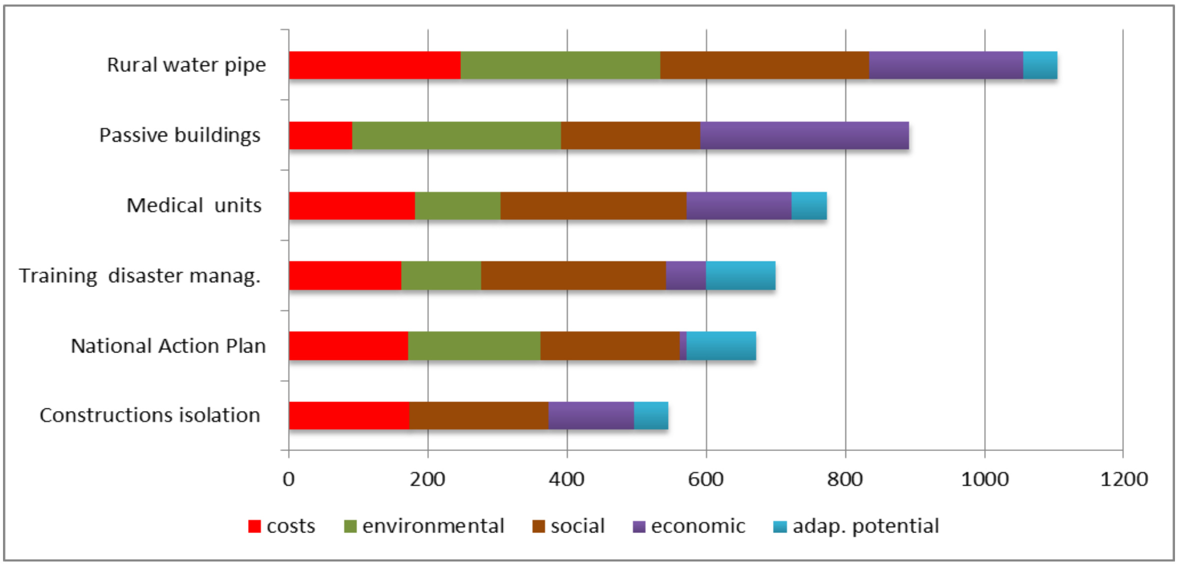


Fig. 5.3-2 By scoring criteria contribution bar in of Small Scale/ Short Term category adaptation measures, Human Health sector

After consideration of cost/beneft analysis, the working group came to common agreement to have included in the Short List the adaptation measures listed in the table 5.3-4**.**

Table 5.3-4 The Short List of Adaptation Measures of the Human Health Sector

		Adaptation Measures	Scale of application	Short, medium, long term availability
HUMAN HEALTH		**Small scale/Short term**		
	1	Supply of high guarantee quality water to rural population. Construction of local water pipe system (aqueducts) (Rural water pipe).	Small scale	Short term
	2	Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves (Medical units).	Small scale	Short term

Sensitivity analysis

For the same reasons as for Agriculture sector, in the sensitivity analysis of the Human Health sector, it was chosen the option of reducing weight given to costs, as most plausible situation.

Reducing the weight of costs related indicators to 20 % for capital costs and 10% for O&M costs did not bring changes in the relations between adaptation measures. The top-level ranked adaptation measures are the same as in the original plot, dominating measure being *Provision of high guarantee quality water to rural population. Construction of local water pipe system (aqueducts)*. This analysis showed that over considerable variations of assigned weights to cots criterion, the relationship between adaptation measures do not change significantly.

Reducing the weight of the costs increased the importance of benefits, the options being displaced on higher values of benefits on the plot area (fig. 5.3-3).

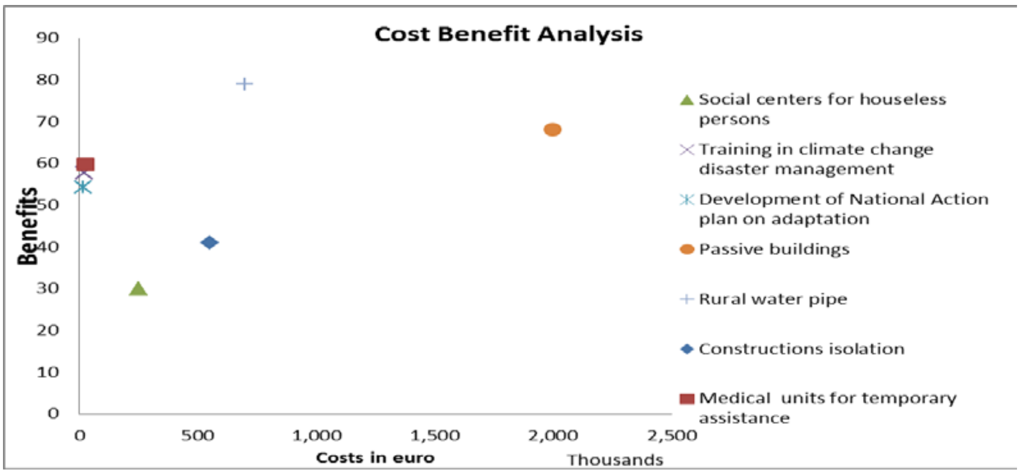


Fig. 5.3-3 Cost-benefits analysis of Small Scale/Short Term category, Human Health sect with reduced capital costs to10% and O&M costs to20%

Considering that the third from the top adaption measure *Organization of postgraduate training of physicians in management of disasters caused by climate change and mitigation of consequences for public health. (Training in climate change disaster management*) is ranked quite close to the second measure, the approach was to follow "optimistic scenario" and give different scores to the indicators for the third adaptation options.

The participants came with the following changes in the scores for measure *Training in climate change disaster management (#3),* setting it to more optimistic level:

Infrastructure development: 2 →8;
Employment and poverty alleviation 7 →8;
Decreased natural resources consumption 5 →6.

These changes brought about differences in the adaptation measures ranking, placing *Training in climate change disaster management* measure on the next to most favorable option. The working group members agreed that this assumption is realistic in a short term and should be considered.

Changes in the scores did not bring changes in the most prefered adaption measure: *Supply of high guarantee quality water to rural population. Construction of local water pipe system (aqueducts)(Rural water pipe*). The whole plot showed quite high robustness (fig 5.3-4).

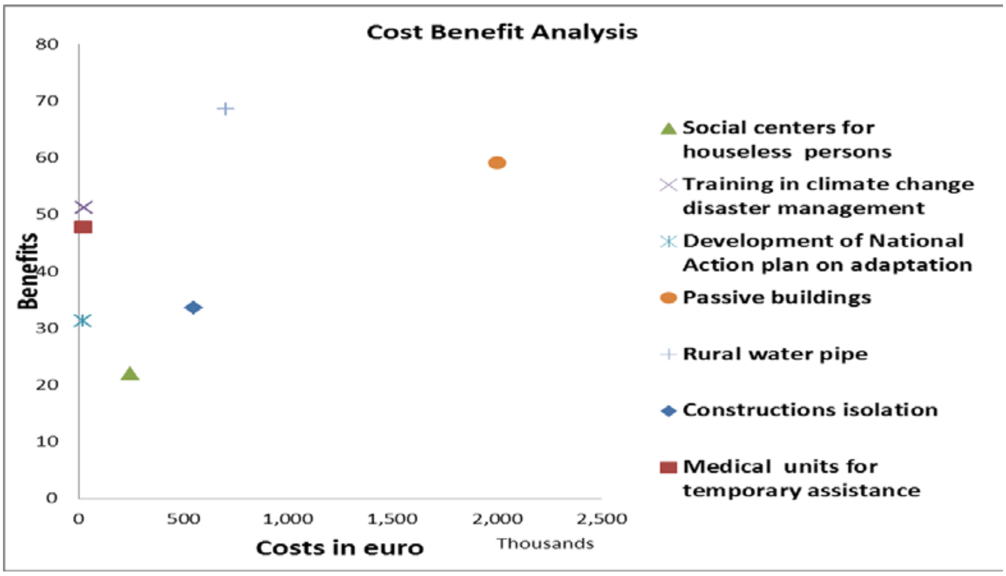


Fig. 5.3-4 Costs-benefits relationship of Small Scale/ Short Term category technologies, optimistic scenario for technology #3

Table 5.3-5 Summarizing table for prioritized adaptation technologies for Human Health Sector

Adaptation measures		Costs	Benefits output from MCDA assessment	Up-scaling potential
Small scale/Short term		euro	points	
1	Supply of high guarantee quality water to rural population. Construction of local water pipe system (aqueducts)	700 000	69	25%
2	Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves	25 000	52	15%

The summarizing table for prioritized adaptation technologies Human Health Sector consists of 2 technologies (table 5.3-5)

Supply of high guarantee quality water to rural population. Construction of local water pipe system (aqueducts) *(Rural water pipe)* in the rural area of Moldova is a technology that would contribute to proving high quality water to rural population living in the communities with drinking water shortage. Building a water pipe system would contribute to better management of water supply both at the supply and demand side and would increase the security of quality water use. Implementation of this type of adaptation measure would have a cross-sectoral benefit as it contributes to the improvement of population health and increased community resilience to long term hydrological drought.

Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves (Medical units for temporary assistance). The experience of many European countries shows that the organization and operation of provisional health posts in public places during critical periods allow preventing many complications generated by heat stress. In the Republic of Moldova it is proposed that temporary health posts to be supplemented by prompt rehabilitation procedures, which ensure more efficient adaptation of the body to high temperatures during critical periods of heat waves, particularly in the urban areas.

Implementation of both adaptation measures would significantly contribute to population resilience and adaptation to adverse climate change factors.

These two technologies will be taken to perform barrier analysis and policy frameworks in the following phases of the TNA Project.

References

1. Brenkert and Malone, 2005. *Modeling Vulnerability and Resilience to Climate Change*.
2. Clements, R., J. Haggar, A. Quezada, and J. Torres.2011. *Technologies for Climate Change Adaptation – Agriculture Sector.* X. Zhu (Ed.). UNEP Risø Centre, Roskilde, 200 p.
3. Climate change and human health. Risks and responses. 2003. Eds AJ MacMichael et al. WHO, Geneva, 322 p.
4. Confalonieri U. et al. Human health. 2007. In: *Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC*. Cambridge, Cambridge University Press.
5. Drought after-effects upon population of the Republic of Moldova. Chisinau, UNICEF Moldova, 2007
6. Economic Research Service, U.S. Department of Agriculture, see on: http://www.ers.usda.gov/data/macroeconomics/.
7. *Environmental Performance Index*, Yale center for Environmental Law and Policy, CT and Columbia University in collaboration with World Economic Forum, Geneva, Switzerland, JRC European Commission.
8. Expert-Group, 2008. *State of the Country Report.*
9. Government of the Republic of Moldova. *Post Disaster Needs Assessment, Floods* 2010." Supported by the European Union, the United Nations, and the World Bank, with the support of the Global Facility for Disaster Reduction and Recovery (GFDRR).
10. Health Annual Report, 2010.
11. Menne B et al., 2008. *Protecting Health in Europe from Climate Change*. Copenhagen, WHO Regional Office for Europe, Available at:http://www.euro.who.int/Document/GCH/Protecting_health.pdf?language=French
12. Millennium Challenge Account –Moldova: Environment and Social Assessment. Project mission September 28-October 17, 2008. *Transition to high value agriculture project.* Authors: S. Budesteanu, J. Ebbeler, I. Gotisan, Rita Klees..-43p.
13. Ministry of the Environment, RM.2011. *State of the Environment in the Republic of Moldova*. National Report 2007-2010.-88p.
14. Moss et al., 2001. *Vulnerability to climate change, a quantitative approach.*
15. Multi-criteria analysis: a manual. 2009. Department for Communities and Local Government, UK. -165p.
16. National Bureau of Statistics (2009), Annual Statistical Yearbook of the Republic of Moldova for 2008. Chisinau, 2009 (see it on: http://www.statistica.md/pageview.php?l=ro&idc=263&id=2193).
17. National Bureau of Statistics (2010), Annual Statistical Yearbook of the Republic of Moldova for 2009. Chisinau, 2010 (see it on: http://www.statistica.md/pageview.php?l=ro&idc=263&id=2193).
18. National Bureau of Statistics (2011), Annual Statistical Yearbook of the Republic of Moldova for 2010. Chisinau, 2011 (see it on: http://www.statistica.md/pageview.php?l=ro&idc=263&id=2193).
19. National Bureau of Statistics (2011), Energy Balance of the Republic of Moldova, 2010: Statistical Book. Chisinau, 2011. – 73 p. See on:
20. http://www.statistica.md/public/files/publicatii_electronice/balanta_energetica/Balanta_energetica_2011_rom.pdf.
21. National Bureau of Statistics (2012), Statistical Database: http://statbank.statistica.md/pxweb/Database/EN/databasetree.asp
22. National Agriculture Sector and Food Processing Industry Sustainable Development Strategy of the Republic of Moldova for 2008-2015: http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=327309.
23. Neamțu Titus, 1996. Eroziune, Ecologie şi Protecție Antierozională. Bucureşti: Cereş, 1996. P. 131-136.
24. Opopol N., Corobov R. 2007. *Excess mortality in Kishinev during hot summer of 2007*.
25. Report on the Activity of the National Agency on Energy Regulations for 2010 year: http://anre.md/upl/file/Rapoarte/Raport%20anual%20de%20activitate%20a%20ANRE%20pentru%20anul%202011.pdf
26. State Statistical Service of the Ministry of Economy of the Transnistrian Moldovan Republic (2011)**,** *Statistical Yearbook of the Transnistrian Moldovan Republic, 2011: Statistical collection (for 2006-2010).* TMP. – Tiraspol, 2011. – 185 c. (in Russian).
27. Subbarao I. et al. 2008; 2(3): *Applying yesterday's lessons to today's crisis: improving the utilization of recovery services following catastrophic flooding*. Disaster medicine and Public Health Preparedness.-132-133.
28. Suter Rene., 2008. *Relief and Technical Assistance Response to the Drought in Moldova*. Programme Review Mission Report, UNDP/BCPR.

29. *Synthesis and Assessment Product 4.5*., 2008. Report by U.S. Climate Change Science Program and the Subcommittee on Global Change Research: Effects of Climate Change on Energy Production and Use in United States. - 85p.
30. Thywissen K., 2006. *Components of Risk*. A Comparative Glossary. SOURCE No.2/2006. UNU-EHS, Bonn.
31. Technology needs assessment and development priorities, Chisinau 2002, 175 p.
32. UN/ISDR. 2004. *United Nations International Strategy for Disaster Reduction*. *Living with Risk.* A Global Review of Disaster Reduction Initiatives. 2004 version. United Nations, Geneva, p. 430.
33. UNDP/Ministry of Environment and Territorial Arrangement (2000), First National Communication of the Republic of Moldova under the United Nations Framework. Convention on Climate Change. Chisinau, 2000. – 87 p. (see it available on: http://www.clima.md/lib.php?l=en&idc=81&).
34. UNEP/Ministry of Environment and Natural Resources (2009), Second National Communication of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Chisinau, 2009. – 316 p. (see it available on: http://www.clima.md/lib.php?l=en&idc=81&).
35. UNEP/Ministry of Environment and Natural Resources (2009), National Inventory Report: 1990-2005. Greenhouse Gas Sources and Sinks in the Republic of Moldova. Chisinau, 2009. 352 p. (see it available on: http://www.clima.md/lib.php?l=en&idc=82).
36. UNDP (2010), National Human Development Report, 2010/2011. Republic of Moldova from Social Exclusion towards Inclusive Human Development. Chisinau, 2010. – 222 p. (see it available on: http://www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf).
37. UNDP/Ministry of Environment (2011), Draft National Climate Change Adaptation Strategy of the Republic of Moldova. Chisinau, 2011. 73 p. (see it on: http://www.clima.md/lib.php?l=en&idc=237&).
38. UNDP/Ministry of Environment (2011), Draft Low Emissions Development Strategy of the Republic of Moldova to the year 2020. Chisinau, 2011. 174 pages (see it available on: http://www.clima.md/lib.php?l=en&idc=236&).
39. UNFCCC/UNDP 2010. *Technology Needs Assessment for Climate Change*. Handbook. -176p
40. UNICEF Moldova, 2007. *Drought after-effects upon population of the Republic of Moldova*. Chisinau, 2007.
41. World Bank, 2002. *Moldova: Transport Strategy Update with Emphasis on the Road Sector*, December 2002.
42. World Bank, 2007. *Rural Productivity in Moldova – Managing Natural Vulnerability*. 23 May 2007, p.107.
43. World Bank, 2009. World Development Indicators.
44. World Bank, 2009. Water and Climate Change: Understanding the Risks and Making Climate-Smart Investment Decisions", 2009. 174p.
45. World Bank, 2010 The Republic of Moldova Climate change and Agriculture note, November, 2010.
46. World Bank, 2010. *Project Appraisal Document on a Proposed Credit to the Republic of Moldova for a Disaster and Climate Risk Management Project*. July 6, 2010. Government of the Republic of Moldova. "Post Disaster Needs Assessment, Floods 2010." Supported by the European Union, the United Nations, and the World Bank, with the support of the Global Facility for Disaster Reduction and Recovery (GFDRR), 2010.
47. World Health Organization, 2008. *Assessment of health security and crisis management capacity, Republic of Moldova*.
48. Ursu, A. (2000), Soils Degradation and Desertification (in Romanian). Chisinau, 307 p.

Annexes 1-2

Annex I. Technology Fact Sheets

AGRICULTURE SECTOR

Sector	Agriculture
Category	Water Requirements and Irrigation Scheduling, Demand - side
Adaptation needs	Reducing of water consumption for irrigation at farm and field scale using real time soil moisture monitoring
Technology Name	**Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus** **(Operational Irrigation Scheduling Technologies at farm and field scale using real time electronic instruments monitoring).**
How this technology contributes to adaptation	Irrigated agriculture generally uses large volumes of water compared to cities and industries, and competition for good water quality is really high in many regions. It is recognized that improved water management practices in agriculture can lead to important benefits in terms of water availability for expanded agricultural activity and for other uses, and can reduce many environmental problems. However, it is difficult to successfully implement efficient practices without field measurements and analytical tools that allow water managers to have a good estimation of crop water use, situation which is constraining water management. Regular feedback of information from the field into water management decision making can substantially improve the performance of water delivery services. However, obtaining repeated objective evaluations about actual field conditions is difficult so that operational tools are needed to facilitate water managers to take right decisions about crop water use and water deliveries. Within the new technologies currently used for irrigation scheduling and crop water use is Operational Irrigation Scheduling Technologies at farm and field scale using real time electronic instruments monitoring, in particular, Real time wireless soil moisture monitoring system.
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus. This soil moisture monitoring system is based on the application of electronic technologies TDR (Time Domain Reflectometry) and consists of the following components: • Wireless Station for measuring of the soil moisture with receiver-transmitter of the 1-st level DL1-10RT model, which includes: - 4 inputs for soil moisture sensors of the IRIS-40Mh; - 1 input for temperature sensor; - 1 input for air temperature sensor; - 1 input for sensor of air humidity; - 3 output clamps to connect with operating devices as URL-4RT; - Receiver-transmitter universal DL1-10RT for the collection, accumulation and radio transmission of information obtained by wire communication from measurement devices. • Controller of the 2-nd level with wireless receiver-transmitter universal DL2-24RTR model, which includes: - 4 inputs for soil moisture sensors of the IRIS-40Mh; - 1 input for temperature sensor; - 1 input for air temperature sensor;

	- 1 input for sensor of air humidity; - 3 output clamps to connect with operating devices as URL-4RT; - Receiver-transmitter universal DL2-24RTR for the receiving and recording information from the receiver-transmitter DL1-10RT, decoding and visualization it at the on-board display, or downloading to the personal computer through the USB port; - Solar battery. • Controller of the 3-th level with wireless receiver-transmitter universal DL3-4SAT model, which includes: - 4 inputs for soil moisture sensors of the IRIS-40Mh; - 1 input for temperature sensor; - 1 input for air temperature sensor; - 1 input for sensor of air humidity; - 3 output clamps to connect with operating devices as URL-4RT; - receiver-transmitter universal DL3-4SAT for the receiving and recording information from the receiver-transmitter DL2-24RTR, decoding and visualization data at the on-board display, or downloading to the personal computer through the USB port, or GPRS transmission of information to the remote computer using Internet. • Wireless device URL- 4RT for solenoid valves operation. • IrrigationLink software for personal computer that allows real-time display of information obtained in graphic or tabular forms, as well as setting up the electronic devices and management operations of the irrigation system, both manually and automatically. • The developer and manufacturer of Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus, including software IrrigationLink is "Iristar-Com" Company (Moldova). The Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus awarded a gold medal and diploma of the Ministry of Agriculture and Food Industry of Moldova at the XXI International Exhibition ' MOLAGROTECH -2011 ' in Chisinau.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	• To introduce this technology in building codes as a mandatory step in the irrigation systems design • Each irrigating system again entered into operation should be equipped by monitoring system IRISTAR Pro2 Plus • Support of local scientists on the implementation of **"Real time wireless soil moisture monitoring system IRISTAR Pro2 Plus."**, developed in Moldova
Costs	• Set of equipment for 100 ha Drip Irrigation System with 10 Wireless Measuring Stations – 4700 € • Set of equipment for 100 ha Lateral-move Sprinkler Irrigation System with 2 Wireless Measuring Stations – 1500 €
Country social development priorities	• Hotărîre cu privire la aprobarea Programului de dezvoltare a gospodăririi apelor şi a hidroameliorației în Republica Moldova pentru anii 2011-2020 (nr. 751, 5 octombrie 2011) Monitorul Oficial Nr. 170-175 • *National Report "Millennium Development Goals Report: New Challenges – New Objectives", NHDR 2009/2010* http://www.undp.md/mdg/MDG1/poverty.shtml, http://www.endpoverty2015.org • *National Report "*Climate Change in Moldova: *Socio-Economic Impact and Policy Options for Adaptation", NHDR 2009/2010* • Irrigation Engineering, Hydrologic, and Agronomic Assessment Report, Republic of

	Moldova. The Millennium Challenge Corporation (MCC)/ Utah State University (USU), 2009 • National Strategy for Sustainable Development of the Agricultural Complex of the Republic of Moldova for 2008-2015 (Government Decision No. 282 of 11.03.2008.Official Monitor No. 57-60, 21.03.2008) • The National Development Strategy (NDS) for 2008-2011 • Program of Water Supply and Sewerage in Communities of the Republic of Moldova until 2015 (Government Decision No. 1406 of December 30, 2005, Decree No. 662 of June 13, 2007)
Country economic development priorities – economic benefits	• High value agricultural development • Impacts on water supply • Decreasing of irrigation water consumption • Increasing of crop yields
Country environmental development priorities (Environmental benefits)	• Decreasing of impact to the irrigated soils • Prevention of "over-water" • Prevention of rising groundwater level • Prevention of secondary soil salinization
Social benefits	• Increasing of the population incomes from guaranteed high yields • Educational and scientific development • Increased community welfare
Other considerations and priorities (such as market potential)	• According to the "Hotărîre cu privire la aprobarea Programului de dezvoltare a gospodăririi apelor şi a hidroamelioraţiei în Republica Moldova pentru anii 2011-2020 (nr. 751, 5 octombrie 2011) Monitorul Oficial Nr. 170-175" till 2020 in Moldova 116,0th ha of new irrigation systems will be built and 121,6th ha will be rehabilitated, totally – 237,6th ha • About half of this area (118,8th ha) will be equipped with Sprinkler Irrigation Systems and other 118,8th ha - with Drip Irrigation Systems • Every Irrigation System has to be equipped with one set of IRISTAR Pro2 Plus.
Capital costs (per facility)	• Total capital investments for 118,8th ha irrigated by Lateral-move Irrigation Systems average capital cost – 0,178 million € • Total capital investments for 118,8th ha irrigated by Drip Irrigation Systems average capital cost – 5,58 million €
Operational and Maintenance costs (per facility)	• 100 ha irrigated by Lateral-move Irrigation Systems – 250 €/per year • Total Operational and Maintenance costs for 118,8th ha irrigated by Lateral-move Irrigation Systems average capital cost – 297th €/per year • 100 ha irrigated by Drip Irrigation Systems – 550 €/per year • Total Operational and Maintenance costs for 118,8th ha irrigated by Drip Irrigation Systems average capital cost – 654th €/per year
Up scaling potential	The increasing of technology application will follow the construction of new and rehabilitation of existing irrigation systems by an average of 24 th ha per year and may reach up to 237.6 th ha in 2020 totaling 5.8 million euro of investments.

Fig.1. Real time irrigation monitoring modern technologies.

Sector	Agriculture
Category	Water Management, Supply - side
Adaptation needs	**Increasing of seasonal and multiannual volume of water storage**
Technology Name	**Construction of new and proper maintenance of existing dams and water reservoirs**
How this technology contributes to adaptation	Dams and reservoirs represent the main option for adaption to climate change in the water sector in Europe. Being deficient in natural lakes and with abundant intermittent streams, Moldova has already developed a large network of ponds and reservoirs for inter-seasonal and inter-annual redistribution of water. Proper maintenance of existing dams and reservoirs, as well as construction additional ones could help in redistributing precipitation between seasons, serving as an important object for both water storage and diminishing flash flood risk. Moldova needs till 2020 to increase volume of the water accumulated to 50 miln $м^3$.
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	The main source of water for agricultural irrigation in Moldova is the surface water of rivers, lakes and artificial reservoirs. An increase in the accumulated amount of water would reduce the risks associated with climate change. Construction technology of dams and water reservoirs is not new for Moldova. These works have been executed earlier and continue to be carried out now. Almost all of the previously constructed dams are earthen dams, equipped with concrete or earthen discharge structures. The most widespread and approved method of their construction in Moldova is layer-by-layer stacking of an earthen body of the dam by scrapers with simultaneous compacting by compacting machines. To reduce the filtration of water through the dam body are various impervious options, including the device impervious screens in the dam body, upland slope facing concrete slabs, and others. TNA Guidebook – Technologies for Climate Change Adaptation – The Water Sector
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	The state program of dams and water basins building across territory of Moldova should be developed. Construction of water basins of long-term redistribution on the small rivers of Moldova being between the rivers Nistru and the Prut should be made.

Costs	• 3,650 € /per 1th m^3 water accumulated (Source: Average data of 6 water reservoirs designed and built by Întreprinderea de Stat „Protecția Solurilor şi Îmbunătățiri Funciare" in Moldova) • Total investments for technology implementation to increase water accumulated volume on 50 million m^3 – 182,5 million €
Country social development priorities	• Hotărîre cu privire la aprobarea Programului de dezvoltare a gospodăririi apelor şi a hidroameliorației în Republica Moldova pentru anii 2011-2020 (nr. 751, 5 octombrie 2011) Monitorul Oficial Nr. 170-175 • *National Report "Millennium Development Goals Report: New Challenges – New Objectives", NHDR 2009/2010* http://www.undp.md/mdg/MDG1/poverty.shtml, http://www.endpoverty2015.org • National Strategy for Sustainable Development of the Agricultural Complex of the Republic of Moldova for 2008-2015 (Government Decision No. 282 of 11.03.2008.Official Monitor No. 57-60, 21.03.2008) • The National Development Strategy (NDS) for 2008-2011 • Program of Water Supply and Sewerage in Communities of the Republic of Moldova until 2015 (Government Decision No. 1406 of December 30, 2005, Decree No. 662 of June 13, 2007)
Country economic development priorities – economic benefits	• High value agricultural development • Impacts on water supply • Increased water security • Support to development stability
Country environmental development priorities (Environmental benefits)	• Increase water use for Agricultural sector • Wetlands rehabilitation • Creation of the nature restoration zones
Social benefits	• Reliable water supply • Reduction of water dependency risks • Improved water safety • Increased community welfare
Other considerations and priorities (such as market potential)	Till 2020 it is necessary to built in Moldova no less 500 water reservoirs with total accumulated capacity of 50 million m^3 of water
Capital costs (per facility)	• Water reservoir of 100th m^3 of water accumulated Capital costs – 350,000 € • Total capital investments needed for building 500 water reservoirs with total accumulated capacity of 50 million m^3 of water – 175 million €
Operational and Maintenance costs (per facility)	• Water reservoir of 100th m^3 of water accumulated Operational and Maintenance costs – 15,000 €/ per year • Total Operational and Maintenance cost of 500 water reservoirs with total accumulated capacity of 50 million m^3 of water - 7,5 million €

Sector	Agriculture
Category	Irrigation Application, Supply - side
Adaptation needs	**Reducing of water and energy consumption for irrigation needs in agriculture**
Technology Name	**Low-flow, low- pressure and water serving Drip Irrigation technologies**
How this technology contributes to adaptation	The main advantage of drip irrigation is that water comes directly into the root zone of the plants. It provides high irrigation uniformity, optimal soil moisture; more than 50% reduced consumption of irrigation water and reduced water losses to evaporation from the soil surface. Fundamentally new going on fertilizer. Fertilizers are supplied in dissolved form, along with irrigation water directly into the root zone of each plant. Thus, no weeds are fed between the rows, but only cultivated crops. Application rates of mineral fertilizers in drip irrigation are reduced to 3... 4 times. At drip irrigation water does not reach the leaves of fruit and vegetables, hence the plant is less exposed to disease. Drip irrigation systems are designed for the cultivation of various crops in outdoor and indoor conditions. These systems show particularly effective when used in orchards, vineyards and vegetables, ensuring the growth of their yield to 50% and more. By its design and working principle the drip irrigation system best meet the environmental, energy-efficient and resource-saving requirements. For example, the main element of the drip irrigation system - drip tube most modifications works under the pressure not more than 0.8 bar, while working pressure of even low-pressure sprinkler irrigation devices is not less than 2.5 – 3.0 bar. Additional advantages of drip irrigation include: • Drip systems are adaptable to oddly shaped fields or those with uneven topography or soil texture; these specific factors must be considered in designing the drip system. Drip systems also can work well where other irrigation systems are inefficient because parts of the field have excessive infiltration, or runoff. • Drip irrigation can be helpful if water is scarce or expensive. Because evaporation, runoff, and deep percolation are reduced and irrigation uniformity is improved, it is not necessary to "over-water" parts of a field to adequately irrigate the more difficult parts. • Precise application of nutrients is possible using drip irrigation. Fertilizer costs and nitrate losses can be reduced. Nutrient applications can be better timed to meet plants' needs. • Drip irrigation systems can be designed and managed so that the wheel traffic rows are dry enough to allow tractor operations at any time. Timely application of herbicides, insecticides, and fungicides is possible. • Proven yield and quality responses to drip irrigation have been observed in onion, broccoli, cauliflower, lettuce, melon, tomato, and cotton.
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	To low-flow irrigation systems (sometimes called as *local irrigation systems)* include *drip* (*trickle)* and micro-sprinkler irrigation systems. Drip irrigation system delivers water to the crop using a network of mainlines, sub-mains and lateral lines with emission points spaced along their lengths. Each dripper/emitter, orifice supplies a measured, precisely controlled uniform application of water, nutrients, and other required growth substances directly into the root zone of the plant. Water and nutrients enter the soil from the emitters, moving into the root zone of the plants through the combined forces of gravity and capillary. In this way, the plant's withdrawal of moisture and nutrients are replenished almost immediately, ensuring that the plant never suffers from water stress, thus enhancing quality, its ability to achieve optimum growth and high yield. The classic drip irrigation system consists of the following elements: -water source; -pumping station; - fertilizers application device; - water filtration plant; - main pipeline;

	- submain pipelines of various levels; - drip lines. Improved drip irrigation system must also be equipped with a measuring-information system to provide continuous monitoring of soil water regime. The main element of the drip irrigation system is drip line which may be of various types in their design and methods of manufacturing: drip tube or drip tape with drippers (emitters). Drip tube of the Drip - In type. Drip tube of Drip-In type is a rigid polyethylene tube wall thickness of 1.1 - 1.2 mm and diameter of 12, 16 or 20 mm with built-in emitters (drippers) inside. Drippers are available in two forms: pressure compensated and non pressure compensated. Drip tube of the Drip - On type. Represent the plastic pipe wall thickness of 1.1 - 1.2 mm, and diameter 16 or 20 mm, outside of which various types and modifications of Drippers are installed. Any distance between drippers depending on the needs of various plants may be chosen. The service life of the drip tube is not less than 8 years, so it is mainly used for irrigation of orchards, vineyards and berry fields. Drip tape, in contrast to the Drip tube, is a flexible polyethylene tube wall thickness from 100 to 400 microns (4 to 16 mil), and diameter of 12 to 22.5 mm with built-in dripper. Another distinctive feature of drip tape is the drippers are also designed as the flexible labyrinth. Invention of the drip tape made a revolution in drip irrigation. Its use has reduced the cost of irrigation systems in about 5 times, improve the performance of laying strips in 8 times, reduce the material consumption of irrigation systems in 10-12 times. Currently being developed and produced drip tape of various types and designs, each of which has its own advantages and disadvantages.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	At present, Moldova has already implemented several projects contributing to the reconstruction and improvement of old and creation of new modernized irrigation systems: • Transition to High Value Agriculture (THVA) Project funded by the Millennium Challenge Corporation (MCC) of the United States (*Centralized Irrigation System Rehabilitation Activity (CISRA), Irrigation Sector Reform Activity (ISRA)).* • RISP – II Program (For installation / improvements of irrigational systems the soft loan at a rate of up to $100.000 from fractions of the grant at a rate of up to 20 % is provided to farmers). • Rural Financial Services and Marketing Program – The Consolidated Unit for the Implementation of IFAD Programs. • Moldova – Japan 2KR Project. It is necessary to increase the number and the budgets of projects that will stimulate farmers to use advanced resource-saving irrigation systems. Creation and Government support of Water Use Associations to increase the purchasing capacity of farmer's communities to acquire modern irrigation systems and promote their sustainable use.
Costs	The average cost of Drip Irrigation System in Moldova is 1,100 – 1,500 €/per ha
Country social development priorities	• Hotărîre cu privire la aprobarea Programului de dezvoltare a gospodăririi apelor şi a hidroamelioraţiei în Republica Moldova pentru anii 2011-2020 (nr. 751, 5 octombrie 2011) Monitorul Oficial Nr. 170-175 • *National Report "Millennium Development Goals Report: New Challenges – New Objectives", NHDR 2009/2010*

	http://www.undp.md/mdg/MDG1/poverty.shtml, http://www.endpoverty2015.org • *National Report "*Climate Change in Moldova: *Socio-Economic Impact and Policy Options for Adaptation", NHDR 2009/2010* • Irrigation Engineering, Hydrologic, and Agronomic Assessment Report, Republic of Moldova. The Millennium Challenge Corporation (MCC)/ Utah State University (USU), 2009 • National Strategy for Sustainable Development of the Agricultural Complex of the Republic of Moldova for 2008-2015 (Government Decision No. 282 of 11.03.2008.Official Monitor No. 57-60, 21.03.2008) • The National Development Strategy (NDS) for 2008-2011 • Program of Water Supply and Sewerage in Communities of the Republic of Moldova until 2015 (Government Decision No. 1406 of December 30, 2005, Decree No. 662 of June 13, 2007)
Country economic development priorities – economic benefits	• High value agricultural development • Impacts on water supply • Decreasing of irrigation water consumption
Social benefits	• Increasing of the population incomes from guaranteed high yields • Educational and scientific development • Increased community welfare
Environmental *benefits*	Decreasing of impact to the country environment
Other considerations and priorities (such as market potential)	• According to the "Hotărîre cu privire la aprobarea Programului de dezvoltare a gospodăririi apelor şi a hidroamelioraţiei în Republica Moldova pentru anii 2011-2020 (nr. 751, 5 octombrie 2011) Monitorul Oficial Nr. 170-175" till 2020 in Moldova 116,0th ha of new irrigation systems will be built and 121,6th ha will be rehabilitated • About half of this area (118,8th ha) will be equipped with Low-flow, low- pressure and water serving Drip Irrigation Systems
Capital costs (per facility)	• 100 ha **Drip Irrigation Systems** average capital cost – 130,000 € • Total capital investments for 118,8th ha – 154,44 million €
Operational and Maintenance costs (per facility)	• 100 ha **Drip Irrigation Systems** average Operational and Maintenance costs – 13,000 €/ per season (120 working days) • Total Operational and Maintenance costs for 118,8th ha – 15,44 million €/ per season (120 working days)
Daily supply capacity per facility	Daily productivity – 35 ha
Up scaling potential	Daily productivity – 50 ha

Sector	Agriculture
Category	Irrigation Application, Supply - side
Adaptation needs	• Guaranteed yields of agricultural crops in an increasingly dry climate • Reducing of water and energy consumption for irrigation needs in agriculture
Technology Name	**Improved low pressure and water serving Sprinkler Irrigation technologies**

How this technology contributes to adaptation	• Irrigation is an essential tool for getting guaranteed yields in conditions increasingly dry climate of Moldova when lack of natural moisture of the soil will only grow in the future. • Irrigation is the most climate-sensitive use of water. The yields and profitability of irrigated land relative to dryland farming tend to increase as conditions become hotter and drier. Consequently, in areas with available and affordable water supplies, hotter and drier conditions would increase both the land under irrigation and the amount of water applied per irrigated area. Increased water use efficiency attributable to higher atmospheric CO_2 levels would tend to counter the tendency to apply more water as temperatures rise (Kenneth Frederick, 1997). • In these conditions, to reduce consumption of energy and water for irrigation is a major challenge to adapt to climate change.
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	At sprinkling irrigation, water on the field is usually served on pressurized pipelines, and then sprayed it in the form of artificial rain over the irrigated area by sprinkling machines and installations. The principles of creating energy and resource-saving irrigation systems. Depending on the method of irrigation, irrigation system must meet the following principles: • High-altitude location of irrigation lot should not exceed 30 m and 50 m in exceptional cases in relation to the source of irrigation; • Agricultural lands irrigated by sprinklers should have surface slope not more than 5% to prevent irrigation soil erosion; • Application low-pressure sprinkler irrigation devices with diameter of drops not more than 1.5 mm and average rain intensity does not exceed the intensity of the absorption of water into the soil (0.2 …0.3 mm/min); • Application of low-flow (local) irrigation methods to reduce the irrigation water consumption; • Eliminating losses of irrigation water from irrigation canals and pipelines and its flow into the groundwater; • Minimization of the impact of irrigation on soil through the use of irrigation regime based on the principle of additional moisture to natural rainfall; • Using of information-measuring systems for: -continuous recording and processing of agro-meteorological data on irrigation site: air temperature, relative humidity, rainfall, wind speed and direction, solar radiation, ultraviolet radiation, evapotranspiration, irrigation terms and forecast weather conditions; -continuous monitoring of the soil moisture movement; • Using of alternative energy sources for water supply: solar energy, wind energy, gravitational energy of the water in case the water source located higher on irrigated area. Improved Sprinkler Systems and Practices: *Improved center pivots* have been developed that reduce both water application losses and energy requirements. Older center pivots, with the sprinklers attached directly to the pipe, operate at relatively high pressure (4.0-5.5 bar), with wide water-spray patterns. Newer center pivots usually locate the sprinklers on tubes below the pipe and operate at lower pressures (1.0-3.0 bar). Existing center pivots have to be retrofitted with system innovations to reduce water losses and energy needs. ***Linear*** or ***lateral-move*** systems are similar to center-pivot systems, except that the lateral line and towers move in a continuous straight path across a rectangular field. Water may be supplied by a flexible hose connected to the pressurized underground pipe or from a concrete-lined ditch along the field edge. ***LEPA (Low-energy precision application)*** is an adaptation of center pivot (or lateral-move) systems that uses drop tubes extending down from the pipeline to apply water at low pressure below the plant canopy, usually only a few inches above the ground. Applying water

	close to the ground cuts water loss from evaporation and wind and increases application uniformity. On soils with slower infiltration rates, furrow dikes are often used to avoid runoff.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	At present, Moldova has already implemented several projects contributing to the reconstruction and improvement of old and creation of new modernized irrigation systems: • Transition to High Value Agriculture (THVA) Project funded by the Millennium Challenge Corporation (MCC) of the United States (*Centralized Irrigation System Rehabilitation Activity (CISRA), Irrigation Sector Reform Activity (ISRA)).* • RISP – II Program (For installation / improvements of irrigational systems the soft loan at a rate of up to $100.000 from fractions of the grant at a rate of up to 20 % is provided to farmers). • Rural Financial Services and Marketing Program – The Consolidated Unit for the Implementation of IFAD Programs. • Moldova – Japan 2KR Project. It is necessary to increase the number and the budgets of projects that will stimulate farmers to use advanced resource-saving irrigation systems. Creation and Government support of Water Use Associations to increase the purchasing capacity of farmer's communities to acquire modern irrigation systems and promote their sustainable use.
Costs	Center Pivot Sprinkler Irrigation System - 1,480 €/per 1 ha Source: Indicative price of Chamsa Urapivot machines (Spain)
Country social development priorities	• Hotărîre cu privire la aprobarea Programului de dezvoltare a gospodăririi apelor şi a hidroamelioraţiei în Republica Moldova pentru anii 2011-2020 (nr. 751, 5 octombrie 2011) Monitorul Oficial Nr. 170-175 • *National Report "Millennium Development Goals Report: New Challenges – New Objectives", NHDR 2009/2010* http://www.undp.md/mdg/MDG1/poverty.shtml, http://www.endpoverty2015.org • *National Report "*Climate Change in Moldova: *Socio-Economic Impact and Policy Options for Adaptation", NHDR 2009/2010* • Irrigation Engineering, Hydrologic, and Agronomic Assessment Report, Republic of Moldova. The Millennium Challenge Corporation (MCC)/ Utah State University (USU), 2009 • National Strategy for Sustainable Development of the Agricultural Complex of the Republic of Moldova for 2008-2015 (Government Decision No. 282 of 11.03.2008.Official Monitor No. 57-60, 21.03.2008) • The National Development Strategy (NDS) for 2008-2011 • Program of Water Supply and Sewerage in Communities of the Republic of Moldova until 2015 (Government Decision No. 1406 of December 30, 2005, Decree No. 662 of June 13, 2007)
Country economic development priorities – economic benefits	• High value agricultural development • Impacts on water supply • Decreasing of irrigation water consumption
Country environmental development priorities	Decreasing of impact to the country environment

Social benefits	• Increasing of the population incomes from guaranteed high yields • Educational and scientific development • Increased community welfare
Other considerations and priorities (such as market potential)	• According to the "Hotărîre cu privire la aprobarea Programului de dezvoltare a gospodăririi apelor şi a hidroamelioraţiei în Republica Moldova pentru anii 2011-2020 (nr. 751, 5 octombrie 2011) Monitorul Oficial Nr. 170-175" till 2020 in Moldova 116,0th ha of new irrigation systems will be built and 121,6th ha will be rehabilitated • About half of this area (118,8th ha) will be equipped with **Improved low pressure and water serving Sprinkler Irrigation Systems**
Capital costs (per facility)	• 100 ha **Lateral-move Irrigation Systems** average capital cost – 150,000 € • Total capital investments for 118,8th ha – 178,2 million €
Operational and Maintenance costs (per facility)	• 100 ha **Lateral-move Irrigation Systems** average Operational and Maintenance costs – 35,000 €/ per season (120 working days) • Total Operational and Maintenance costs for 118,8th ha – 41,58 million €
Daily supply capacity per facility	Daily productivity – 15 ha
Up scaling potential	Daily productivity – 25 ha

Sector	**Agriculture**
Adaptation needs	Climate change which is a feature of the last three decades, causes not only high temperatures (annual, seasonal), but also other frequent natural extreme events (droughts, floods, etc.). The past 62 years (1945-2007) featured: 12.7% annual droughts with reduced crop productivity levels to 16.9%, spring droughts with respectively 24.6% and 32.8%, and summer droughts: 20.9% and 14.8%. The annual average losses (62 years) are estimated at 220 million Lei at prices of 2009-2011. In the years when extreme phenomena occurred (2003, 2007) the amount of losses can be estimated at $ 130-170 million.
Technology Name	**Technologies for breeding hybrids with high adaptation potential to meteoindicators.**
How this technology contributes to adaptation	For each crop (following the analysis of biological systems) "weak indicators" of modern genotypes to changing the existing and projected meteorological parameters have been identified. For winter crops (wheat, barley, canola, etc.) - resistance to frost and winter, spring crops - drought and extremely high temperatures during critical stages of development of agricultural plants, resistance to (tolerance of) the new pest species and diseases. Modification of improvement programs (aimed at developing such features in new genotypes) after their implementation will enable agriculture to reduce losses of these crops yields.
Background/Notes, Short description of the technology....	The technologies aimed at improving varieties and hybrids with a high potential to adapt to climate change include the following steps: • analysis (assessment) of the adaptive level of approved varieties (hybrids) and identify "weaknesses" in the studied genotypes; • supplementing the collections with original material having blocks of genes needed

	to further include them into the improvement (selection) programs; • testing and selection of new genotypes created naturally and artificially (cold rooms, fitotrones, etc) • inquiring into the level of compliance with bio-economic and ecological capacities in selected genotypes, assessing the new varieties potential for reproduction of seeds and implementation in real production conditions.
Implementation assumptions, How the technology will be implemented and spread across the subsector?	Implementation of newly created varieties (hybrids) in real production conditions can be accomplished through traditional methods: • producing the seeds of newly created varieties on the premises of research institutions (seeds of the highest categories (basic, super-elite seeds) • testing under the system of the State Commission for testing and registration of new genotypes with the registration of the most promising ones; • continuous multiplication (after the registration of varieties) of seeds at the seed farms specialized conditions (elite seeds, I-III reproductions, hybrid seeds (F1)); • Use of new varieties (hybrids) seeds in farming to produce agricultural commodities.
Costs	The final amount of expenditures for technology improvement programs depends on a number of factors and can be estimated at: - total of 470 thousand (?) euro, including for wheat and sun-flower - 319 thousand euro • wheat and winter barley - 234 600 euro; • sun-flower – 77.4 thousand euro; • corn – 75.2 thousand euro; • sugar beet – 56.4 thousand euro; • soybeans and beans – 27.8 thousand euro
Country social development priorities	Implementation of varieties (hybrids) with high adaptive potential in Moldovan agriculture would offset, as a consequence, about 60-70% of crop losses, reducing the fluctuation of amounts of agricultural production in favorable years and years with extreme climate conditions (now sometimes by 5 - 7 times). Stability of amounts of commodities would stimulate the practice of multiannual commercial contracts, would quiet down the fluctuation of prices (now sometimes by 2-3 times), thus making the agribusiness more stable and profitable (with low risk). The following can be projected as consequences: processing enterprises, improved rural infrastructure, etc. The process of implementing programs aimed at improving varieties with high adaptive potential from 5.8 to 6.1 thousand new jobs will be created, including: • in research institutions – 45-50 jobs; • in seed farms – 400-450 jobs; • in farms (level II) – 4.0-4.5 thousand jobs; • at processing enterprises in rural sector – 0.8-1.0 thousand jobs
Country economic priorities-economic benefits	Reducing the fluctuation of agricultural commodities amounts, as well as of risk, is a key condition for financial and economic situation stabilization in rural areas, accumulation of equity, and for attracting credit resources, including foreign investment. Implementation of modern growing and processing technologies in agribusiness can serve as the next step to building upon the scientific and technical progress in the rural sector.
Country environmental development priorities....	Economic wellbeing of rural businesses, increased capital investment in new businesses (for agricultural production processing, new branches of industrial enterprises, service companies, etc.) will form the need (demand) for different highly skilled specialists, and thus stimulate intensive development of rural infrastructure (energy supply, business communications, roads etc).

Social benefits	Strengthening rural businesses, increasing the tax base will drive stimulate growth of local budgets, as well as financial opportunities to improve rural infrastructure (schools, hospitals, cultural objects, etc.). Creating new jobs will decrease the motivation for massive migration of rural population, as well as the sustainability of the demographic decline.
Other considerations and priorities (such as market potential)	Increased amounts of agricultural raw materials, the possibility to process it in rural conditions will ensure the opportunity to sell bigger quantities of high value added products, thus contributing to the increase of profitability of agribusiness and sustainability of financial situation of agricultural enterprises.
Capital (per facility)	Strengthening of technical and material resources required to implement programs improving varieties (hybrids) with perfect adaptive potential, will have the following financial and capital expenditures: • for research institutes – 231.4 thousand euro; • for agricultural enterprises specialized in production of seeds – 21.6 thousand euro.
Operational and Maintenance costs (per facility)	Implementation of the program aimed at improving new varieties (hybrids) adapted to climate change require the following operating costs (annual) • to purchase reagents and the original genetic material from the world collections - 13.0 thousand euro; • remuneration of scientific staff labor - 53.0 thousand euro.
Up scaling potential	In case of successful implementation of the program (technology) aimed at improving the varieties (hybrids) of crops with high potential to adapt to changing climatic parameters, implementation is possible within the existing seed systems on the following areas: • autumn wheat and barley crop - 150-180 thousand ha, 40-45% of the occupied areas • maize – 195-200 thousand ha (50-52%); • sun-flower – 180-190 thousand ha (65-70%); • sugar beet – 15-16.0 thousand ha (62-65%); • soybeans and beans – 38-40 thousand ha (65-67%).

Sector	Agriculture
Adaptation needs	1. Better adaptation to low temperatures during sowing and early vegetation season of plants. 2. Adaptation to drought conditions. 3. Adaptation to vulnerable prices in the process of first generation hybrid seed production.
Technology Name	**Application of anthers culture and "in vitro" isolated pollen methods to obtain and use double haploid lines in plant breeding.**
How this technology contributes to adaptation	1. Enhancement of plant breeding for resistance to different stress factors (cold weather during the first growing season, drought, etc.) by obtaining "pure" or inbred, absolutely homozygous lines as "in vitro" cultures. 2. The possibility to detect valuable mutations at the level of haploid and further - diploid cell may facilitate obtaining of lines resistant to drought, low temperatures, various pathogens, with many valuable features in the main species of crops. 3. The possibility to remove certain inappropriate individuals at early stages of selection, due to the *hemizygot* state of haploids that allow expression of all genes, including unfavorable recessive genes. 4. The possibility to rapidly create, by method of androgenesis, of *androsterile*

	analogues - female genitor lines in the process of first generation hybrid seed production. 5. The possibility of fixing the heterocyst revealed in the first and further hybrid generations. 6. The possibility of reproducing a large number of descendants, which possess valuable features and properties specific to the initial form (parent body) in a short time and a very limited area. 7. Selection and breeding of new plant varieties resistant to drought, diseases and pests. 8. Reducing the costs for human and financial resources while creating varieties of pollinated plants and obtaining the initial material for breeding cross-fertilized plants.
Background / Notes, Short description of the Technology option sourced from Climate TechWiki, Seminars etc	The current system of production of hybrid seed of first generation (F1) is based on development of inbred lines, which, by using a conventional method, are obtained as a result of controlled self-pollination of the original form (variety, population, hybrid) for 5-8 consecutive generations. The genetic research carried out in early '60s of the last century have demonstrated the possibility of obtaining "pure" or double haploid inbred lines in a number of species, including maize, by androgenesis in "in vitro" culture. Androgenesis is the transformation of a haploid cell of the male gametophyte into a mature plant with a gametal number of chromosomes. Androgenesis may be induced through "in vitro" culture of anthers or pollen at a certain stage of development. In order to obtain normal plants, perfect homozygote, haploids diploidize. The fact that the double haploid lines, which are absolutely homozygotic, can be obtained during two generations, while using conventional methods inbred lines are obtained in at least 6-8 generations justify the increased interest of breeders to haploid method. So, the haploid method determines an important reduction of the selection process duration.
Implementation assumption, How the technology will be implemented and spread across the subsector	The technology of "in vitro" culture for obtaining double haploid lines will be used in the Institute of Crop Husbandry "Porumbeni", Institute of Genetics and Plant Physiology of the ASM, the Moldova State Agricultural University, Research Institute for Field Crops "Selectia". The final product of the technology: a) double haploid lines valuable from agronomic point of view can be used directly in production, as commercial varieties in self-pollinated plants and plants with vegetative reproduction. b) haploid lines derived from heterozygotic plants of cross-fertilized species, which necessarily originate from a single gamete, will have a completely different genotype due to re-combinations and large number of genes. c) first generation hybrid seeds will be used by farmers to obtain high yields of crops. The expected scientific results will be published in scientific papers, radio and television, so that farmers, PhD candidates, students will be informed and will make efficient use of knowledge gained from practical implementation.
Country social development priorities	• Improving the living standards of population • Increasing the number of jobs on the labor market • Expanding institutional cooperation (R & D) both nationally and internationally. • Improving the human health care system
Country economic priorities-economic benefits	• Reduce human and energy costs related to organization and care of experiments in the field conditions • Reduce financial costs related to storage of seeds • Stimulate economic activities with environmental impact • Enhance financial support in the agricultural sector, and subsequently the income of rural population. • Expanding the market to sell agricultural production.

Country environmental development priorities (environmental benefits)	• Increase biodiversity and avoid erosion of germplasm. • Improve human health by excluding harmful effects of fertilizers, pesticides and even the allergic effect of pollen on human health. • More rational use of farm land (by reducing the areas used for research and multiplication of seeds purposes. • Preserve fertility and reduce soil erosion. • Reduce GHG emissions and global warming
Social benefits	• More people will be engaged in research and innovation • Increased interest for the implementation of modern biotechnology methods and cultivation of other species and varieties of plants important to the national economy. • Reduce poverty
Other consideration and priorities (such as market potential)	• Increasing knowledge transfer and exchange of know-how among farmers • Stimulate interest for getting higher education and possibility of employment in modern biotechnologies • Expanding the market for selling seeds
Operational costs (without maintenance costs)	Salaries for staff *3 persons x 1200 euro x 1 year=-* 3 600 euro *Annual maintenance (energy, water, gas)* 1400 euro Toal=5000 euro
Upscaling potential	Double haploid lines, absolutely homozygotic, can be obtained within two generations, and relatively homozygotic inbred lines are obtained by the conventional method in at least 6-8 generations. By using double haploid lines and controlled fertilization segregating generations are eliminated, what considerably shortens the improvement program. It has been stated that 100 double haploid plants have genetic variability equal to that shown by the 6000-7000 F2 diploid plants. Given the recessive characteristics, 100 haploids equals to 10 000 diploid plants in F2.

Sector	Agriculture
Adaptation needs	1. Adaptation of agrophytocenoses to environmental changes. 2. Adaptation of seeds reproduction to the adverse impact of biotic and abiotic factors. 3. Adaptation to vulnerable prices in the seed production process.
Technology Name	**Micro-propagation of valuable genotypes by "in vitro" cultivation of plant cells and tissues**.
How this technology contributes to adaptation	1. Possibility to reproduce a large number of descendants having valuable features and properties specific to the initial forms (parent body) in short time and on a very limited areas. 2. Selection and reproduction of new plant varieties resistant to drought, diseases and pests. 3. Revealing varieties with enhanced capacity to assimilate carbon dioxide and respectively, with higher productivity. 4. Obtaining virus-free plants in a series of species (potato, tomato, strawberry, tobacco, vine, fruit and floriculture). 5. Reducing costs for human resources and financial expenditures for the process of seeds and planting material reproduction.
Background / Notes, Short description of the Technology option sourced from Climate	Many species of plants (vine, fruit trees, bushes, strawberries, carnations, etc) reproduce both sexually- by seeds, and by vegetative propagation (by cuttings, tubers, bulbs, buds, rhizomes, etc). – Reproduction by seeds in these species is limited, expensive, takes a long time

TechWiki, Seminars etc	(getting a generation by seeds takes 3-10 years), and causes a high genetic diversity of offspring. This mode of reproduction, now is used more frequently in theoretical research and process improvement only. – In case of vegetative propagation the descendants feature great genetic uniformity and stability and the juvenile period (the period between germination and blooming) is much shorter. In terms of genetics, identical plants can be obtained only through cloned propagation. – Unlike multiplication by seeds, which are usually healthy, vegetative propagation is disadvantaged by the fact that different pathogens (viruses, viroids, fungi, etc.), are transmitted in the course of the cells division. – In order to obtain faster a large number of genetically stable, resistant to biotic and abiotic factors descendants, plant cells and tissues "in vitro" cultivation technique was developed in the 50-60-s of the last century. This method allows regeneration "in vitro" of plant organs (root, apex, reproductive organs) from an initial cell of the whole and even mature body, genetically similar to the one from which they descended. Thus, the "in vitro" culture allows multiplication of valuable genotypes in a relatively short period of time and in a limited space. To use this methods is used in areas that can be grouped according to the three complexes of research tasks aimed at improvement: a) broadening the genetic base of improvement by creating new original material, b) industrial cloned micro-multiplication of precious genotypes c) obtaining virus-free planting material. 1. selection of donor plants, isolation of explants and obtaining a sterile well-bred culture. 2. Micro-propagation itself, when maximum amount of micro-clones is achieved. 3. rooting of multiplied shoots with their further adaptation to field conditions and, if necessary – depositing of regenerated plants at low temperatures (+2 o - 10oC). 4. Growing plants in greenhouses and preparing them for selling or planting in the field, and if necessary – depositing at low temperatures (2 a - 10oC).
Implementation assumption, How the technology will be implemented and spread across the subsector	The technology of valuable varieties by "in vitro" culture multiplication can be used by the Institute of Horticulture and Food Technology, Institute of Genetics and Plant Physiology of the ASM, the Moldova State Agricultural University, Research Institute for Field Crops "Selection", Institute of Botany of the ASM. The final product of this technology: 1. Obtaining of genetically identical clones of elite plants to be used for improvement and plant breeding; 2. Rapid and effective multiplication of new varieties of valuable plants; 3. Advantageous multiplication of highly productive genotypes of wood crops, wood decorative plants or vine rootstocks, as well as vine and fruit crops; 4. Multiplication in sterile conditions aimed at obtaining virus free planting material. 5. Preservation and multiplication of valuable genotypes, separated as initial form for specific improvement purposes; 6. Achieving energy savings compared to greenhouse crops. The crop obtained on 2500 sq.m, can be obtained on 10 sq.m if in vitro culture technique is employed.
Country social	• Reduce poverty

development priorities	• Create jobs • Expand institutional cooperation (R & D) both nationally and internationally • Improve product quality and food security • Improving the system of health care for people
Country economic priorities-economic benefits	• Reduced costs for human resources and energy resources related to organization and maintenance of seed plantations. • Reduce financial costs related to storage of seeds. • Stimulate economic activities with environmental impact • Increase financial support for the agricultural sector, the income of rural population inclusively. • Expand the market for selling agricultural products.
Country enviromental development priorities (environmental benefits)	• Increase biologic diversity and avoid erosion of germplasm. • Improving human health by excluding harmful effects of fertilizers, pesticides, as well as allergic effect of pollen. • More rational use of land (by reducing areas occupied by fields used for growing and multiplication of seeds. • Reduce GHG emission and global warming effect. • Maintain soil fertility and reduce erosion. • Reduce water and air pollution.
Social benefits	• More people in rural areas will be employed. • Improve health, increase birth rate and reduce mortality. • Increasing interest for implementation of modern biotechnologies and cultivation of other species and varieties of plants important to the national economy. • Reduce poverty
Other consideration and priorities (such as market potential)	• Increase knowledge transfer and exchange of know-how among farmers • Higher motivation for university education and employment in modern biotechnologies sector. • Expanding the market or seeds sales.
Capital costs for one unit of:	The laboratory for vegetal tissues cultures shall include: I. Chamber of inoculation, sampling and balances; II. Chamber for preparation of culture media III. Tissue culture growth chamber; IV. Washing – sterilization room; V. Special conditioned chambers (for research purposes); VI. Materials and chemicals storage; VII. Green House Laboratory endowment, approximate cost, thousand euro I. *Chamber of inoculation, sampling and balances -* 3 - Laminar flow hood for two operators, - Binocular magnifying glass (stereomicroscope) - Electronic analytical balance II. *Chamber for preparation of culture media -* 5 - Technical scale - ; - Refrigerators for solutions stock, - Freezer for storing the substances and solutions - Digital pH-meter - Oven thermostat 100 dm3 - Centrifuge 500 - 1500 rotations/min. III. *Tissue culture growth chamber* 8 - Conditioning chambers - Conditioning units - Termofrig - Enameled iron metal shelves, adjustable in four levels, - Ventilators - Humidifier.

	IV. *Washing – sterilization room* 4 - Time controlled autoclave - Water boiler; - Stainless steel sinks (double); - Sterilization oven - Soil sterilizer (oven) V. *Materials and chemicals storage* 3, 76 - Freezer - Refrigerator - Enameled iron metal adjustable shelves - Culture dishes - Dishes and glassware are specific biochemistry laboratories VI. *Other equipment, including reagents* 2 VIII. Green House 2 **TOTAL**- *for 5 laboratories = 27315 th euro*
Operational costs (without maintenance costs)	*3persons x 2000 x 1 year -* 6 *Annual maintenance (energy, water, gas)* 1 *Occupied space, annually (100 sq. m)* 0,65 *7,76 th euro*
Upscaling potential	The up-scaing potential is for 5 laboatories, to cover biotechnological needs in plant propagation for horticulture, forestry, viticulture, vegetable areas. The advantages of in vitro culture tissue are very big. For example, a raspberry meristem can yield 50,000 descendants, while cuttings can generate 20-30 offsprings per year from one plant; in fruit and forest crops this technology can produce up to one million plantlets per year. Given these advantages, since 1986, about 350 tissue culture laboratories and specialized industrial units were created in the U.S.A, of which 18 plants had annual production capacity of 20-25 million plants used as multiplication material. Later such units were created in Japan, England, Holland, France, Germany, Israel, Belgium, Canada, etc. C. Damiano (1980) recommended for productive purposes a space with five rooms (sterile room with five hoods for five workers, each with an incubation norm of 100-120 incubations per day, resulting in one million plants per year.)

Sector	Agriculture
Adaptation needs	Adaptation to increased desertification of agricultural lands situated on slopes, occurring due to increased erosion generated by climate change. In Moldova the lands on slopes with a gradient greater than 2 ° account for 57 percent of the total area. Eroded soils on agricultural lands pedologically evaluated occupy 878 thousand ha. The crops harvested from eroded arable lands (400 thousand hectares) are by 20% smaller in comparison with crops from non-eroded lands. Based on the average yield of cereal crops of 3 t / ha on non-eroded soils, crop losses are 0.6 t / ha / year, or 240 tons / year units of cereals on all eroded areas, which in terms of money is 46 million euro / year. Climate change is expected to generate aridization, increased frequency of torrential rains and, consequently increased erosion (Annex 1). This will lead to increased fertile soil losses and water from the arable soils on slopes, increased pedological drought and crop reduction. To facilitate adaptation to climate change two simple, inexpensive and effective soil erosion control technologies are proposed. Technology (small scale/short term implementation)
Name of technologies	**Cultivation of agricultural crops in alternative strips** (fig.4)

How this technology contributes to adaptation	Reduces erosion by 50-60 percent. In combination with field operations proposed for lands requiring cultivation, it practically stops the erosion on up to 8° gradient slopes. Minimization of soils degradation processes and improvement of the slopes soils moisture regime decrease the risk of desertification of arable soils eroded as a result of climate change.
Background, Short description of the technology option sourced from ClimateTechWiki.	The technology is based on the principle of differential protection provided to soil by the crop foliage and variable crop density, which according to the degree of protection are divided into the following groups: Very good protective crops - perennial grasses and legumes after the first year of growth, provide 90-95 percent protection; Good protective crops - cereal grains, legumes and perennial grasses in the first year of vegetation, annual high density fodder plants, provide 70-90 percent protection; Medium protective crop - annual legumes, provide 50-70 percent protection; Weak protective crops - low density of weeding crops requiring cultivation (corn, sunflower, beets, vegetable crops), provide 20-50 percent protection. Anti-erosion effect on the slopes is ensured by alternating strips of very good and good protective crops, and medium and poorly protective ones.
How this technology will be implemented and spread across the sector?	Can be implemented without limitations. The optimal width of the strips shall be determined based on a very simple special diagrams, depending on the slope. This technology shall be implemented by agricultural businesses on their own land. The initial location of the strips will require appropriate topographical work by a surveyor.
Costs	Large additional expenditures are not necessary. One time investment, of about 40 € for a plot (field), in the first year of implementation, to instrumentally correctly locate the strips on the slopes, will be needed. Given the average area of 20ha of a field on a slope, the implementation cost will be 2 € / ha or 800 thousand euro for the entire area of eroded arable soils (400 ha).
Country social development priorities	It will effectively protect soils from damage caused by erosion, ensure long-term welfare of the rural population, will decrease migration of population, will make it possible to develop and implement various social projects
Country economic development priorities (economic benefits)	The yields on arable eroded soils (about 400 thousand ha) will increase by 5 percent or 1q grain units generating a benefit of about 20 € / ha / year, and a total benefit for all arable eroded soils (400 thousand ha) will be 8 million per year.
Country environmental development priorities (environmental benefits)	The erosion-caused soil degradation processes will be minimized. The risk of roads, ponds, rivers, valleys salination and groundwater pollution will decrease.
Social Benefits	The socio-economic effect from the implementation of this technology will be the following: increased turnover and quality of agricultural production on eroded soils will increase well being and decrease migration of rural population.
Other considerations and priorities (ex. market potential)	This technology implementation potential will grow due to the fact that climate change will lead to increased danger of erosion on agricultural lands
Capital (investment) costs	Implementation of this technology requires upfront expenditures of 2 € / ha or 800 thousand euro for the entire area of eroded arable soils (400 000 ha), for surveying services.

Operational and maintenance costs	The costs will be 1 € / ha / year or 400 thousand euro for the entire area of eroded arable soils for maintenance and operational correction of alternative bands size
Growth potential	The weight of the technology on the market will increase along with the increasing danger of climate change related erosion. Annually, this technology can be implemented on approximately 5-10% of agricultural lands on slopes.

Sector	**Agriculture** (fig.2)
Adaptation needs	Adaptation to increased desertification of agricultural lands situated on slopes, occurring due to increased erosion generated by climate change. In Moldova the lands on slopes with a gradient greater than 2 ° account for 57 percent of the total area. Eroded soils on agricultural lands pedologically evaluated occupy 878 thousand ha. The crops harvested from eroded arable lands (400 thousand hectares) are by 20% smaller in comparison with crops from non-eroded lands. Based on the average yield of cereal crops of 3 t / ha on non-eroded soils, crop losses are 0.6 t / ha / year, or 240 tons / year units of cereals on all eroded areas, which in terms of money is 46 million euro / year. Climate change is expected to generate aridization, increased frequency of torrential rains and, consequently increased erosion (fig2). This will lead to increased fertile soil losses and water from the arable soils on slopes, increased pedological drought and crop reduction. To facilitate adaptation to climate change two simple, inexpensive and effective soil erosion control technologies are proposed.
Name of technologies	**In depth fissuring (30-35 cm)** (fig. 5 and 6)
How this technology contributes to adaptation	Results in erosion reduction by up to 70-80% on slopes with 2-5 ° gradient, used for growing weeding crops. In combination with the growing crops on alternative strips ensures reduction of erosion up to 90%. It reduces the risk of soil deterioration and desertification of arable soil eroded as a result of climate change.
Short description of the technology option sourced from ClimateTechWiki.	The deep loosening of soil increases water permeability, thus decreasing liquid and solid leaking from the slopes. Virtually total absorption of the water from precipitations by soil, stops the erosion and ensures more effective use of water by plants and provides for their better development. Losses of topsoil from the slopes are decreased by on average 5 t / ha.
How this technology will be implemented and spread across the sector?	This technology shall be implemented by agricultural businesses on their eroded lands, occupied by weeding crops. The total area of such lands in the country is about 200 000 ha. Implementation will require a PRVH -2.5 type aggregate with arrow type rippers and a tractor). Small scale/short term implementation.
Costs	Purchasing of a ripper and a tractor (Belarus type tractor, at a price of 25 000 euro, and a ripper at a price of 15 000 euro for 200 ha, total 40 000 euro), and costs of scarification works (1ha-20 €, taking into account the cost of wear and fuel).
Country social development priorities	It provides long-term preservation of soil fertility - the main means of production of the country, increases yields by 10%, decreases the negative effect of climate change by retention of summer rainfall water in soils.

Country economic development priorities (economic benefits)	The weeding crops on eroded soils (about 200 thousand ha), will increase yields by 10 percent or 2q cereal units. It will generate an additional gross income of about 40 € / ha / year (net income 20 € / ha / year), the total gross for all weeding crops on eroded soils (200 thousand ha) - 8 million euro per year, the net economic benefit - 4 million euro per year. The cost of one tone of washed away black soil from the slopes is about 8 euro. Loosening reduces soil losses by 5 t / ha, the calculated benefit based on the cost of prevented soil losses is 40 € / ha or 8 million per year.
Country environmental development priorities (environmental benefits)	The erosion-caused soil degradation processes will be minimized. The risk of roads, ponds, rivers, valleys salination and groundwater pollution will decrease. The ecologic stability of agricultural landscape will improve.
Social Benefits	Socio-economic effect from implementation of this technology will be the following: increased turnover and quality of agricultural production on eroded soils will increase well being and decrease migration of rural population.
Other considerations and priorities (ex. market potential)	The need to implement this technology will grow by 5-10% annually
Capital (investment) costs	40 million euro for purchasing the equipment needed to loosen the 200 000 ha of arable land under weeded crops, or 200 € / ha / 7 years (the time of equipment wearing), or 29 € / ha / year.
Operational and maintenance costs	The cost of loosening of 1ha of land under weeding crops on slopes, taking into account the wear of equipment and fuel costs is 20 € / ha / year or 4 million euro for 200 ha / year.
Growth potential	Increasing resistance of agricultural soils to erosion as a result of adverse climate change effects increases the market potential of this technology. Loosening of eroded soils on slopes can be made between rows and in vineyards and orchards.

Sector	**Agriculture**
Adaptation needs	Adaptation to increasing desertification by dehumification, dissolution and secondary compaction of the soil arable layer (fig.3) Climate aridization along with classic cultivation lead to dehumification of agricultural soils, soil structure damage and strong secondary compaction of the arable layer (Annex 2). Currently the arable layer of agricultural soils lost its natural ability to compaction resistance. Dehumification, dissolution and secondary arable soil compaction is a global problem, but particularly acute in Moldova where 80 percent of soils are characterized by fine texture. These soils have a high production capacity only if their structure is agronomically favorable and contributes positively to regulate air-fluid and nutrients regimes, ensuring optimal conditions for plant growth and development. In a compacted layer of soil moisture reserves are almost by 2 times less accessible than in the same loose layer with agronomically favorable structure. Therefore, soils with high content of humus, agronomically favorable structure and loose arable layer are more adapted to climate change. To adapt to increasing desertification due to dehumification, dissolution and secondary compaction of the arable layer of soil generated by climate change, 6 technologies described below are recommended.

Name of technologies	**Introduction of 50 t/ha of manure with bedding to agricultural soils once in five years** (fig.7)
How this technology contributes to adaptation	This technology helps maintain a stable content of organic matter in the soil. The content of nutrients increases, and the soil structure improves. The arable layer becomes more loose, more resistant to compaction, better provided with reserves of water accessible to plants. This increases crop resistance to drought.
Background, Short description of the technology option sourced from ClimateTechWiki, etc	The technology implies the return of the biophil elements contained in dung, urine and vegetal waste of cattle bedding, in the biological circuit. One tone of manure with bedding at 50-55% humidity contains about 15-16 kg of nitrogen, phosphorus and potassium.
How this technology will be implemented and spread across the sector?	Currently there are no large farms and cattle herd is concentrated in rural households. To use manure as fertilizer, municipalities have to organize the collection, storage, fermentation and storage of manure on special platforms. Technologies for processing and introduction of manure in the soil are provided in specially developed recommendations (Organic Fertilizer User Ghuide. Ch Pontos, 2012.115p). Realistically possible reserves of manure collection in the country do not exceed 2 - 3 million tons, which would be sufficient to fertilize only 200 thousand ha of agricultural lands annually, provided this amount is indeed collected (regretfully the amount collected is tens times smaller). The amount of manure possible to collect is 9 times lower than required.
Costs	The incurred costs will be for collection, processing, transportation and incorporating manure into the soil. Investments are needed to build communal manure platforms and purchase the equipment necessary for such platforms (fig.7)
Country social development priorities	This technology will ensure long-term preservation of soil fertility - the main means of production of the country, will protect agricultural land from desertification processes which lead to impoverishment of population and migration. It will improve the sanitary condition of rural environment.
Country economic development priorities (economic benefits)	The total increase of crop through the entire period of action of the 50 t of manure / ha is 1t/ha/year grain units in 5 years or - 200 € / ha/year in money terms. Total (gross) benefit over 5 years is 1000 € / ha or 200 € / ha annually. If this technology is applied regularly, it contributes to developing carbon balance in soil, and practically excludes CO_2 emissions from agricultural soils.
Country environmental development priorities (environmental benefits)	This technology stops the accelerated degradation of soils, it reduces the risk of nitrate pollution of water in wells in villages, improves sanitary conditions in villages and health of population.
Social Benefits	The social - economic effect of this technology implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, decrease migration, and increase the earnings for social infrastructure development.
Other considerations and priorities (ex. market potential)	Along with the growth of cattle herds, areas fertilized with manure will also expand.

Capital (investment) costs	Investments are needed to build communal collective platforms for manure collection - about 70 thousand euro and 30 thousand euro - for purchase of an excavator, a total of 100 thousand euro.
Operational and maintenance costs	About 4000 euro per year will be needed to pay the salary to two manure collection platform operators.
Functionality ensuring needs per technological unit per day (optional)	Expenditures for application of manure amount to 12 € per ton, 600 € for 50 t / ha introduced once in five years, or 120 € / ha / year
Growth potential	The weight of this technology on the market will grow along with environmental friendliness of agriculture

Sector	**Agriculture**
Adaptation needs	Adaptation to increasing desertification by dehumification, dissolution and secondary compaction of the soil arable layer Climate aridization along with classic cultivation lead to dehumification of agricultural soils, soil structure damage and strong secondary compaction of the arable layer (fig.3). Currently the arable layer of agricultural soils lost its natural ability to compaction resistance. Dehumification, dissolution and secondary arable soil compaction is a global problem, but particularly acute in Moldova where 80 percent of soils are characterized by fine texture. These soils have a high production capacity only if their structure is agronomically favorable and contributes positively to regulate air-fluid and nutrients regimes, ensuring optimal conditions for plant growth and development. In a compacted layer of soil moisture reserves are almost by 2 times less accessible than in the same loose layer with agronomically favorable structure. Therefore, soils with high content of humus, agronomically favorable structure and loose arable layer are more adapted to climate change. To adapt to increasing desertification due to dehumification, dissolution and secondary compaction of the arable layer of soil generated by climate change, 6 technologies described below are recommended.
Name of technologies	**Vetch field as green fertilizer into 5 year crop rotation**
How this technology contributes to adaptation	Vetch can yield two crops of air mass (about 12 t / ha dry air mass containing 4% nitrogen) and roots (dry root mass of about 8t/ha containing 2 % of nitrogen) per year. It provides for accumulation of about 20 tons of organic matter in soil which ensures synthesis of almost 5 t / ha of humus which contains about 400 kg of nitrogen. This amount of humus is sufficient to create a positive carbon and nitrogen balance in soil during 5 years. The arable layer will become structured, loose, will contribute to a favorable air-fluid and nutrients regime and will increase the plants resistance to drought. Technology entails environmental friendliness of agriculture, more effective use of water and nutrients from soil.
Short description of the technology option sourced from ClimateTechWiki.	The technology is based on the fact that green mass of vetch is very rich in nitrogen, which leads to fertilization of soil on account of symbiotic nitrogen. A good quality green mass contributes to rapid synthesis of organic matter in soil. The root system of vetch is well developed and contributes to the structuring of the arable soil layer. Given the two harvests of vetch per year, the arable layer of the soil becomes biogenic, structured, loose, and permeable for water and roots. Technology (small scale/long term implementation)

How this technology will be implemented and spread across the sector?	This technology can be successfully implemented on all agricultural lands of farmers. It can be implemented under any land cultivation system. In order to implement this technology, it is necessary to create the autumn and spring vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September and spring vetch – in early May of the next year after incorporation of autumn vetch mass into soil.
Country social development priorities	This technology ensures a long-term preservation of soil fertility - the main means of production of the country, protects the land from desertification processes, creates economic prerequisites for replacing the existing system of subsistence agriculture with sustainable agriculture based primarily on employment of natural processes, biological and renewable resources and only secondarily - purchased resources. Preserved internal resources, the soil with its characteristics, water, biodiversity, etc., are a prominent feature of sustainable agriculture and subsequently, of combating desertification and land degradation caused by climate aridization.
Country economic development priorities (economic benefits)	The total crop growth over the whole period of vetch green mass action (5 years) is 4t/ha cereal units or 800 € / ha / year in monetary terms. The net benefit is € 191 / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO_2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.
Country environmental development priorities (environmental benefits)	It stops soil degradation, makes the humus and soil carbon balance positive or well-balanced, cardinally improves the soil biota status, increases resistance of soil to pollution and of plants to drought.
Social benefits	The social - economic effect of this technology implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, decrease migration, create the economic prerequisites for projects to improve the ecological status of villages.
Other considerations and priorities (ex. market potential)	This technology will be employed in colder parts of Moldova, where vetch can not be used as an intermediate crop for green fertilizer
Capital (investment) costs	Investment costs are the same as the cost in conventional agriculture (150 euro once in 10 years or 15 euro / ha/year. For areas of 200 000 ha – 30,000,000 euro once in 10 years or 3,000,000 euro /year (for purchasing of the necessary equipment).
Operational and maintenance costs	Organization of the seed production process or purchasing of vetch seeds is worth 85 € / ha / year. These expenses are included in the cost of technology. Expenses for seedbed preparation, sowing and incorporation of vetch green mass into soil are € 170 / ha / year, given two harvests per year for 5 years - 34 € / ha / year. Implementation area is 200 000 ha. The operational costs of technology is: €34 x 200 000=€6 800 000 Total cost: €9 800 000
Growth potential	The weight of this technology on the market will grow along with environmental friendliness of agriculture

Sector	Agriculture
Name of technologies	**Vetch field as green fertilizer as successive into existing crop rotation.**
How this technology contributes to adaptation	A crop of vetch (about 6 t / ha of dry weight containing 4% of nitrogen), and roots (about 4t/ha dry weight containing 2% of nitrogen) accumulates about 10 tons of organic matter in soil, which ensures synthesis of about 2.5 t / ha of humus containing about 200kg of nitrogen. This amount of humus is sufficient to create a positive carbon and nitrogen balance in soil during 2 years. The arable layer will become structured, loose, will contribute to a favorable air-fluid and nutrients regime and will increase the plants resistance to drought.
Short description of the technology option sourced from ClimateTechWiki.	This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.
How this technology will be implemented and spread across the sector?	Technology can be successfully implemented on the entire surface of agricultural soils under any soil tillage system. Vetch as a successive crop used as green fertilizer, shall be sown once in two years after harvesting spiked cereals. Implementation of this technology requires autumn and spring vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September.
Costs	Annual expenditures for including vetch as successive crop used as green fertilizer in the agricultural systems, are 85 € / ha / year per harvest.
Country social development priorities	This technology ensures a long-term preservation of soil fertility - the main means of production of the country, protects the land from desertification processes, creates economic prerequisites for replacing the existing system of subsistence agriculture with sustainable agriculture based primarily on employment of natural processes, biological and renewable resources and only secondarily - purchased resources. Preserved internal resources, the soil with its characteristics, water, biodiversity, etc., are a prominent feature of sustainable agriculture and subsequently, of combating desertification and land degradation caused by climate aridization.
Country economic development priorities (economic benefits)	The total crop growth over the whole period of vetch green mass action (2 years) is 2.0 t / ha grain units or - 400 € / ha in monetary terms. The net benefit is 315 € / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO_2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.
Country environmental development priorities (environmental benefits)	It stops soil degradation, makes the humus and soil carbon balance positive or well-balanced, cardinally improves the soil biota status, increases resistance of soil to pollution and of plants to drought.
Social benefits	The social - economic effect of this technology implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, and decrease migration.
Other considerations and priorities	The agricultural production process becomes more environment friendly.

Capital (investment) costs	It is necessary to purchase an organic waste chopper similar to the ones manufactured by Lemken - worth 20 thousand €.
Operational and maintenance costs	Organization of the seed production process or purchasing of vetch seeds is worth 58 € / ha / year. These expenses are included in the cost of technology. Total costs for all operationl works are 11 600 000 euro. Total costs per technology are:11 620 000 euro.
Growth potential	The weight of this technology on the market will grow along with environmental friendliness of agriculture

Sector	Agriculture
Adaptation needs	Due to specifics of some crops (sugar beet and fodder, vegetables, etc..), the classical soil cultivation system can be replaced with a system aimed at soil conservation on only 80 percent of arable lands. Based on this, it is proposed to improve the classical cultivation system that will still be used for 20 percent of lands, by including a " vetch field as green fertilizer" into a 5 fields crop rotation, or using the vetch as successive green fertilizer crop.
Name of technologies	**Conventional land cultivation system with moldboard plow in 5 fields crop rotation with a field of vetch used as green fertilizer**.
Short description of the technology option sourced from ClimateTechWiki.	This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.
How this technology will be implemented and spread across the sector?	This technology can be successfully implemented on 20 percent of agricultural lands, on which for various reasons it is not possible to implement the soil conservation system. On the "occupied field" vetch shall be sown and applied to soil twice a year (the soil accumulates about 20t/ha of organic matter that maintains the balance of nitrogen and carbon during 4 years). Vetch as a successive crop used as green fertilizer, shall be sown once in two years after harvesting spiked cereals. Implementation of this complex technology requires vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September.
Costs	Annual expenditures for including vetch as green fertilizer in the classical soil cultivation system as "occupied field" in crop rotation, as well as using it as successive crop are equal and are worth 85 € / ha / year per harvest, and 170€/ha/year for 2 harvests per year. Under the classical soil cultivation system, the cost of tillage stubble-turning, weed control, plowing, seedbed preparation, sowing of the basic crops and post sowing compression are 135 € / ha / year. Other expenses after planting are equal for all soil cultivation systems.
Country social development priorities	This technology ensures a long-term preservation of soil fertility - the main means of production of the country, protects the land from desertification processes entailing impoverishment and migration of population, creates economic prerequisites for replacing the existing system of subsistence agriculture with sustainable agriculture based primarily on employment of natural processes, biological and renewable resources and only secondarily - purchased resources. Preserved internal resources, the soil with its characteristics, water, biodiversity, etc., are a prominent feature of sustainable agriculture and subsequently, of combating land degradation and desertification.

Country economic development priorities (economic benefits)	The total crop growth over the whole period of vetch green mass action (5 years) is 4t/ha cereal units or 765 € / ha / year in monetary terms. The net benefit is € 20 / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO_2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.
Country environmental development priorities (environmental benefits)	It stops soil degradation, makes the humus and soil carbon balance positive or well-balanced, cardinally improves the soil biota status, increases resistance of soil to pollution and of plants to drought.
Social benefits	The social - economic effect of this technology implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, and decrease migration.
Other considerations and priorities (ex. market potential)	The agricultural production process becomes more environmentally friendly.
Capital (investment) costs	Investment costs are the same as the cost in conventional agriculture (171 euro once in 10 years or 17.1euro / ha/year. For areas of 200 000 ha – 34,200,000 euro once in 10 years or 3,400,000 euro /year (for purchasing of the necessary equipment).
Operational and maintenance costs	Expenses for organizing the vetch seed production process or purchase are 170 € / ha once in 5 years for each field or 34 € / ha / year. These expenses are included in the cost of technology. Expenses for classical soil cultivation are 135 € / ha / year. Total operating expenses - 169 €/ha/year. Total implemented area is 200, 000ha. Thus, the operational costs are: 33, 800, 000 euro. The total costs of this technology is 37,220,000 euro.
Growth potential	The weight of this technology on the market will grow along with environmental friendliness of agriculture.

Sector	Agriculture
Adaptation needs	The classical soil cultivation system generated the phenomena of soil features degradation. Excessive plowing favored dehumification, damage of the soil structure, increased compaction, danger of erosion. It became necessary to develop new tillage systems known as “soil conservation works systems, SCWS". Mini-till and No-Till systems turned out to be the most effective. It is proposed to improve these two systems by including vetch as successive crop for green fertilizer.
Name of technologies	**Mini-till system and vetch as successive plant**
How this technology contributes to adaptation	A crop of vetch (about 6 t / ha of dry weight containing 4% of nitrogen), and roots (about 4t/ha dry weight containing 2% of nitrogen) accumulates about 10 tons of organic matter in soil, which ensures synthesis of about 2.5 t / ha of humus containing about 200kg of nitrogen. This amount of humus is sufficient to create a positive carbon and nitrogen balance in soil during 2 years. The arable layer will become structured, loose, will contribute to a favorable air-fluid and nutrients regime and will increase the plants resistance to drought. Technology (large scale / medium-long term implementation)

Short description of the technology option sourced from ClimateTechWiki.	This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.
How this technology will be implemented and spread across the sector?	This technology can be successfully implemented on 50 percent of agricultural lands. Vetch, as a successive crop used as green fertilizer, shall be sown once in two years after harvesting spiked cereals. Implementation of this complex technology requires vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September.
Costs	The costs for including vetch as successive crop used as green fertilizer under the mini-till soil cultivation system are worth 85 € / ha for 2 years or 43 € / ha / year. Summary costs for tillage stubble-turning, weed control, disc harrowing, seedbed preparation, sowing of the basic crops and post sowing compression are 70 € / ha / year.
Country social development priorities	This technology ensures a long-term preservation of soil fertility - the main means of production of the country, protects the land from desertification processes entailing impoverishment and migration of population, creates economic prerequisites for replacing the existing system of subsistence agriculture with sustainable agriculture based primarily on employment of natural processes, biological and renewable resources and only secondarily - purchased resources. Preserved internal resources, the soil with its characteristics, water, biodiversity, etc., are a prominent feature of sustainable agriculture and subsequently, of combating land degradation and desertification.
Country economic development priorities (economic benefits)	The crop growth over the whole period of vetch green mass action (2 years) is 1t/ha cereal units or 200 € / ha / year in monetary terms. The net benefit is € 115 / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO_2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent.
Country environmental development priorities (environmental benefits)	It stops soil degradation, makes the humus and soil carbon balance positive or well-balanced, cardinally improves the soil biota status, increases resistance of soil to pollution and of plants to drought, agricultural products become ecologically cleaner.
Social benefits	The social - economic effect of this technology implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, and decrease migration.
Other considerations and priorities	The agricultural production process becomes more environmentally friendly.
Capital (investment) costs	It is necessary to purchase an organic waste chopper similar to the ones manufactured by Lemken - worth 20 thousand € and a combined drill tillage and sowing machine worth € 50 000, in total 70 thousand €.
Operational and maintenance costs	Expenses for organizing the vetch seed production process or purchase are 85€/ha/2 years or 43€/ha/. These expenses are included in the cost of technology. Costs for tillage stubble-turning, weed control, disc harrowing, seedbed preparation, sowing of the basic crops and post sowing compression under the mini-Till soil cultivation system are worth 70 € / ha / year. Total operational costs - 113€/ha/year. Implementation area-200 000 ha. Total operational costs-32 600 000 euro.
Growth potential	The weight of this technology on the market will grow along with environmental friendliness of agriculture based on natural processes.

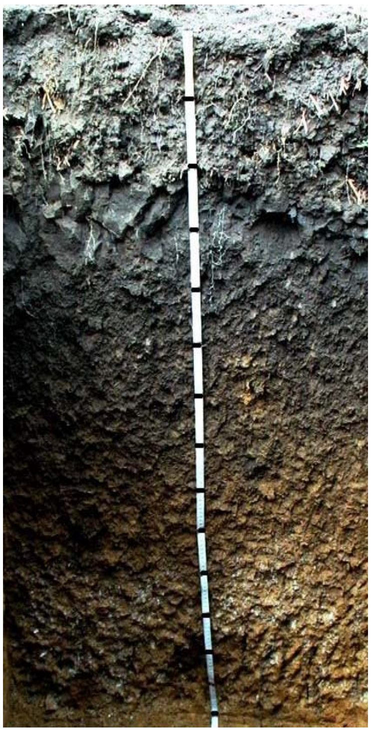
Sector	Agriculture
Adaptation needs	The existing soil cultivation systems entail intensive physical, chemical and biological degradation of soil. The classical soil cultivation system generated the phenomena of soil features degradation. Excessive plowing favored dehumification, damage of the soil structure, increased compaction, danger of erosion. It became necessary to develop new tillage systems known as " soil conservation works systems, SCWS". Mini-till and No-Till systems turned out to be the most effective.
Name of technologies	**No-tlll system and vetch as successive plant**
How this technology contributes to adaptation	It is proposed to improve these two systems by including vetch as successive crop for green fertilizer. A crop of vetch (about 6 t / ha of dry weight containing 4% of nitrogen), and roots (about 4t/ha dry weight containing 2% of nitrogen) accumulates about 10 tons of organic matter in soil, which ensures synthesis of about 2.5 t / ha of humus containing about 200kg of nitrogen. This amount of humus is sufficient to create a positive carbon and nitrogen balance in soil during 2 years. The No-till soil cultivation system means that the sowing is done directly on the stubble field or field containing vegetal waste of the previous crop. The main mechanism for No-Till is the sowing machine. The main element of the sowing machine is the cutter. Recently, the cutters are combined with corrugated disc type blades in combination with chisel type blades. Gradually, the topsoil will become biogenic, well structured, loose, will contribute to a favorable air-fluid and nutrients regime and will increase the plants resistance to drought. Technology (large scale / medium-long term implementation)
Short description of the technology option sourced from ClimateTechWiki.	This technology contributes to environmental friendliness of agriculture, creating a positive balance of humus and soil carbon, return of about 200 kg of nitrogen into soil, of which 50% are of symbiotic origin, reduces the risk of reduced yields due to climate change.
How this technology will be implemented and spread across the sector?	This technology can be successfully implemented on 50 percent of agricultural lands. Vetch, as a successive crop used as green fertilizer, shall be sown once in two years after harvesting spiked cereals. Implementation of this complex technology requires vetch seeds production operation. The autumn vetch shall be planted, as appropriate, in late August or early September.
Costs	The costs for including vetch as successive crop used as green fertilizer under the no-till soil cultivation system are worth 85 € / ha for 2 years or 43 € / ha / year. Summary costs for weed control, sowing under no-till system are worth 60 € / ha / year, total of 103€/ha/year.

Country social development priorities	This technology ensures a long-term preservation of soil fertility - the main means of production of the country, protects the land from desertification processes entailing impoverishment and migration of population, creates economic prerequisites for replacing the existing system of subsistence agriculture with sustainable agriculture based primarily on employment of natural processes, biological and renewable resources and only secondarily - purchased resources. Preserved internal resources, the soil with its characteristics, water, biodiversity, etc., are a prominent feature of sustainable agriculture and subsequently, of combating land degradation and desertification. It reduces tractor wear and fuel costs by 2 times.
Country economic development priorities (economic benefits)	The annual crop growth over the whole period of vetch green mass action (2 years) is 1t/ha cereal units or 200 € / ha / year in monetary terms. The net benefit is € 115 / ha / year. If applied regularly, this technology contributes to a positive balance of soil carbon, excludes CO2 emissions, reduces the need to purchase and apply nitrogen fertilizers by 80-90 percent
Country environmental development priorities (environmental benefits)	It stops soil degradation, makes the humus and soil carbon balance positive or well-balanced, cardinally improves the soil biota status, increases resistance of soil to pollution and of plants to drought, agricultural products become ecologically cleaner.
Social benefits	The social - economic effect of this technology implementation will be the following: it will increase the turnover and quality of agricultural production on arable soils, wellbeing of rural population, and decrease migration.
Other considerations and priorities (ex. market potential)	It improves the ecological status of the land, the agricultural production process becomes more environmentally friendly.
Capital (investment) costs	It is necessary to purchase No-Till drill worth € 75thousand and a vetch green mass chopper of CHIARA type, worth € 7500, total capital expenditures - € 82,500.
Operational and maintenance costs	Expenses for organizing the vetch seed production process or purchase are worth 85€/ha/2 years or 43€/ha/ year. These expenses are included in the toal cost of vetch technology wich are 162 euro/ha.. The implementation area – 200 000 ha Total costs of technology: 32 400 000 euro.
Growth potential	The weight of this technology on the market will grow along with environmental friendliness of agriculture based on natural processes.

Figures 2-10 refer to the Agriculture Soils Technologies.

Fig.2. Degradation of agricultural soil as a result of erosion

Favorable natural structure of fallow black earth



Black earth with de-structured arable layer and post-arable compact layer

Structural element of post-arable compact layer

Fig.3. Dehumification, destruction and strong compaction of black earth as a result of tillage

Fig.4. The system of land cultivation in alternative strips

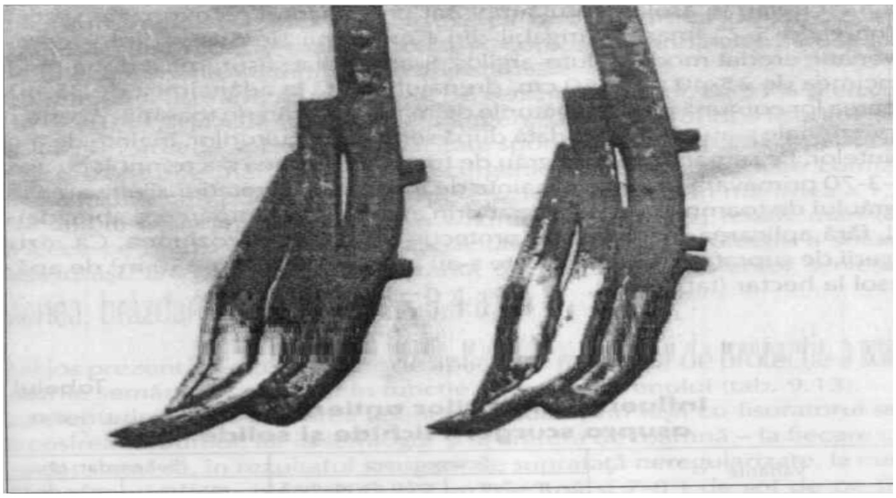


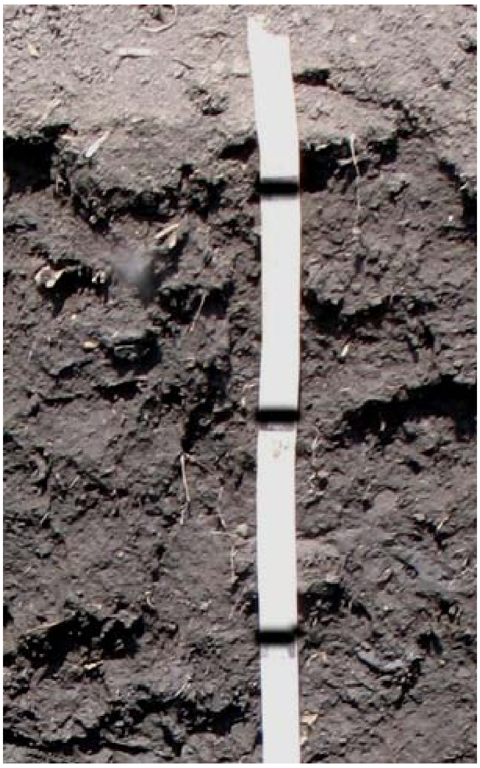
Fig.5. Construction of the working tools of a loosener

Fig.6. Ripper (on the basis of PRVH-2.5)

Fig.7. Communal and individual manure platforms

Fig.8. Vetch strip, 24.04. 2010 and wheat strip after vetch, 17.05. 2011

Higher top quality yield compared with control sample – 1.3 t/ha/year


a


b

Fig.9. Arable layer of cambic black earth before (a) and after 2 years of

phyto-improvement with organic waste and vetch roots (b).

Application of vetch to soil has been done by disc harrowing.

Fig.10. No-till soil loosening mechanisms

Fig.11. Agricultural machinery for the mini-till soil cultivation system

Sector	**Agriculture**
Adaptation needs	1. Higher adaptability to more frequent droughts 2. Higher adaptation to limited natural resources (water, nonrenewable sources of energy, soil) 3. Higher adaptation to prices vulnerability for agricultural products and resources (nonrenewable sources of energy) in globalized economy
Technology Name	**Conventional system of soil tillage for winter wheat**
How this technology contributes to adaptation	1. Moldboard plow for winter wheat has some avantages and disadvantages. Among advantages we can mention: - possibility to control better weeds, especially perennial weeds - better control of pests and deseases - a deeper layer for root penetration etc. Among disadvantages: - higher vulnerability to wind and water erosion - higher consume of fuel - negative influence on earth warms etc 2. Sowing of winter wheat after early harvested predecessors allows to accumulate more soil moisture, thus reducing the vulnerability to droughts.
Background notes. Short description of the technology	Moldboard plow is one of the most important technological operation in the existing technology of growing field crops in Moldova. Immediately after this operation we need to work soil with disks and after this with cultivator.
Implementation assumption.	This technology is already used on large scale in Moldova. The reason for this is missing of a balanced structure of sowing area with high percent of row crops. In order to implement alternative systems of soil tillage we need to make a transition to other agricultural equipments, which allows to keep crop residues on the surface of the soil.

<table>
<tr><td>Costs per 1 ha</td><td>

	Fuel, l/ha	Salary, lei/ha
1. Moldboard plow (MTZ-80+PLN-3-35)	25,0	41,3
2. Disks, MTZ-80+BDT-3	6,0	10,9
3. Cultivation, MTZ-80+KPG-4	6,0	10,9
TOTAL	37,0	63,1

</td></tr>
<tr><td>Country social development priorities</td><td>• Reducing the pouverty
• Increasing the employment of people
• Increasing the rates of burth and decreasing the mortality of people
• Improving the system of health care for people</td></tr>
<tr><td>Country economic priorities - economic benefits</td><td>• Increasing the sustainability of agricultural sector, including profitability
• Reducing the dependence from nonrenewable sources of energy and their derivates (mineral fertilizers and pesticides)
• Creating condition for the development of smal and medium enterprises</td></tr>
<tr><td>Enviromental benefits</td><td>Achieving a more sustainable use of natural resources through preventing soil degradation, soil and water pollution, preservation of biodiversity etc.</td></tr>
<tr><td>Social benefits</td><td>Maintaining the fertility of soil as the basis for maintaining and increasing productivity for achieving economic stability for the welbeeing of people.</td></tr>
<tr><td>Other consideration and priorities</td><td>Providing self – sufficiency at differrent levels</td></tr>
<tr><td>Capital costs for one unit of:</td><td>Moldboard plow – PR-4 – 82862 lei
The required amount for the total area of field crops in Moldova 48571 (the productivity per day is 5 ha; the optimal time for doing such work is 7 days).
The total cost of tillage equipment is: 335,4 mln.am.doll.</td></tr>
<tr><td>Operational costs</td><td>Use of fuel per 1 ha
31 l x 15 lei = 465 lei</td></tr>
</table>

Sector	**Agriculture**
Adoptation needs	1. Higher adaptability to more frequent droughts 2. Higher adaptation to limited natural resources (water, non renewable sources of energy, soil) 3. Higher adaptation to prices vulnerability for agricultural products and resources (non renewable sources of energy) in globalized economy
Technology Name	**Conservation system of soil tillage for winter wheat with herbicides**
How this technology contributes to adaptation	1. Minimum tillage in crop rotation contributes to the reduction of soil erosion and uncompensated mineralizational losses 2. By reducing soil erosion and mineralization losses of soil organic matter the global warming is decreasing through increased carbon sequestration 3. By reducing the consumption of fuel as a result of replacing moldboard plow with minimum tillage it is possible to adapt to the limited sources of non renewable energy, to the fluctuation of prices for non renewable sources of energy at the international

	level 4. By keeping mulch on the soil surface it is possible to reduce evaporation of soil moisture and to increase the stoks of soil moisture in the soil. So, the negative influence of drought can be reduced
Background/Notes. Short description of the technology	The moldboard is replaced by soil tillage with combinator. So, three technological operation (in the previous model of technology) are replaced by one.
Implementation assumption. How the technology will be implemented and diffused across the subsector	Minimum tillage system (conservation tillage) is studied in long-term field experiments at the Research Institute of Field Crops „Selectia". Research results are available for farmers through publication, recommendation, TV, radio, newspapers etc. Farmers are visiting the experimental plots of the institute. We are organising also seminars for farmers – at least two time during the year – before sowing in the spring after harvesting in the fall.
Costs per 1 ha	Combination T-150+Sunflower CN-3 The economy of fuel by using combinator for winter cereal crops instead of moldboard plow consists 15 l/ha and the economy for salary 50,1 lei/ha
Country social development	• Reducing the pauverty • Increasing the employment of people • Increasing the rates of burth and decreasing the mortality of people • Improving the system of health care for people
Country economic priorities	• Increasing the sustainability of agricultural sector, including profitability • Reducing the dependence from non renewable sources of energy and their derivates (mineral fertilizers and pesticides) • Creating condition for the development of smal and medium enterprises
Enviromental benefits	• Higher carbon sequestration which allows to reduce global warming • Reduction of soil erosion and better storage of soil moisture • Reduction of pollution of ground water with nitrates • Reduction GHG emision as a result of lower amount of burned fuel
Social benefits	• Maintaining soil fertility as the basis for maintaining and increasing productivity for achieving economic stability for the welbeeing of people • Improving health of people as a result of increased soil functionality and decreased inputs (mineral fertilizers, pesticides) • More people remaining in rural communities
Other consideration and priorities (such as market potential)	• Decreasing the expenditures for fuel will lead to higher competitivness of agr. producers at the local, regional and international markets • Providing self – sufficiency of food at different levels
Capital costs for one unit of:	Combinator (CN 3-3) – 110,000 lei The required amount for the total area of field crops in Moldova: - combinators – 7500 (the productivity per day is 12 ha and the optimal time for doing such work is 5 days) The total costs of tillage equipment is: - combinators – 825 mln.lei which is equivalent to 66 mln.am.doll.
Operational costs (without maintenace costs)	Use of fuel per 1 ha 10 l x 15 lei = 150 lei The cost of fuel for total area by tillaging soil with combinator – 67,5 mln.lei, which is equivalent to 5,4 mln.am.doll
Daily supply capacity perfacility	The combinator can tillage 12 ha/day
Upscaling potencial	Area to be tillaged consists: for winter cereal crops – 450.000 ha

Technology name	**Conservation system of soil tillage without herbicides for winter wheat**
How this technology contributes to adaption	- Moldboard plow is replaced by combinator, which contributes to the reduction of soil erosion and uncompensated mineralizational losses - By reduction of soil erosion and mineralization losses of soil organic matter we decrease global warming through increased carbon sequestration - By reducing the consumption of fuel as a result of replacing moldboard plow with minimum tillage it is possible to adapt to the limited sources of nonrenewable sources of energy, to the fluctuation of prices for nonrenewable sources of energy at the international level - By keeping mulch on the soil surface it is possible to reduce evaporation of soil moisture and to increase the resistance
Background Notes, Short description of the technology	By using combinator we can replace moldboard plow or chisel plow. After both of them as a rule discing is done. So, by using combinator we can replace three technological operations by one. After this direct sowing is done.
Implementation assumption	Minimum tillage system is studied in the long/term field experiments at the RIFC «Selectia". Research results are available for farmers through publications of books, recommendations, articles, TV, radio etc. Farmers are visiting experimental plots of the institute with different systems of soil tillage. Each year we are organizing seminars for farmers at least two times (in the spring, before sowing spring crops, and in the fall before sowing winter cereal crops). Diring these seminars farmers can see the equipment in operation for minimum tillage in crop rotation
Costs per 1 ha	Costs of technological operations for conventional tillage: fuel – 37 lei/ha; salary – 63.1 lei/ha. Costs of technological operation by using combinator: fuel – 10 lei/ha; salary – 13 lei/ha
Country social development priorities	- Reducing the poverty - Increasing the employment of people - Increasing the rates of burth and decreasing the mortality - Improving the system of health care for people
Country economic priorities – economic benefits	- Increasing the sustainability of agricultural sector, including profitability - Reducing the dependence from nonrenewable sources of energy and their derivates (mineral fertilizers and pesticides), which we have to import at the moment and in the future - Creating conditions for the development of small and medium enterprises

Environment benefits	- Achieving a more sustainable use of natural resources through preventing soil degradation, soil and water pollution, preservation of biodiversity etc.
	- By implementing a conservative system of soil tillage it would be possible to increase the environment benefits through:
	    - higher carbon sequestration which allows to reduce global warming;
	    - reduction of soil erosion and better storage of soil moisture;
	    - reduction of pollution for ground water with nitrates;
	    - reduction of GHG emission as a result of lower amount of burned fuel

Social benefits	Maintaining soil fertility as the basis for maintaining and increasing productivity for achieving economic stability for the wellbeing of people
Other considerations:	• Decreasing expenditures for fuel will lead to higher competitiveness of agricultural products at the local, regional and international markets • Providing food self-sufficiency at different levels
Capital costs for one unit	The moldboard plow costs (PR-4) – 82862 lei The combinator costs (CN3-3) – 110000 lei The chisel plow costs – 80000 lei The required amount for the total area of field crops in Moldova for this technology is 340 200 ha Total capital costs 353808000lei (22,113,000 euro)

Operational costs	Costs of technological operation by using combinator: fuel – 10 lei/ha; salary – 13 lei/ha Total operational costs per ha 4160 lei (260 euro) Tota operational costs rquiered: 1415232000lei (88,452,000 euro).

Sector	**Agriculture**
Adaptation needs	1. Higher adaptability to more frequent droughts 2. Higher adaptation to limited natural resources (water, non renewable sources of energy, soil) 3. Higher adaptation to prices vulnerability for agricultural products and resources in globalized economy
Technology Name	**Conventional tillage for sunflower**
How this technology contributes to adaptation	Moldboard plow for sunflower has some advantages and disadvantages. Among advantages are: • Better control of weeds, especially perennial weeds • Better control of pests and descases • Creation of a deeper layer for root growing Among disadvantages are: • Higher vulnerability to water and wind erosion • Higher consume of fuel • Negative influence on earth worms etc
Background/Notes. Short description of the technology	Moldboard plow is one the main technological operation for sunflower regarding soil tillage. It requires supplementary soil tillage operation before sowing sunflower
Implementation assumption.	This technology is already used on large scale in Moldova.
Costs per 1 ha	Conventional technology: (see table below)
Country social development priorities	• Reducing the pauverty • Increasing the employment of people • Increasing the rates of burth and decreasing the mortality of people • Improving the system of health care for people
Country economic priorities – economic benefits	• Increasing the sustainability of agricultural sector, including profitability • Reducing the dependence from non renewable sources of energy and their derivates (mineral fertilizers and pesticides) • Creating condition for the development of smal and medium enterprises
Enviromental benefits	Achieving a more sustainable use of natural resources through preventing soil degradation, soil and water pollution, preservation of biodiversity etc
Social benefits	Maintaining soil fertility as the basis for maintaining and increasing productivity for achieving economic stability for the welbeeing of people

Costs per 1 ha – Conventional technology:

	Fuel, l/ha	*Salary, lei/ha*
1. Moldboard plow (MTZ-80+PLN-3-35)	25,0	41,3
2. Disks, MTZ-80+BDT-3	6,0	10,9
3. Cultivation, MTZ-80+KPG-4	6,0	10,9
TOTAL	37,0	63,1

Capital costs for one unit of:	Moldboard plow PR-4 – 82862 lei The required amount for the total area of field crops in Moldova 48571 (the productivity per day is 5 ha. The optimal time for doing such work is 7 days).
Operational costs (without maintenace costs)	Use of fuel per 1 ha 31 l x 15 lei = 465 lei

Sector	**Agriculture**
Adaptation needs	1. Higher adaptability to more frequent droughts 2. Higher adaptation to limited natural resources 3. Higher adaptation to prices vulnerability for agricultural products and resources in the globalized economy
Technology Name	**Conservation tillage with herbicides for sunflower**
How this technology contributes to adaptation	• Minimum tillage in crop rotation contribute to the reduction of soil erosion and uncompensated losses • By reducing soil erosion and mineralization losses of soil organic matter the global warming is decreasing through increased carbon sequestration • By reducing the consumption of fuel as a result of replacing moldboard plow with minimum tillage it is possible to adapt to the limited sources of non renewable energy, to the fluctuation of prices for non renewable sources of energy at the international level • By keeping mulch on the surface it is possible to reduce evaporation of soil moisture and to increase the stoks of soil moisture in the soil. So, the negative influence of drought can be reduced
Background/Notes, Short description of the technology	The moldboard plow is replaced by soil tillage with combinator. So, three technological operation (in the previous model of technology) are replaced by one.
Implementation assumption.	Minimum tillage system (conservation tillage) is studied in long-term field experiments at the Research Institute of Field Crops „Selectia”. Research results are available for farmers throuFarmers are visiting experimenatal fields of the institute with different systems of soil tillage. Each year we are organising seminars for farmers – at least two times (in the spring, before sowing spring crops and in the fall – before sawing winter cereal crops). During these seminars farmers can see the equipment in operation for minimum tillage in crop rotation.
Costs per 1 ha	Total costs per 1 ha only for conventional tillage is 37 lei for fuel and 63,1 lei for labor. By using chisel plow the total cost only for tillage is: fuel – 20 l/ha and salary – 26,9 lei/ha
Country social development priorities	• Reducing the pouverty • Increasing the employment of people • Increasing the rates of burth and decreasing the mortality of people • Improving the system of health care for people
Country economic priorities - economic benefits	• Increasing the sustainability of agricultural sector, including profitability • Reducing the dependence from non renewable sources of energy and their derivates (mineral fertilizers and pesticides) • Creating condition for the development of smal and medium enterprises
Country enviromental priorities (enviromental	By implementing a conservative system of soil tillage it would be possible to increase the environmental benefits through: • Higher carbon sequestration which allows to reduce global warming

benefits)	• Reduction of soil erosion and better storage of the soil moisture • Reduction of pollution of ground water with nitrates • Reduction of GHG emision as a result of lower amount of burned fuel
Social benefits	• Maintaining soil fertility of soil as the basis for maintaining and increasing productivity for achieving economic stability for the welbeeing of people • Improving health of people as a result of increased soil functionality and decreased inputs (mineral fertilizers, pesticides) • More people remaining in rural communities
Other consideration and priorities (such as market potential)	• Decreasing the expenditures for fuel will lead to higher competitivness of agr. producers at the local, regional and international markets • Providing self – sufficiency of food at different levels
Capital costs for one unit of:	Chisel plow + disks – 80.000 lei The required amount for the total area of field crops in Moldova: - Chisel plow – 40.000 (the productivity per day is 6 ha and the optimal time for doing such work is 5 days) The total costs of tillage equipment is: - Chisel plow – 3200 mln.lei or 256 mln.am.doll.
Operational costs (without maintenace costs)	Use of fuel per 1 ha • For chisel plow – 20 lit.x 15 lei = 300 lei The cost of fuel for total area: • For chisel plow – 360 mln.lei or 28,8 mln.am.doll
Daily supply capacity perfacility	The chisel plow can tillage 6 ha per day
Upscaling potencial	Area to be tillaged consists: for spring crops – 1.200.000 ha

Sector	**Agriculture**
Adaptation needs	1. Higher adaptability to more frequent droughts 2. Higher adaptation to limited natural resources (water, non renewable sources of energy, soil) 3. Higher adaptation to prices vulnerability for agricultural products and resources (non renewable sources of energy) in globalized economy
Technology Name	**Conventional system of soil tillage for sugar beet**
How this technology contributes to adaptation	Moldboard plow for sugar beet has some advantages: - Perennial weed control - Better humification of crop residues and manure - More uniform distribution of organic fertilizers in deeper arable layer But, moldboard plow has also some negative consequences: - higher vulnerability to wind and water erosion - higher consume of fuel - negative influence on earth warms etc
Background notes, Short description of the technology	Moldboard plow is one of the basic technological operation in the existing technology of growing sugar beet. After, moldboard plow it is necessary to do disking and cultivation (in the fall), but in the spring at least one cultivation before sowing.
Implementation assumption.	This technology is already used on large scale in Moldova, but it has some drowbacks (uncompensated losses of soil organic matter, soil erosion, soil compaction etc).

	Our, task is to convince farmers to reduce the number of moldboard plow in crop rotation.
Costs per 1 ha	<table><tr><td></td><td>*Fuel, l/ha*</td><td>*Salary, lei/ha*</td></tr><tr><td>4. Moldboard plow (MTZ-80+PLN-3-35)</td><td>25,0</td><td>41,3</td></tr><tr><td>5. Disks, MTZ-80+BDT-3</td><td>6,0</td><td>10,9</td></tr><tr><td>6. Cultivation, MTZ-80+KPG-4</td><td>6,0</td><td>10,9</td></tr><tr><td>TOTAL</td><td>37,0</td><td>63,1</td></tr></table>
Country social development priorities	• Reducing the pouverty • Increasing the employment of people • Increasing the rates of burth and decreasing the mortality of people • Improving the system of health care for people
Country economic priorities - economic benefits	• Increasing the sustainability of agricultural sector, including profitability • Reducing the dependence from non renewable sources of energy and their derivates (mineral fertilizers and pesticides) • Creating condition for the development of smal and medium enterprises
Country enviromental development (enviromental benefits)	Achieving a more sustainable use of natural resources through preventing soil degradation, soil and water pollution, preservation of biodiversity etc.
Social benefits	Maintaining the fertility of soil as the basis for maintaining and increasing productivity for achieving economic stability for the welbeeing of people.
Other consideration and priorities	Providing food self – sufficiency at differrent levels (local, regional, country)
Capital costs for one unit of:	Moldboard plow – PR-4 – 82862 lei The required amount for the total area of field crops in Moldova 48571 (the productivity per day is 5 ha. The optimal time for doing such work is 7 days. The total cost of tillage equipment is: 335,4 mln.am.doll.
Operational costs (without maintenace costs)	Use of fuel per 1 ha 31 l x 15 lei = 465 lei

Sector	**Agriculture**
Adaptation needs	1. Higher adaptability to more frequent droughts 2. Higher adaptation to limited natural resources 3. Higher adaptation to prices vulnerability for agricultural products and resources
Technology Name	**Conservation tillage with herbicides for sugar beet**
How this technology contributes to adaptation	1. Minimum tillage in crop rotation contribute to the reduction of soil erosion and uncompensated mineralizational losses 2. By reducing soil erosion and mineralization losses of soil organic matter the global warming is decreasing through increased carbon sequestration 3. By reducing the consumption of fuel as a result of replacing moldboard plow with minimum tillage it is possible to adapt to the limited sources of non renewable energy, to the fluctuation of prices for non renewable sources of energy at the international level 4. By keeping mulch on the surface of soil it is possible to reduce evaporation of soil moisture and to increase the stoks of soil moisture in the soil.

Background notes, Short description of the technology	By using conservation system of soil tillage we can avoid using moldboard plow by replacing it with chisel plow in agregate with disks. For weed control herbicides are used, although they can't garantee always a good weed control.
Implementation assumption. How the technology will be implemented and diffused acrossthe subsector	Conservation system of soil tillage is studied in long-term field experiments at the Research Institute of Field Crops „Selectia" (Balti, Moldova). Research results are available for farmers through publication of books, recommendations, articles, TV, radio. Farmers are visiting the experimental plots of the institute with different system of soil tillage. Each year we are organising seminars at the institute.
Capital costs for one unit:	Chisel plow + disks – 80.000 lei The required amount for the total area of field crops in Moldova: chisel plow – 40.000 (the productivity per day is 6 ha. The optimal time for doing such work is 5 days). For the total area of spring sown crops the economy of fuel consists 17400 tonnes and for salary 43,4 mln.lei
Country social development priorities	• Reducing the pouverty • Increasing the employment of people • Increasing the rates of burth and decreasing the mortality of people • Improving the system of health care for people
Country economic priorities (economic benefits)	• Increasing the sustainability of agricultural sector, including profitability • Reducing the dependence from non renewable sources of energy and their derivates (mineral fertilizers and pesticides) • Creating condition for the development of smal and medium enterprises
Country enviromental development (enviromental benefits)	Achieving a more sustainable use of natural resources through preventing soil degradation, soil and water pollution, preservation of biodiversity. By implementing a conservative system of soil tillage it would be possible to increase, the environmental benefits through: • Higher carbon sequestration which allows to reduce global warming • Reduction of soil erosion and better storage of the soil moisture • Reduction of pollution of ground water with nitrates Reduction of GHG emision as a result of lower amount of burned fuel
Social benefits	• Maintaining soil fertility and productivity of crops as basis for economic stability • Improving health of people as a result of increased soil functionality and decreased inputs, which are leading to better quality of food and water.
Other consideration	• Decreasing expenditures for fuel will lead to higher competitivness of agr.products at the local, regional and international markets • Providing food self-sufficiency at different levels

Sector	Agriculture. Animal breeding subsector.
Adaptation needs	Adaptation of animals to higher temperature conditions.
Technology Name	**Extensive system of animal husbandry.**
How this technology contributes to adaptation	Currently the extensive system of animal husbandry is the most common in the Republic of Moldova. Approximately 96% of livestock are raised in the private sector, mostly in households with few animals (eg 1-2 cows) in primitive conditions, without observance of sanitary and veterinary requirements. At the same time it should be noted that only about 1% of the overall population is breeding animals, the other 99% are crossovers with no known origin and productive qualities. For these reasons the animal yields obtained under such circumstances in all species (cattle, swine, sheep, goats, poultry) are small and their quality is low.
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	The absolute majority of animals raised in Moldova are now accommodated to environmental conditions, have a better adaptability, are less vulnerable than the breeds of high yield animals, but have low production indicators and breeding them is economically not cost-efficient. In this respect it should be noted that low quality is a factor that generally do not allow to penetrate into the European market.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Currently used technologies in the livestock sector in Moldova, except for a few large farms, do not imply mechanization and automation of livestock industry processes. Along with the introduction of such procedures is necessary to improve the gene pool by implementing high yield breeds and creating such animals maintenance conditions that would ensure the possibility to control the parameters of the microclimate, including the temperature, in order to mitigate the environmental impact on animals.
Costs	If the extensive system of animal husbandry is further used without increasing prices for livestock production, one can not expect a considerable development of animal husbandry sector and the decreasing trend in livestock, well felt in recent years, will perpetuate because currently production is not profitable (eg kg of milk costs 2.50 to 3.50 lei, 1kg of live weight meat - 15 to 20 lei) and most livestock farmers, in fact, produce for own consumption. The cost of a heifer is 15,000 lei. The average milk production per country is 3000kg. Consequently, selling milk will yield 9,000 lei (3000 kg X 3 = 9000 lei lei). However, expenditures for animal feed, labor force, barn maintenance, electricity, veterinary services, etc must be included, so the sales price could be 5-6 lei, while the producer gets only half of it from sales. In conclusion, it should be said that other technologies, other animal husbandry systems are needed, which will be discussed later.
Country social development priorities	Development of animal husbandry sector contributes to: • increase of welfare of population; • improving human health; • decrease of human mortality rate.
Country economic development priorities – economic benefits	• Food security. • Dependence of the livestock sector on feed produced by crop husbandry branch.
Country environmental development priorities (Environmental benefits)	• Grazing outdoors means less accumulation of ammonia in manure. • Extensive animal husbandry entails reduced environmental pollution • Construction of manure storing platforms • Fermented manure is a valuable organic fertilizer.

Social benefits	Acquiring knowledge for compliance with veterinary animal welfare and environmental requirements. • Along with the disappearance of large livestock farms, ammonia emissions significantly reduced. • Use of best practices. • Identification and selection of genotypes with high potential for adaptation to climate change. • Conservation of endangered gene pools.
Other considerations and priorities (such as market potential)	• Identification of genotypes of indigenous breeds with a high level of adaptability. • Development of balanced diets that contribute to less greenhouse gas discharge.
Costs	
Capital costs (per facility)	see table below
Operational and Maintenance costs (per facility)	Beef costs per capita – 500 euro. 300 000 anim X 500 euro= 150 000 000 euro. Swine costs per capita – 100 euro. 500 0000 anm X 100 euro= 50 000 000 euro. Sheep goat costs per capita – 50 euro. 1 000 000 anim X 50 euro= 50 000 000 euro. Horse costs per capita – 100 euro. 50 000 anim X 100euro=5 000 000 euro. Poultry costs per capita – 1 euro. 23 000 000 anim X 1 euro=23 000 000 euro. Total costs of animals – 578 000 000 euro. Total costs of feed – 622 000 000 euro. Labour – 200 000 000 euro. **Total operational costs -1 400 000 000 euro**

Capital costs (per facility):

Sps	75% extensive	25% semi-intensive, intensive
Beef	375 000 anim. X 50 euro = 18 750 000 euro	125 000 anim.: 20 anim.= 6250 ferme X 53000 euro = 331 250 000 euro
Swine	375 000 anim. X 24 euro = 9 000 000 euro	125 000 anim.: 40 anim = 3125 ferme X 40000 euro = 125 000 000 euro
Sheeps, goats	1 000 000 anim. X 10 euro = 2 500 000 euro	_
horses	50 000 anim.X 50 euro = 2 500 000 euro	_
poutry	17 250 000 anim X 1 euro = 17 250 000 euro	5 750 000 anim.: 1000 anim. = 5 750 farms X 15 000 euro= 86 250 000 euro
Costs	57 500 000 euro	542 500 000 euro
Total	600 000 000 euro	

Sector	Agriculture. Animal breeding sub-sector.
Adaptation needs	Adaptation of animals to higher temperatures.
Technology Name	**Intensive system of animal husbandry.**
How this technology contributes to adaptation	Intensive animal husbandry system features a concentration of hundreds and thousands of heads of livestock in the same unit. It was quite widely spread in the republic of Moldova in the 80'-90's of the last century, when many farms and livestock feeding lots operated on industrial scale. However, with the break up of large farms, livestock feeding lots practically disappeared (except for some pigs and poultry farms).
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Under the intensive animal breeding system, animals are permanently kept in paddocks, thus a high degree of technicality being ensured: skilled staff, operationally advanced livestock breeding equipment and technologies. High value breeds and hybrids can be grown based on scientific reproduction, breeding and selection programs, ensuring maximum genetic progress. Animal feeding can be done differentially, taking into account the age, category of animals, the production level, etc.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Under the intensive animal breeding system, virtually all farm activities are mechanized, and some of them even automated. Animals are kept in several barns and are milked in special rooms. The milk obtained is cleaner, and of better quality. This system allows for the concentration and specialization of livestock and its rapid improvement. Switching from traditional animal breeding systems in the intensive ones allows to meet the growing demand for food products of animal origin, but at the same time, they are incompatible with animal health and entail a number of diseases: pneumopathies favored by the microclimate, stress, illness of hoofs, mastitis, behavior disorders (cannibalism, coprophagy, etc.)
Costs	The intensive animal breeding system yields good results when high productivity breeds and their half-breeds are used. Therefore, the purchase of such genotypes to complete the herds of the farms and feeding complexes will be quite expensive. Also, procurement of barn equipment and feed preparing equipment will be quite costly. For example, building a 100-cows farms, supplying equipment and import of animals costs about 15 million lei. According to the dairy sector development plan of the Republic of Moldova, the amount of 12.2 billion lei will be needed for the next 15 years.
Impact Statements - How this option impacts the country development priorities	
Country social development priorities	• The growth of population worldwide raise the demand for food. • Intensive animal breeding systems allow to better ensure the population with animal food. • Farms and feeding complexes can be supplemented with slaughterhouses, processing stations, even shops selling production.
Country economic development priorities – economic benefits	• Ensures labor productivity. • Allows to increase production in economically efficient way. • Concentration of large herds of livestock on small areas. • The workforce used is skilled and specialized. • Scientific organization of production and work based on economic efficiency indicators • High quality breeding material, technical equipment, feeding of animals with combined, scientifically substantiated rations, employment of state-of-the-art technologies allow to get high production and good economic results.

<table>
<tr><td>Country environmental development priorities (Environmental benefits)</td><td>• Concentration of a large number of animals on small areas entails accumulation of essential quantities of manure, which presents great danger to environment
• Accumulation in large amounts of manure increases the amount of ammonia, carbon dioxide, carbon released into the atmosphere.
• It is possible to build big facilities to produce biogas from manure.</td></tr>
<tr><td>Social benefits</td><td>• The animal breeding process can be computerized along the entire flow.
• To facilitate the work of people milking cows, milking rooms can be equipped with robots.
• There is a well established and rhythmic sales flow throughout the year.
• Production is certified and complies with HACCP, SSOP, etc.</td></tr>
<tr><td>Other considerations and priorities (such as market potential)</td><td>• Intensive technologies must be adapted to the physiological and behavioral needs of animal species.
• It is necessary to ensure animal welfare (feeding conditions, adaptation, microclimate, information flow between animals and their living environment), etc.</td></tr>
<tr><td colspan="2">Costs</td></tr>
<tr><td>Capital costs (per facility)</td><td><table>
<tr><td>Species</td><td>Intensive production 100%</td></tr>
<tr><td>Beef</td><td>1 000 000 anim.: 600 anim=1600 farms X 2 000 000 euro= 3 200 000 000 euro</td></tr>
<tr><td>Swine</td><td>900 000 anim.: 3000 anim = 300 farms X 2 000 000 euro = 600 000 000 euro</td></tr>
<tr><td>Sheep/goats</td><td>1 000 000 anim.: 1000 anim. = 1000 farms X 200 000 euro = 200 000 000 euro</td></tr>
<tr><td>Horses</td><td>10 000 anim.: 50 anim. = 200 farms X 50 000 euro = 10 000 000 euro</td></tr>
<tr><td>Poultry</td><td>35 000 000 anim.: 100 000 anim.= 350 entrep X 1 400 000 euro = 400 000 000 euro</td></tr>
<tr><td>Total costs</td><td>4 500 000 000 euro</td></tr>
</table></td></tr>
<tr><td>Operational and Maintenance costs (per facility)</td><td>Bred beef cots per capita – 1500 euro
500 000 anim X 1500 euro = 750 000 000 euro
Other beef costs per capita – 500 euro
500 000 anim X 500 euro = 250 000 000 euro
Swine costs per capita – 100 euro
900 000 anim X 100 euro = 90 000 000 euro
Sheep /goat costs per capita – 50 euro
1 000 000 anim X 50 euro = 50 000 000 euro
Horse costs per capita – 100 euro
10 000 anim X 100 euro = 1 000 000 euro
Poultry costs per capita – 1 euro
35 000 000 anim X 1 euro = 35 000 000 euro
Total costs of animals -1 176 000 000 euro
Total costs of feed - 1 624 000 000 euro
Labour – 200 000 000 euro
Total operational costs – 3 000 000 000 euro</td></tr>
</table>

Sector	Agriculture. Animal breeding sub-sector.
Adaptation needs	Adaptation of animals to higher temperatures.
Technology Name	**Semi-intensive(semi-intensive) system of animal husbandry.**
How this technology contributes to adaptation	The semi-intensive system of animal breeding implies breeding of animals at mini-farms. For example, dairy cattle - at farms of 10-20-50 heads, provided such farms are model farms meeting the basic maintenance requirements of breeding technologies (areas, number of stock, microclimate), employment of mechanized milking, etc., breeding cattle for meat – at farms with 50-100 heads; breeding of pigs – at mini-farms of 10-20 breeding sows; pig fattening farms - with a capacity of 100-500 heads / year, sheep and goats - 100-200 sheep or goats. It is a family business operated by family members.
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Along with best genotypes of indigenous breeds, some world renown breeds may be raised at such mini-farms. They can be grown in optimum conditions and therefore will be less prone to unfavorable environmental conditions and, being fed with proper feed, are more likely to yield better production.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Such mini-farms may employ modern technologies allowing mechanization of many processes, both in terms of fodder preparation, as well as milking cows, sheep or goats, manure disposal; installation of some biogas plants. The animals will be milked inside the barn.
Costs	The costs of semi-intensive animal husbandry system and construction of mini-farms are higher in comparison with extensive animal breeding systems. For example, construction and furnishing of a mini-farm with a herd of 10 dairy cows and 10 calves and heifers would cost about 650,000 lei, while setting a mini-farm with a herd of 20 dairy cows and 20 calves and heifers would need an investment of about 1,125,600 lei. Such farms can be profitable provided the average production of one milking cow is not lower than 5500 kg of milk. In pig breeding, setting a mini-farm of 20 reproductive sows would need an investment of about 1.13 million lei, while a feeding lot for raising and fattening with a capacity of 360 heads would need an investment of about 287,000 lei.
Country social development priorities	The animal breeding sector contributes to: • ensuring the population with high quality products; • improving human health; • reducing human mortality rate.
Country economic development priorities – economic benefits	The semi-intensive animal breeding system is economically more superior to the intensive one. In case of farms, the livestock sector depends on crop production to a larger extent than in case of extensive animal breeding. • More diverse feed contribute to increased productions. • Makes it possible to improve the breeds.
Country environmental development priorities (Environmental benefits)	• In case of mini-farms, construction of manure storage platforms will be required, what will lead lo a reduction in environmental pollution. • It will become possible to set biogas plants which will ensure the energy needs of the farm. • Manure fermentation will produce valuable organic fertilizer.

Social benefits	• Use of best practices. • Compliance with sanitary and veterinary requirements and obtaining animal products of higher quality. • Ensuring human health.
Other considerations and priorities (such as market potential)	• It is possible to set cultivated pastures. • Along with the most productive genotypes of indigenous breeds, imported breeds with high production will be used. • It will be necessary to develop rations that ensure high yields and will produce less elimination of greenhouse gases in the atmosphere.
Costs	

Capital costs

Species	20% extensive	80% semi- intensive and intensive
Beef	180 000 anim. X 50 euro = 9 000 000 euro	720 000 anim.: 500 anim.=1440 ferme X 1 500 000 euro=2 166 000 000 euro
Swine	140 000 anim. X 24 euro = 3 000 000 euro	560 000 anim,: 2000 anim.=560 ferme X 750 000 euro= 420 000 000 euro
Sheeps, goars	200 000 anim. X 10 euro = 2 000 000 euro	800 000 anim.: 1000 anim.=800 ferme X 200 000 euro=160 000 000 euro
Hourses	20 000 anim. X 50 euro = 100 000 euro	_
Poultry	6 000 000 anim. X 1 euro = 6 000 000 euro	24 000 000 anim.: 100 000 anim.= 240 întreprinderi X 1 000 000 euro= 240 000 000 euro
Total	20 000 000 euro	2 980 000 000 euro
Total costs 3 000 000 000 euro		

Operational and Maintenance costs	Beef costs per capita of bred animal – 1500 euro 400 000 anim X 1500 euro = 600 000 000 euro Per capita costs of other types of beef – 500 euro 500 000 anim X 500 euro = 250 000 000 euro Swine costs per capita – 100 euro 700 000 anim X 100 euro = 70 000 000 euro Sheep/ goat costs per capita – 50 euro 1 000 000 anim X 50 euro = 50 000 000 euro Horse costs per capita – 100 euro 20 000 anim X 100 euro = 2 000 000 euro Poultry costs per capita – 1 euro 30 000 000 anim X 1 euro = 30 000 000 euro Total costs of animals -1 002 000 000 euro Total costs of feed - 1 300 000 000 euro Labour – 198 000 000 euro Total opertional costs– 2 500 000 000 euro

Sector	Agriculture
Adaptation needs	Moldova is highly vulnerable to climate variability and change[102]. According to a range of studies, including Moldova's Second National Communication (SNC) under the United Nations Framework Convention on Climate Change (UNFCCC)[103] and the National Human Development Report (NHDR, 2009)[104], the impacts of climate change are expected to intensify as changes in temperature and precipitation affect economic activity. Furthermore, socio-economic vulnerability to these changes is high. Moldova is one of the least advanced countries in the region – in 2005, Moldova had the fourth lowest Human Development Index out of 20 countries in the region[105]. The economy was in decline before 1991, a process that was intensified with separation from the USSR[106], and Moldova's economy suffered during the recent economic crisis. The impacts of climate change on agriculture are of particular concern – agriculture is a major source of income in Moldova, where more than half the population lives in rural areas and about one third of the labour force is employed in agriculture.[107] The socio-economic costs of climate related natural disasters such as droughts, floods and hail are significant and both their intensity and frequency are expected to further increase as a result of climate change. During the period 1984-2006, Moldova's average annual economic losses due to natural disasters were about US$61 million, or 2.13 percent of national GDP. More recent events have had a significant impact: the 2007 drought caused estimated losses of about US$1.0 billion; the 2008 floods cost the country about US$120 million.[108] The most recent floods in 2010 are estimated to have had an adverse economic impact on GDP of about 0.15 percent, with total damage and losses estimated at approximately USD 42 million. The floods primarily affected rural and agricultural regions of the country[109].
Technology Name	**Climate insuranse (CI): named-peril (NPCI) and multi-peril crop insurance (MPCI), and Index-based Insurance (II)** **Large scale technology available in the short term**
How this technology contributes to adaptation	Climate has become an urgent issue on the development agenda. There is a high degree of interest in the potential role of CI in agricultural adaptation to climate change. Climate change is expected to give rise both to changes in the average agro climatic conditions for growing different crops and to increases in the variability of weather, with more frequent or extreme weather events. Adaptation to these changes is built on actions to increase resilience and reduce risk (e.g. appropriate crops, varieties and cropping patterns; irrigation; and soil and farm management techniques). In spite of these actions, risks remain or will increase (particularly to extreme weather events). CI can support appropriate climate change strategies, but it should not be seen as a way to avoid taking proper adaptation measures; nor should CI be seen as replacing other

[102] National Adaptation Strategy for the Republic of Moldova. Draft, 2 May 2011. 67p.
[103] Second National Communication of the Republic of Moldova under the United Nations Framework. Convention on Climate Change / United Nations Environment Progr.; coord. Violeta Ivanov, George Manful. Synthesis Team: Vasile Sorpan, Marius Taranu, Petru Todos, Ilie Boian. Ch.: "Bons Offices" SRL, 2009. 316 p.
[104] UNDP, 2009/2010 National Human Development Report, "Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation.
[105] Namely 20 Central and Eastern European (CEE) and Commonwealth of Independent States (CIS) countries.
[106] Second National Communication, 2009.
[107] UNDP, 2009/2010 National Human Development Report, "Climate Change in Moldova: Socio-economic Impact and Policy Options for Adaptation.
[108] World Bank, "Project Appraisal Document on a Proposed Credit to the Republic of Moldova for a Disaster and Climate Risk Management Project", July 6, 2010.
[109] Government of the Republic of Moldova. "Post Disaster Needs Assessment, Floods 2010." Supported by the European Union, the United Nations, and the World Bank, with the support of the Global Facility for Disaster Reduction and Recovery (GFDRR), 2010.

	measures that address the effects of climate change.
Background/Notes Short description of the technology option	Moldova was a part of the Soviet Union until 1991. The subsidized agricultural insurance system was available in the whole country. Agricultural insurance was offered on mandatory basis by the state Insurance company "Gosstrakh". After the independence of the country, the agricultural insurance almost stopped. In 2004 the national parliament adopted a Law on Agricultural Insurance. Subsidized agricultural insurance was implemented in 2005. The law defines the basic features of the subsidized agricultural insurance, including the premium subsidies. The farmers pay only their share of the premium due on the insurance policy. The rest is paid by the government directly to the insurance companies. In practice the insurers receive the subsidized share of the premiums from the government within 2 to 3 weeks after the sales of the contracts (4-week term is established by the Law on Agricultural Insurance). The government subsidizes premiums on most crops, fruits, vegetables, and grapes. Livestock insurance is also subsidized. **Agricultural Insurance Products Available** The Republic of Moldova's insurance companies at the moment offer named-peril (NPCI) and multi-peril crop insurance (MPCI) products for additional information and description see (Annex A: Table 1 and Box 1). Farmers can choose the perils to be covered by the subsidized MPCI contract. The MPCI product differs from the traditional understanding of MPCI insurance because the farmer can select the list of perils covered. MPCI that indemnifies yield losses on an individual farm basis is subject to problems of adverse selection (the highest risk farmers insuring) and moral hazard (farmer influence over yield-based loss assessment, which is difficult for the insurer to control). High administrative and loss adjustment costs are incurred in operating MPCI. It requires significant investment in monitoring farm yields to prevent higher payments than those losses actually incurred by the farmer. Furthermore, MPCI has large correlated risks, so it is exposed to extremely high potential claims in adverse years. International reinsurers are reluctant to provide reinsurance for MPCI, particularly for new and unproven programs, and if available**,** costs are high. Experience internationally indicates that it is technically extremely difficult to insure farm-level crop yields from losses caused by any number of natural perils. Massive and unsustainable levels of government subsidies may be needed to support multiple peril crop insurance[110].
Implementation assumptions, How the technology will be implemented and diffused across the subsector	**Agricultural Insurance Market Structure** Subsidized agricultural insurance is offered only by private insurance companies. Currently, two companies participate in the program, but the biggest market share for last 5 years (about 75%) belongs to the MOLDASIG insurance company (Annex A: Figure 1). The insurers offer both crop and livestock insurance services. Data on voluntary unsubsidized agricultural insurance is insignificant. **Delivery Channel** Insurance agents are the main delivery channels. Insurance brokers are the second most important delivery channel. Banks and other finance institutions as delivery channels are marginal. There are no specific organizations in the Republic of Moldova

[110] WB Report, 2007. Rural Productivity in Moldova – Managing Natural Vulnerability. 23 May 2007, p.107.

	for delivering agricultural insurance services to small and marginal farmers. **Voluntary vs. Compulsory Insurance** Crop and livestock insurance in the Republic of Moldova is voluntary. There are no mandatory requirements on agricultural insurance though the financial institutions might require insurance policy as collateral**.** **Types of Public Support for Agricultural Insurance** The Government of the Republic of Moldova subsidizes agricultural insurance premiums. The premium subsidy in 2011 was 60% of the OGP premium for perennial crops, sugar beet and vegetables. For insurance of other crops as winter wheat, barley, sunflower, maize, soybean, winter rape and livestock premium subsidies were 50%. The farmer should pay his share of the insurance premium when the insurance contract is signed. The rest of the premium is paid by the Government directly to the insurance company. The insurance premium paid on agricultural insurance contracts is exempt from taxes.
Costs	**Calculation of the sum of insurance and premium rates** The sum of insurance (SI) is calculated using the following formula: ***SI = ensured area x planned productivity x production forecast price*** The premium rates (see Annex A, Table 2) are calculated as percentage of the risk covered by the underwriters based on the information provided by the farmer. The cost of the agricultural insurance for farmers ranges and depends largely from crop culture and number of insured risks. For example, insurance premium paid by the insured, lei per 1 ha, for such individual risk as winter frost, can range from 94 lei (winter wheat) to 420 lei (grape) (see Annex A, Box 2), or in case of excessive drought from 140 lei (soy bean) to 1400 lei (vegetables) (see Annex A, Box 3). Further, information on calculation of the cost of agricultural insurance for farmers - insurance premium paid by the insured (in red) and maximum amounts of the insurance indemnity, lei per 1 ha for different crops yield and risks in 2011 is revealed in Annex A, Box 2 and 3. Livestock insurance is a multi-peril product where the client can choose the perils to be insured. The insurance companies insure livestock, sheep, goats, bees, and fish. Usually a livestock insurance contract includes perils such as weather perils, fire, epidemic diseases, accidental loss, and unlawful actions of third parties (theft, robbery, etc.).
Impact Statements - How this option impacts the country development priorities	
Country social development priorities	There are numerous reasons why risk transfer out of developing countries is important. Natural disasters impede the development process, push households into poverty, and drain fiscal resources of developing countries. Many of these natural disasters are directly tied to extreme weather events. Bad weather events have devastating impacts on agriculture. Of the 1.3 billion people in the world who are living on less than US$1 per day, nearly three-fourths depend on agriculture for their livelihood. In many countries around the world, agricultural development will still clear the way for overall economic development of the broader economy[111]. ***Access to formal risk financing instruments, such as insurance, can help farmers transfer excessive losses to a third party (such as an insurance company), thus stabilizing household income, facilitating their access to credit, and ultimately enhancing their livelihoods.***

[111] WB, Report No. 32727-GLB Managing Agricultural Production Risk Innovations in Developing Countries, May 2005, p.86.

Country economic development priorities – economic benefits	The management of crop production risks is an issue of fundamental importance to agricultural economies. Because of the random nature of production conditions (e.g., weather, pests, diseases), agricultural producers face an array of risks that may influence their level of output per acre from year to year. Management of such yield risks has long been an important issue for producers as well as for policy makers. ***Crop insurance is additional mechanism for the management of the risks associated with random yield shocks once all cost-effective risk mitigation strategies have been implemented; and disaster assistance effort.*** ***Although, as a rule insurance multi-peril schemes are not sustainable without heavy government subsidies.***
Country environmental development priorities (Environmental benefits)	"*Resilient is the flip side of vulnerability - a resilient system or population is not sensitive to natural hazards, climate variability and change and has the capacity to adapt*" (IPCC, 2001; Thywissen 2006[112]) or more precisely: "*Resilience is the capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures*." (UN/ISDR, 2004[113]; Thywissen 2006). ***Assist to constructing a resilient to climate change social-environmental system capable of anticipating, adapting to and coping with uncertainties and unexpected extreme events without losing its sustainable stability, performance and regenerative ability.***
Social benefits	See above.
Other considerations and priorities (such as market potential)	**Insurance Penetration Rate** In 2007 private insurers signed 145 crop insurance contracts under the subsidized program. The participation rate is low. Only 3.7% of the crops (by area), or 72,900 ha, are insured (see Annex A, Table 3)[114]. According to the AIPA[115] in 2010 were completed only 122 crop insurance contracts under the subsidized program in agriculture to total 9.9 ml lei. As in previous years this type of insurance most receives large producers. Small producers, especially GȚF (21.3%) were assimilated 8.6 percent of the sum allocated, or 860.2 thousand lei. At the same time without financial coverage remained 127 applicants because of a deficiency in this subsidized measure being 8.9 ml lei. For comparison, in 2009 for this direction were used 25.5 ml lei from which over 2 ml were offered as compensation to 58 GȚF (individual farmers). **Financial Performance** The loss ratio data is very volatile, ranging from 1.9% in 2006 up to 126.7% in 2009 for first insurance company MOLDASIG and 21.3% in 2008 up to 76.3% in 2009 for second insurance company MOLDCARGO (see Annex A, Table 4 and Figure 2).

[112] Thywissen, K. (2006): Components of Risk. A Comparative Glossary. SOURCE No.2/2006. UNU-EHS, Bonn.
[113] UN/ISDR (United Nations International Strategy for Disaster Reduction) (2004): Living with Risk. A Global Review of Disaster Reduction Initiatives. 2004 version. United Nations, Geneva, p. 430.
[114] WB Survey, 2008. Government Support to Agricultural Insurance: Challenges and Options for Developing Countries, co-authored by Olivier Mahul and Charles Stutley. 275p.
[115] AIPA (Agenția de Intervenție și Plați pentru Agricultură) http://www.aipa.md/index.php/lista-beneficiarilor/31-lista-beneficiarilor-2006-2009/177-lista-beneficiarilor-de-subventii-acordate-pentru-asigurarea-riscurilor-in-agricultura-2006-2009

Capital costs (per facility)	Don't require capital investments for farmers.
Operational and Maintenance costs (per facility)	**Cost of Agricultural Insurance Provision** According to WB report[116] the average delivery, loss adjustment, and administration costs amount to a total of 5% of the original gross premium (OGP). Marketing and acquisition costs are 3%, and loss adjustment costs are 2%. The insurance companies explain low operating costs by their good knowledge of clients and small size of the country.
Daily supply capacity per facility	Not applicable.
Upscaling potential	**Issues and Options for Crop Insurance in the Republic of Moldova** The Republic of Moldova faces significant constraints in introducing crop insurance. These issues can be summarized as follows[117]: ▪ Farmers are suffering from other economic and structural difficulties, notably loss of market, low profit margins, and availability of inputs and infrastructure. In this respect, farmers may regard insurance as low on the list of their priorities for improving their economic circumstances. ▪ Insurance, as a mechanism, operates most effectively where it is linked to other measures to mitigate the farmer's situation (e.g. improving credit availability, market access, investment into machinery, irrigation equipment and so on). Insurance cannot operate effectively in isolation, and will be regarded as a cost by the farmer. Hence, any decision concerning the type and timing of introduction of crop insurance in Moldova has to be taken in the context of other initiatives for development of agriculture. The main hazards causing widespread crop loss in Moldova are reported as drought (for rainfed crops), hail, and frost (especially for vines). Winter frost can also cause widespread damage of autumn-sown crops. ▪ The insurance sector in Moldova is poorly developed, especially in rural areas, and there is a lack of insurance awareness amongst farmers. MOLDASIG and MOLDCARGO are the only two insurance companies involved in crop insurance, and it requires state subsidies (see above). ▪ There is a structural division between large, former state farms and small private farms. Insurance should be designed so that all farmers can benefit from coverage. ▪ Financial capacity to manage major national systemic risks, such as drought, is beyond the capacity of the insurance sector in Moldova and would be dependent on international reinsurance. Such reinsurance is unlikely to be available to support a traditional individual-farmer MPCI. It may be more available for an index program or for conventional crop hail insurance. ▪ The legislation that is in force provides a framework for subsidized, individual, multiple-peril crop insurance. *As an alternative to MPCI, could be recommended the piloting of privately run index based weather insurance for broad-based threats like drought and frost.*

[116] WB Survey, 2008. Government Support to Agricultural Insurance: Challenges and Options for Developing Countries, co-authored by Olivier Mahul and Charles Stutley. 275p.

[117] WB Report, 2007. Rural Productivity in Moldova – Managing Natural Vulnerability. 23 May 2007, p.107.

ANNEX A

Table 1: Agricultural Insurance Products, Available 2011

Crop Insurance Products Available				**Greenhouse**	**Forestry**	
MPCI	Named-peril	Crop Revenue	Index-based			
Yes	Yes	No	No	No	No	
Livestock Insurance Products Available					**Aquaculture**	**Bees**
All Risk	Accident & Mortality	Epidemic Disease	Other	Index-based		
Yes	Yes	Yes	No	No	Yes, some	No

Box 1: Indemnity Based Agricultural Insurance (insurance payouts based on the actual loss at the insured unit level)

Named peril agricultural insurance products (damage-based products)

Provides indemnity against those adverse events that are explicitly listed in the policy. This subclass has a number of distinctive features:

- The sum insured is agreed at the inception of the contract and may be based on production costs, or on the expected crop revenue;
- The loss is determined as a percentage of the damage incurred by the insured party as established by a loss adjuster as soon after the damage occurs;
- The indemnity is calculated as the product of the percentage of the damage and the sum insured;
- Deductibles* and franchises** are normally applied to reduce the incidence of false claims and to encourage improvements in risk management.

Multiple peril agricultural insurance products (yield-based products)

Provides insurance against all perils that affect production unless specific perils have been explicitly excluded in the contract of insurance.

- The sum insured is defined in terms of the expected yield to the producer on the basis of the actual production history of the producer or the area in which the producer operates.
- The sum insured can be based on the future market price of the guaranteed yield if the producer has an insurable interest or alternatively, if the producer has taken a loan to finance the crop, the sum insured may be based on the amount of the loan if the financier has an insurable interest in the crop.
- Cover is normally set in the range of 50 percent to 70 percent of the expected yield.
- The calculation of the payout is based on the extent to which the actual yield falls short of the guaranteed yield at the agreed price or as the shortfall in yield as a percentage of the guaranteed yield applied to the sum insured.

Note: *A deductible is an amount or a percentage of the loss that is deducted from the indemnity and represents the first portion of the claim that the insured bears. Te purpose of a deductible is to reduce moral hazard by encouraging the insured to prevent losses. Deductibles can be either a percentage of the sum insured or a percentage of the loss and can be applied to each and every loss or to the total losses over a specified period, normally the currency of the contract.

**A franchise is a loss threshold that the insured has to reach in order to be able to receive the indemnity. Once the threshold is reached the amount of any subsequent loss is paid in full. Te purpose of a franchise is to reduce claim frequency.

Source: adapted from Ramiro Iturrioz, 2009[118]

[118] WB, (2009) Agricultural Insurance, by Ramiro Iturrioz. PRIMER SERIES ON INSURANCE ISSUE 12, NOVEMBER 2009. 35p.

Fig. 12: Agricultural Subsidized Insurance Market Structure

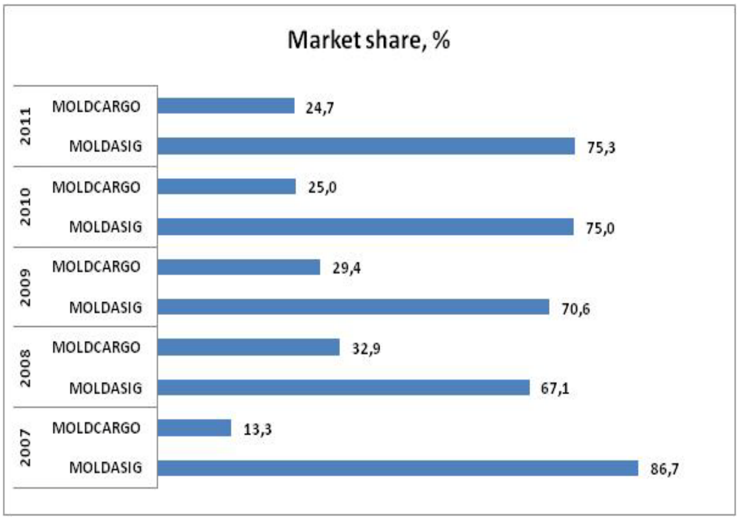


Table 2: Agricultural Insurance - Premiums Charged by MOLDASIG in 2011

Name of crop	Insurance premium as % of insurance sum									
	Excessive drought	Hail	Torrential rains	Flood	Spring frost	Field grain fire	Winte r frost	Crop lodging	Dust storm	Locust / pest
Winter wheat	7	4	0.3	5	-	0.5	2.5	3	-	0.1
Winter barley	7	5	0.3	5	-	0.5	5	3	-	0.1
Winter rape	7	6	0.3	5	6	-	7	2	-	0.1
Spring cereals	7	5	0.3	5	-	0.5	-	3	-	0.1
Spring rape	7	5	0.3	5	6	-	-	2	-	0.1
Peas, haricot	8	6	0.3	6	3	-	-	-	-	0.1
Maize	6	4	0.3	4	2	-	-	3	-	0.1
Sugar beet	7	3	0.5	5	2	-	-	-	2	0.1
Sunflower	7	5	0.3	4	2	-	-	3	1	0.1
Soybean	7	4	0.3	6	-	-	-	2	-	0.1
Tobacco	6	6	0.3	5	3	-	-	-	-	0.1
Vegetables	7	7	0.5	6	3	-	-	-	2	0.1
Potato	7	3	0.3	5	2	-	-	-	-	0.1
Watermelon	6	8	0.3	6	3	-	-	-	-	0.1
Apple	-	7	-	6	8	-	5	-	-	0.1
Plum	-	7	-	6	8	-	7	-	-	0.1
Apricot	-	7	-	6	8	-	8	-	-	0.1
Peach	-	7	-	-	8	-	8	-	-	0.1
Cherry	-	6	-	-	6		5		-	0.1
Walnut	-	6	-	-	9	-	9	-	-	0.1
Wine grape	-	6	-	-	5	-	6	-		0.1
Table grape	-	7	-	6	8	-	8	-	-	0.1
Fruit tree nursery	-	6	-	6	-	-	6	-	-	0.1
Grapevine nursery	-	6	-	-	-	-	-	-	-	0.1

Box 2: Proposal for insurance of the agricultural risks **in the second half of 2010, for the harvest of 2011 year** (MOLDASIG Insurance Company)

Law on the subsidized insurance risks № 243-XV from 08.07.2004 in agriculture provides state subsidies for crop insurance contracts concluded in 2010 for the harvest of 2011.

At the conclusion of the insurance contract the **Insured** pays **only 40%** of the cost of the insurance for the perennial crops (yield, plantation) and **50%** for winter crops on conditions that they should pay the premium rate on the following dates:

- Winter wheat, winter barley and winter rape – up to November 30, 2010.
- Fruits and grapes (yield, plantation) – up to December 31, 2010.

Below it is revealed an indicative calculation of insurance premium paid by **Insured** and maximum amounts of the insurance indemnity, **lei per 1 ha** for different crops yield and risks **in the second half of 2010, for the harvest of 2011 year.**

(For calculating there were used average crop yields and prices in the Republic of Moldova for the last few years)

Crops	**The insured crop yield per 1ha (q)**	**The cost of the crop yield per 1ha (SI) (lei)**	**Winter frosts**		**Spring frosts**		**Hail**		**Excessive drought**		**Crop lodging**		**Flood**	
			Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)
Winter wheat	30	7500	94	2250	-	-	150	6000	263	5250	113	6000	188	6000
Winter barley	25	5000	125	1500	-	-	125	4000	175	3500	75	4000	125	4000
Winter rape	20	6000	180	1800	150	1800	180	4800	210	4200	60	4800	150	4800
Fruits	70	14000	280	5600	448	5600	392	9800	-	-	-	-	336	9800
Grapes	60	15000	420	6000	420	6000	360	10500	-	-	-	-	-	-

- ✓ Particular conditions of insurance are stipulated in the insurance contract
- ✓ Risk insurance for “spring frosts” and “excessive drought” are undertaken together with the base risk of hail
- ✓ In case of insurance of two or more risks, additional benefits are provided for Insured

Box 3: Proposal for insurance of the agricultural risks **in the first half of 2011, for the harvest of 2011 year** (MOLDASIG Insurance Company)

Law on the subsidized insurance risks № 243-XV from 08.07.2004 in agriculture provides state subsidies for crop insurance contracts concluded in 2011 for the harvest of 2011.

At the conclusion of the insurance contract the **Insured** pays **only 40%** of the cost of the insurance for the perennial crops, sugar beet, vegetables and **50%** for other crops on conditions that they should pay the premium rate on the following dates:

- Spring crops – up to June 1, 2011.
- Perennial crops - orchards, vineyards (yield, nursery and plantations) – throughout 2011.

Below it is revealed an indicative calculation of insurance premium paid by **Insured** and maximum amounts of the insurance indemnity, **lei per 1 ha** for different crops yield and risks **in the first half of 2011, for the harvest of 2011 year.**

(For calculating there were used average crop yields and prices in the Republic of Moldova for the last few years)

Crops	The insured crop yield per 1ha (q)	The cost of the crop yield per 1ha (SI) (lei)	Dust storm		Spring frosts		Hail		Excessive drought		Flood		Crop lodging	
			Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)	Insurance premium paid by insured (lei)	Maximum amounts of the insurance indemnity (lei)
Sunflower	20	7000	35	2100	70	2100	175	5600	245	4900	140	5600	105	5600
Maize	35	7000	-	-	70	2100	140	5600	210	4900	140	5600	105	5600
Soybean	20	4000	-	-	-	-	80	3200	140	2800	120	3200	40	3200
Tobacco dry	15	30000	-	-	450	9000	900	24000	900	21000	750	24000	-	-
Tobacco green	18	29000	-	-	435	8700	870	23200	870	20300	725	23200	-	-
Vegetable	200	50000	400	15000	600	15000	1400	35000	1400	35000	1200	40000	-	-
Sugar beet	300	14000	112	4200	112	4200	168	11200	392	9800	280	11200	-	-
Fruits	80	20000	-	-	640	8000	560	14000	-	-	480	16000	-	-
Wine grape	70	17500	-	-	350	7000	420	12250	-	-	420	14000	-	-
Table grape	80	40000	-	-	1280	16000	1120	28000	-	-	960	32000	-	-

- ✓ Particular conditions of insurance are stipulated in the insurance contract
- ✓ Risk insurance for "spring frosts" and "excessive drought" are undertaken together with the base risk of hail
- ✓ In case of insurance of two or more risks, additional benefits are provided for Insured

Republic of Moldova

Table 3: Estimated Agricultural Insurance Penetration, 2005 to 2007

Year	Contracts Signed	Percent of Farmers Insured	Total Area Insured (ha)	Percent of National Crop Area Insured
2005	**9**	**-**	**1,200**	**0.1%**
2006	121	8%	17,900	0.9%
2007	**178**	**10%**	**72,900**	**3.7%**

Source: WB Survey, 2008. Government Support to Agricultural Insurance: Challenges and Options for Developing Countries, co-authored by Olivier Mahul and Charles Stutley.

Table 4: Estimated Agricultural Insurance Financial Performance, 2006 to 2011 conform to CNPF[119]

Year	Company	Premium, Including Subsidies (Lei)	Paid Claims (Lei)	Loss Ratio, %
2006	MOLDASIG	8059551	149903	1,9
2007	MOLDASIG	27089406	7980597	29,5
	MOLDCARGO	4158256	0	0,0
2008	MOLDASIG	30176763	9981289	33,1
	MOLDCARGO	14815581	3152863	21,3
2009	MOLDASIG	14887191	18868982	126,7
	MOLDCARGO	6192473	4722597	76,3
2010	MOLDASIG	30446806	13339961	43,8
	MOLDCARGO	10138386	3927585	38,7
2011	MOLDASIG	20437238	7113267	34,8
	MOLDCARGO	6686586	1526761	22,8

Source: Taranu L, 2011 (survey)

[119] CNPF (Comisia Națională a Pieței Financiare) http://www.cnpf.md/md/infost/

Annex I

Republic of Moldova

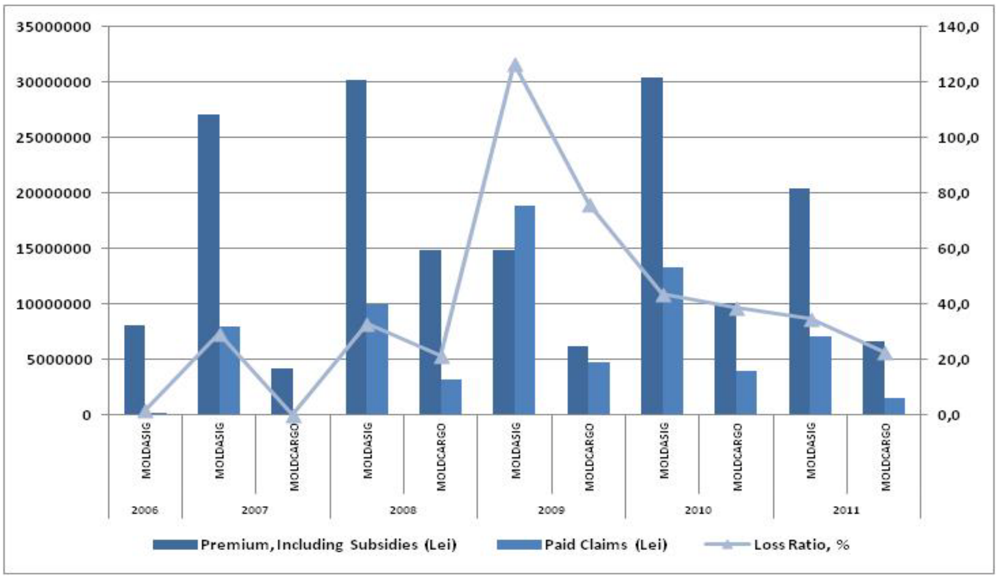


Fig 13: Estimated Agricultural Insurance Financial Performance, 2006 to 2011 conform to CNPF

HUMAN HEALTH SECTOR

Sector	Human Health
Adaptation needs	In recent decades deaths and morbid conditions caused by low temperatures are becoming more frequent and pronounced. Under the climate change circumstances the situation has become a new problem for the country and the region. Low temperatures increasingly affect the health of homeless people, as well as those who live in temporary dwellings with no heating, in tents or cars. During strong frosts such persons are at risk of major trauma, disease, death. The statistics on the number of people with injuries and deaths as a result of low-temperatures serve as convincing argument for the need of the state's involvement in social support of vulnerable groups of population in extreme conditions.
Technology Name	***Organization of social centers for homeless persons.***
How this technology contributes to adaptation	This measure is crucial for adaptation of the homeless, who are part of vulnerable population, primarily in urban areas. During the cold season and, in particular, when the temperature falls below 15 °C the number of people with frostbites and deaths due to total hypothermia grows.
Background	It is a long-term measure. It is part of national health care and social assistance policy with regard to vulnerable strata of population. This measure shall be accomplished by organizing social centers for the homeless and people living in temporary housing without heating, in tents or cars, in Chisinau and Balti municipalities. Under such conditions social centers for the homeless is the only and the most effective measure to prevent injuries and premature death in case of low temperatures. Social centers for the homeless can be operated jointly with other similar institutions or attached to such, for example, together with the for Children Placement Center.
Costs	Costs are determined by the spending needed to equip the premises to ensure proper functioning of the centers (electricity, heat, water, sewage, etc.), staff wages, food. Costs per one social center for homeless persons with 5 beds: - the cost of premises with the area of 200m^2 x 7 200 = 1 440 000 lei; - cost of furniture = 100 000 lei; - staff wages = 500 000 lei. Total, approximately 2 million lei. Current expenditures: - food 5 persons x 50 lei = 750 lei; - electricity, water, canalization, etc. = 50 lei; - sanitary costs = 50 lei; - other costs = 50 lei. Total, daily costs = 900 lei.
Specification of Impact – how this option affects the country's development priorities	
Country Development Priorities	Support to vulnerable groups of population is one of the main priorities in social assistance, included in the National Development Strategy for 2008-2011, approved through the Law On approval of the National Development Strategy for 2008-2011, nr.295 as of 21.12.2007.

Annex I

Republic of Moldova

Economic Benefits	Supporting vulnerable groups of population is one of the organic components of the country's economic development.
Environmental benefits	Supporting vulnerable groups, society creates a better environment for human population
Social benefits	Social benefits are essential, because the society supports one of the most vulnerable groups of population.

Sector	Human Health
Adaptation needs	In the recent decades deaths and morbid conditions caused by heat waves become more frequent and pronounced. They turned into a new problem in the region and in the country. Development of modalities to adapt to heat waves is becoming more and more vital, especially for vulnerable groups of population. Increased access to emergency medical care and provision of prompt simple and effective rehabilitation services contribute greatly to saving lives and adapting of population to extreme temperatures generated by climate change.
Technology Name	***Provisional posts of emergency care and prompt rehabilitation during critical periods of heat waves.***
How this technology contributes to adaptation	Prolonged exposure to high temperatures is an obvious risk for the population, especially for the urban population. Heat stress, which develops as a result of prolonged exposure of the body to high temperatures in the environment is a pathophysiological state which affects health and may entail sudden death. Certain inexpensive, timely and sufficient measures prove to be effective to reduce heat stress and its consequences. Also, these measures are essential in the process of adapting to climate change, first of all for population in urban areas.
Background	It is as a short term measure, which is part of the national health policy. This measure is accomplished by inexpensive, but efficient methods employed during critical periods of heat waves. The experience of many European countries shows that the organization and operation of provisional health posts in public places during critical periods allow to prevent many complications generated by heat stress. In the Republic of Moldova is proposed that temporary health posts to be supplemented by prompt rehabilitation procedures, which ensure more efficient adaptation of the body to high temperatures.
Costs	The costs are determined by the expense incurred to mantle and dismantle, to equip the health posts, the operating costs (medicines, drinking water, etc.) and nurses' salaries. Costs per one health post: - cost of one tent 10 000 lei; - cost of furniture 400 lei; - cost of medicines and medical instruments 1 000 lei; - the staff salary - 150 lei per shift x 2 = 300 lei.
Specification of Impact – how this option affects the country's development priorities	
Country Social Development	Support to vulnerable groups of population is one of the main priorities in social assistance, included in the National Development Strategy for 2008-2011, approved through the Law On

Priorities	approval of the National Development Strategy for 2008-2011, nr.295 as of 21.12.2007.
Economic Benefits	Support to vulnerable groups of population in critical periods of natural disasters is a very effective measure in terms of the national economy as it allows to maintain the human potential of the country.
Environmental benefits	In terms of environmental development it is an indisputable priority, as it creates a better environment for human population during critical periods of heat waves.
Social benefits	Social benefits are obvious due to health care measures, respectively, significant spending cuts for the rehabilitation of people affected.
Up-scaling potential	Due to the advance effect of heatwaves, it would be necessary to extend this adaptation measure. A great advantage of this measure is the low investments costs, thus increasing it affordability.

Sector	Human Health
Adaptation needs	The frequency and intensity of heat waves, which are becoming more pronounced, has an apparent impact on all branches of national economy, lowers the quality of life and affects health. In management of emergencies, which occur along with the extreme events generated by climate change, central public administration authorities should take the lead in developing a relevant policy, developing and implementing certain measures. A national action plan would be of essential help for central government authorities.
Technology Name	***Development of a National Action Plan on adaptation and health protection during heat wave***
How this technology contributes to adaptation	A national action plan on adaptation and health protection measures during heat waves, related to economic and human potential of the state and coordinated with all relevant ministries will contribute to the adaptation and health protection during critical periods of heat waves. The plan shall provide for essential measures for adaptation of population to climate change, primarily, urban population.
Background	Development of an action plan on adaptation and health protection measures during heat waves is a short-term measure, while implementation of actions included in the plan – a long-term measure. Both are part of the overall policy of adaptation to climate change. This measure shall be implemented by mobilizing the population to better adapt to events generated by climate change.
Costs	Measures shall be implemented in urban areas. The estimated cost is determined both by organizational activities (workshops with the actors), as well as the need to write, edit and multiply the materials, and it amounts to approximately 17 500 lei.
Country Social Development Priorities	In terms of the country social development, development and implementation of the national action plan on adaptation and health protection measures during heat waves is a priority measure that will allow for a systemic and comprehensive implementation of measures at national and local level.
Economic Benefits	Economic benefits will be high, given that many public health emergency will be prevented, while dealing with consequences of such emergencies imply significant expenditures.
Environmental	Development and implementation of the national action plan on adaptation and health

benefits	protection measures during heat waves will contribute, to a certain extent, to biodiversity consrvation.
Social benefits	Social benefits are obvious due to health care measures, respectively, significant spending cuts for the rehabilitation of people affected.

Sector	Human Health
Adaptation needs	Buildings built up to date do not sufficiently isolate the internal environment from the external one, do not ensure energy conservation during the cold season, do not prevent overheating during heat waves and do not contribute to maintaining optimal temperatures in rooms unless with significant expenditures for energy. The term *passive house* refers to observance of a rigorous energy efficiency standard for buildings, also called Passivhaus standard (in German). The result of observance of this standard are buildings with ultra low energy consumption for heating or cooling. In addition, the concept of passive house is based on the principle of reducing long-term investment through energy efficient house design. Passive houses provide a comfortable indoor climate, whatever the season, practically without the need to employ a conventional heating source. Such constructions meet the adaptation requirements under the extreme events generated by climate change.
Technology Name	***Construction of passive houses in conditions of the Republic of Moldova (pilot project).***
How this technology contributes to adaptation	Perfect insulation of living premises not only essentially reduces energy costs during the cold and warm seasons, but also contributes to ensuring optimal habitat conditions (below 32oC during the day and below 24 ° C at night). These measures are essential for adaptation to climate change, first of all, for population in urban areas.
Background	Buildings built up to date do not sufficiently isolate the internal environment from the external one, do not ensure energy conservation during the cold season, do not prevent overheating during heat waves and do not contribute to maintaining optimal temperatures in rooms unless with significant expenditures for energy. A long-term measure is proposed, which is a part of the global climate change adaptation and energy consumption reduction policy, and along with fuel consumption, of reduced emissions into the atmosphere. This measure is accomplished by the new way of designing buildings in the residential areas, on the basis of the principle of a *passive house*, ie buildings with ultra low consumption of energy for heating or cooling. In addition, the concept of passive house is based on the principle of reducing long-term investment through energy efficient house design. *Passive houses* provide a comfortable indoor climate, regardless of season.
Costs	The cost of passive houses is only 20% above the cost of buildings built according to old technologies, while their efficiency ensures savings of financial resources in the process of exploitation.
Country Social Development Priorities	In terms of the country's social development, passive houses are a priority measure, because they allow future saving of significant amounts of energy thus reducing emissions of greenhouse gases in the atmosphere, and saving of financial resources.
Economic Benefits	Conservation of internal temperature entails high economic efficiency. It should significantly reduce heating costs during the cold season and air-conditioning costs in summer. Building of experimental passive houses in Chisinau and Cahul cities aim to demonstrate the economic efficiency of such buildings in the Republic of Moldova.
Environmental	Passive houses are ecological. Reducing heating costs in winter and air conditioning costs

benefits	during summer will contribute to environmental development due to fuel (gas and solid fuel) and electricity savings. Thus, reducing heating costs in winter and air conditioning costs during summer will contribute to sustainable environmental development through energy saving.
Social benefits	Social benefits are obvious due to significant spending cuts for heating during winter and air conditioning during summer. The resources saved could be channeled to other needs: healthier diets, cultural needs, etc.
Other considerations and priorities	Energy conservation measures will result not only in reducing the adverse effects of extreme temperatures (heat waves and low temperatures) on the health and quality of life, but also reduce greenhouse gas emissions into the atmosphere.

Sector	Human Health
Adaptation needs	In the recent decades deaths and morbid conditions caused by heat waves become more frequent and pronounced in Central Europe, including in the Republic of Moldova. They turned into a new problem in the region and in the country. The frequency and intensity of heat waves, strong frosts, abundant precipitations and flooding, which are more pronounced from year to year, worsen the quality of life and health of population. The basic characteristics of buildings, built until now do not ensure energy conservation during the cold season, do not provide sufficient insulation of internal environment from the external one during heat waves, and do not contribute to maintaining optimal temperatures in rooms unless significant energy costs are incurred.
Technology Name	***Energy conservation measures, measures aimed at maintaining optimal temperature in homes and public places and reducing the adverse effects of extreme temperatures (heat waves and low temperature) on health and quality of life of population.***
How this technology contributes to adaptation	Perfect insulation of housing and public premises, production and training areas not only essentially reduces energy costs during the cold and warm season, but also contributes, on the one hand, to assuring optimal habitual conditions and, on the other, ensures optimal conditions for professional activities, education and training (below 32oC during daytime, and below 24 ° C at night). These measures are essential to adaptation of population to climate change, primarily, in urban areas.
Background	Poor indoor environmental quality resulting from insufficient air circulation, poor lighting, mold build up, temperature variances, carpeting and furniture materials, pesticides, toxic adhesives and paints, and high concentration of pollutants contribute widely to respiratory problems, allergies, nausea, headaches, and skin rashes. This measure, which is part of the overall policy of adaptation to climate change, reducing energy consumption and subsequently reducing greenhouse gases in the atmosphere. This measure shall be accomplished by a more efficient thermal insulation of all residential, industrial and administrative buildings, by conserving energy and reducing energy spent for heating.
Costs	Measures have to be implemented in urban areas. The approximate cost is 750 lei per 1m2 of wall. Local public administration authorities in towns have to not only plan allocation of budgetary resources, seek donors' assistance, but also mobilize resources of businesses and population to make this work.
Country Social	In terms of the country's social development, perfect insulation of housing and public spaces,

Development Priorities	production and training areas is a priority matter, because it allows to save significant amounts of energy in the future, and respectively, reduce greenhouse gas emissions.
Economic Benefits	Economic benefits will be higher since it heating costs in winter and internal air conditioning costs in summer will be significantly reduced.
Environmental benefits	Reducing heating costs in winter and air conditioning costs in summer will contribute to environmental development due to fuel savings (natural gas and solid fuel), and electricity.
Social benefits	Social benefits are obvious due to significant savings in spending for heating in wintertime and internal air conditioning during summer. The resources saved could be channeled to other needs: healthier diets, more decent living conditions, cultural needs, etc.
Other considerations and priorities	Energy conservation measures will result not only in reducing the adverse effects of extreme temperatures (heat waves and low temperatures) on health and quality of life, but also reduce greenhouse gas emissions into the atmosphere, biodiversity conservation.

Sector	Human Health
Adaptation needs	In recent decades both incidence and severity of morbid conditions, as well as deaths caused by extreme phenomena of climate change are becoming more pronounced in Central Europe, including Moldova. They turned into a new problem in the region and the country. Among the worst cases are the heat waves, floods and other weather events that increasingly affect the quality of life and health of a growing number of people. In the Republic of Moldova the situation becomes alarming because of exhaustion of ground waters reserves, as there are more than 150 thousands sources. Intense evaporation from the surface of the soil in summer, especially during heat waves, depletes these reserves. An effective way to adapt to climate change extreme phenomena could be building of water supply systems in many rural areas.
Technology Name	***Suuply rural population with drinking water of guaranteed quality. Building of local water supply systems.***
How this technology contributes to adaptation	This measure is crucial for adapting of rural population to climate change.
Background	This is a long-term measure, which is a part of the global climate change adaptation, reduction of risks caused by deficiency of safe and good quality drinking water in rural areas of Moldova. In the recent years this measure is being implemented by building of water supply systems, supported by external donors. However, the population of more than 500 rural communities will still suffer from lack of access to safe drinking water.
Costs	Measures will be implemented in rural areas. The estimates cost of one water supply system built in a village is 750 thousand Euro. Local public administration authorities can not allocate own resources due to budget constraints.
Country Social Development Priorities	In terms of the country's social development, providing safe drinking water to rural population remains a priority measure documented in the Law of the Republic of Moldova nr.272 of 02.10.1999 on Drinking Water, and in a number of government decrees.
Economic Benefits	Economic benefits will be high, given that rural population will have access to safe drinking water. This measure will reduce morbidity by hepatitis A, diarrheal diseases and other

	chronic non-communicable diseases.
Environmental benefits	Reducing the volume of water extracted from groundwater will contribute to conservation biodiversity.
Social benefits	Social benefits are obvious due to significant reduction of cost for the treatment of acute diarrheal diseases, viral hepatitis and chronic non-communicable diseases.
Other considerations and priorities	Ensuring access of the rural population to safe quality water sources will substantially contribute to improving the quality of rural life.
Up-sacling potential	There is considerable up-scaling potetntial due to high interest of intrenation adonnors and investors to invest money in this adaptation measure. Thus the up-scalin gpotential is at least 25%.

Sector	Human Health
Adaptation needs	In the recent decades deaths and morbid conditions caused by heat waves become more frequent and pronounced in Central Europe, including in the Republic of Moldova. They turned into a new problem in the region and in the country. The frequency and intensity of heat waves, strong frosts, abundant precipitations and flooding, which are more pronounced from year to year, worsen the quality of life and health of population. Effectiveness of adaptation measures and consequences for human health, including sanitary and epidemiological well-being during the outbreak and during the liquidation of consequences of extreme events largely depends on the actions taken by professionals who provide preventive care services, as well as emergency and primary health care services. Training of such professionals plays an important role in policy development in this area (including local action plans), preventive health measures and primary health care, etc.
Technology Name	***Organization of postgraduate training of physicians in management of disasters caused by climate change and mitigation of consequences for public health.***
How this technology contributes to adaptation	The professional activity of the specialists of the State Public Health Surveillance Service plays an important role in the organization and implementation of sanitary-epidemiological measures during the outbreak of extreme events generated by climate change. Family doctors also have an important role as they provide primary health care and undertake preventive measures in the areas served. Awareness of these professionals about the regularities of epidemics outbreaks, intoxications, trauma, mental and behavioral disorders, etc. is a prerequisite for preventing epidemiological complications and mitigating the consequences for public health in case of medical emergencies.
Background	The professional activity of the specialists of the State Public Health Surveillance Service plays an important role in the organization and implementation of sanitary-epidemiological measures during the outbreak of extreme events generated by climate change. Family doctors also have an important role as they provide primary health care and undertake preventive measures in the areas served. Awareness of these professionals about the regularities of epidemics outbreaks, intoxications, trauma, mental and behavioral disorders, etc. is a prerequisite for preventing epidemiological complications and mitigating the consequences for public health in case of medical emergencies
Costs	Taking into consideration that the State University of Medicine and Pharmacy already has the faculty of Continuous Training in Medicine and Pharmacy, the cost of one training cycle

	(for 15 to 20 physicians) with a duration of 0.16 months (25 hours) is approximately 25 000 lei. The cycle is taught once a year.
Country Social Development Priorities	In terms of social development, practitioners will be able to achieve planning of measures aimed to maintain the sanitary-epidemiological welfare of the population and provision of better quality primary health care, enhanced awareness of local public administration authorities, businesses, mobilization of population. etc. at a higher professional level.
Economic Benefits	The benefits of economic development will be high, provided that sanitary-anti-epidemic and primary health care measures will be undertaken at a high professional level and efficiently.
Environmental benefits	The benefits of economic development will be high, provided that sanitary-anti-epidemic and primary health care measures will be undertaken at a high professional level and efficiently.
Social benefits	Social benefits are obvious due to more efficient public health protection measures.

Annex II. List of stakeholders involved and their contacts

1) Ministry of Environment: (Maria Nagornii, Chief of Department for Analysis, Monitoring and Evaluation of politics, tel 373-22-204520).
2) Ministry of Economy (Cristina Guriev, Deputy Chief, Department of Thermoenergetics, tel 373-22- 23-32-67
3) Ministry of Agriculture and Food Industry (Iurie Senic, Chief of Department Ecological Agriculture, Renewable resources and irrigation, tel 373-22-233427)
4) National Agency for Energy Regulation (Andrei Sula, senior specialist, Department Regulation and Licensing, ANRE, tel 373-22-541-384)
5) National Agency for Energy Efficiency (Mihai Stratan; Director, tel +078885505)
6) Institute of Power Engineering of the Academy of Sciences of Moldova (Sergiu Robu, tel, 373-22-727-040)
7) Institute of Ecology and Geography of the Academy of Sciences of Moldova (Maria Sandu, Deputy Director, tel 373-22-211-134)
8) Research Institute in Forestry and Silviculture planning (Ion Talmaci, Deputy Director 373-22-593-351);
9) Technical State University (Petru Todos, Deputy Rector, tel 373-22-235-400)
10) State Agrarian University of Moldova (Ion Bacean, associate professor, tell 373-22-432-258)
11) RED Union Fenosa S.A.; (Sergiu Codreanu, Regulation specialist tel 373-22-431441)
12) Ministry of Health (Ion Salaru, Deputy Director, National Center for Public Health. Tel 373-22-574-666)
13) State Hydrometeorological Service (Elina Plesca, Deputy Director, tel 373-22-773-511)
14) National Agency for Energy Regulation (Anatolie Boscaneanu, main specialist, Direction Regulation and Licensing, tel 373-22-544-936).
15) State University of Medicine and Pharmaceuticals of Moldova “Nicolae Testimiteanu” (Grigore Friptuleac, Chief of the Department Preventive Medicine tel 373-22-205-464
16) NGO “Ecospectr” (Alexandru Teleuta, Director, tel 373-22-523-898)
17) NGO “Energie Plus” (Vice-Director, Anderi Chiciuc, tel 373-22-237-619