Ministry of Natural Resources, Ecology and Technical Supervision
of the Kyrgyz Republic

Technology Needs Assessment Report

Part I
Adaptation Technologies Prioritization

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Technology Needs Assessment for Adaptation Technologies

National TNA Coordinator:
Mr. Beksultan Ibraimov, Deputy Minister of Natural Resources, Ecology and Technical Supervision, UNFCCC National Focal Point, GCF NDA

National TNA Director:
Mr. Ruslan Iliasov, Director of the Climate Finance Centre. CTCN NDE.

Contributing Experts:
Mr. Aleksandr Temirbekov, Team Leader, Agriculture Sector Adaptation
Ms, Ekaterina Sahvaeva, Water Sector Adaptation
Mr. Edilbek Bogombaev, Energy Sector Mitigation
Ms. Oksana Zabenko, Waste Sector Mitigation

TNA UNEP-CCC Coordination
Mr. James Haselip
Mr. Paul Riemann

TNA International Consultants
Ms Ala Druta, Republic of Moldova
Mr. Yuri Matveev, Republic of Ukraine
Ms Jiska da Groot, South Africa

Foreword

The Kyrgyz Republic strives to play an active role in the international climate change cooperation processes. Being a Party of United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, our country undertakes significant efforts through its policies and measures to reduce overall national GHG emissions as much as possible and to enhance adaptive capacities to reduce climate change vulnerabilities.

The identification and prioritization of climate change adaptation and mitigation technologies, as well as assessing the barriers for technology deployment and developing measures for overcoming those barriers, and expanding our project pipeline are important steps for Kyrgyzstan in developing its climate-resilient and low emission strategies.

In 2021, Kyrgyzstan submitted its Updated NDC in which it is committed to provide for reducing its emissions as well as enhancing its adaptive capacities. Now Kyrgyzstan is working to elaborate a more ambitious Long-Term Strategy for Carbon Neutrality by 2050, as well as implementing National Adaptation Planning.

GHG emission reduction activities are not an end in itself, it should be a stimulus for growth of an innovative economy sector, population welfare and creation of fair market conditions, while increasing the climate resilience of ecosystems, economy, communities and households. Such goals cannot be achieved without transfer of technologies.

The “Technical Guidance and Support to Conduct a Sectoral Technology Needs Assessment and a Technology Action Plan for the Kyrgyz Republic” project is funded by the Green Climate Fund (GCF), implemented by the United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC) and coordinated by Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic in close collaboration with all relevant ministries, agencies, academia institutions, non-governmental organizations, private sector and independent experts.

Identification and prioritization of technologies to reduce GHG emissions and adapting to climate change, based on international methodologies with the support of the international expertise is an important contribution to develop the national low carbon and climate resilient development strategies.

We also consider that TNA Report will complement the Kyrgyz Republic UNFCCC reporting documents, while facilitating climate technologies development and transfer.

Beksultan Ibraimov

Deputy Minister of Natural Resources Ecology and Technical Supervision of the Kyrgyz Republic
UNFCCC Focal Point and NDA for GCF.

Abbreviations

CFC	Climate Finance Centre in the MNRETS
CTCN	UN Climate Technology Centre and Network. UNFCCC Technology Mechanism
DWSS	Drinking Water Supply and Sanitation
GCF	Green Climate Fund
GDP	Gross Domestic Product
MNRETS	Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic
NC	National Communication under UNFCCC
NDA	National Designated Authority
NDC	Nationally Determined Contribution
NDP	National Development Programme
NDS	National Development Strategy of the Kyrgyz Republic for 2018-2020
NSC	National Statistical Committee of the Kyrgyz Republic
RCP	Representative Concentration Pathway
SWG	Sectoral Working Group
TAP	Technology Action Plan
TFS	Technology Fact Sheet
TNA	Technology Needs Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP-CCC	UNEP Copenhagen Climate Centre
UNIDO	United Nations Industrial Development Organization
UNFCCC	United Nations Framework Convention on Climate Change

Table of Contents

List of Tables

List of Illustrations

Executive Summary

This Technology Needs Assessment Report presents the process, participants, analysis and outputs of the prioritisation of the adaptation technologies in the sectors of agriculture and water resources undertaken in the Kyrgyz Republic in 2022 with support from GCF and UNEP CCC.

Chapter 1 Introduction provides information about the TNA project existing policies on climate change and technologies frames. It also shortly described the national circumstances, including the country's geography, climate, natural resources, demography, economy, social development, etc.

It also provides the information on the vulnerability assessment as by the Kyrgyz Republic NATCOMs and climate action mentioned by updated NDC. And finally, it provided information on the sectors selection and the expected climate change impacts in vulnerable sectors.

Chapter 2 is devoted to the institutional arrangement for the TNA and the stakeholder involvement. It presents the National Steering Committee, and the Sectoral Working Groups (corresponding TORs annexed to the report). It provides information about the National TNA Coordinator and the National Consultants Team. It also provides the overall assessment of the stakeholders' engagement. Considerations on gender equality are also detailed in chapter 2.

Chapter 3 Describes technology prioritisation in the agricultural sector, providing information about the key climate change vulnerabilities of the agriculture sector including the following:

- Exposure of the main crop farming areas to rising temperatures challenging sensitivity of crops resulting in the reduction of crop yields.
- High dependency of Kyrgyzstan crop farming on irrigation make agriculture vulnerable to climate change impacts: shrinking water runoff in summer and shifts in precipitations regime, heat waves and long periods without rains.
- Practically full dependency of livestock breeding on natural grasslands and unsustainable pasture use is now aggravated by the climate change hazards like lack of spring rains and hot summers, which undermine pasturelands capacities to regenerate grass cover. This led to growing degradation of grass lands reducing rural communes' livelihoods.
- The growing occurrence of spring floods and mudflows affect crops and cause considerable loss for rural households in climate induced disaster-prone areas.
- Inadequate land management practices coupled with climate change impacts pose a threat to overall national food security.

Among the main climate change related risks the following were identified:

- Increased risk of drought and water scarcity;
- Increased irrigation requirements;
- Increased pasturelands degradation;
- Soil erosion, salinization, desertification;
- Wheat, sugar beet and barley yields decrease;
- Increased risk of spring floods and mudflows.

The decision making context and an overview of the existing agricultural technologies are also presented in the same chapter. The list of the adaptation technologies options is presented with short descriptions, as well as the long list for the MCA analysis. It also presents the selection criteria and the detailed steps of the TNA process. The following major steps have been taken in the assessment process:

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

The results of the technology prioritisation in Agriculture include the following as per subsectors:

Livestock breeding:

1. Sustainable Pasture Management (resilient to climate change)

Crop Farming priority technologies included:

2. Organic agriculture
3. Drip Irrigation

Chapter 4 provides information about the TNA in the water sector. Among the key vulnerabilities of the water sector the following were mentioned:

- High temperatures impacts on glaciers leading to glacial water loss and uncertainty with summer river runoff
- Models of the future surface waters runoff shows its reduction in future under RCP 6.0 and 8.5 scenario.
- Uneven distribution of the surface runoff as per 4 typical hydrologic areas as per seasons.
- Growing number of floods and mudflows caused by heavy precipitations, as well as other climate induced water related disasters (snow avalanches, hails, landslides etc).

After the overview of existing in water sector technologies, the chapter provides information on the adaptation technology options presenting the corresponding long list, criteria and the weights, MCA matrixes and a short list of prioritised technologies including the following as per subsectors:

Drinking Water Supply and Sanitation

1. Energy- and resource-saving drinking water supply systems form the surface water sources using local materials

Irrigation:

2. Energy efficient pumps for pumping stations in the Kyrgyz Republic.
3. Subsurface irrigation on the background of closed drainage by sub irrigation method

Under the first stage conducting a TNA in Kyrgyzstan, the technologies have been assessed for agriculture and water sectors adaptation to climate change. For this, a wide process of the key stakeholder engagement was organised, and two Sectoral Working Groups (SWG) were established involving representatives of the government, academia, private sector, farmers and civil society organizations. The working sessions of SWG were conducted to assure quality of the TNA first stage outputs and their alignment to the national development priorities and climate policies (NDC and NATCOMs).

The implementation of these technologies would require a strengthening of the policy framework through the development of supporting strategies, laws, regulations, other documents to speed up the deployment of these technologies. For this, a stocktaking exercise to analyse existing gaps and barriers to improve enabling frames will be undertaken. This will lead to recommendations for improvements to deploy and diffuse prioritised adaptation technologies in the Agriculture and Water sectors, feeding into the

Technological Action Plan (TAP). Finally, as a means to mobilise significant financial resources, the TNA project will deliver three GCF Concept Notes, informed by the analysis and conclusions on the TAPs.

Finally, Kyrgyzstan has committed to implement policies and measures aimed at climate resilient development. Activities related to adaptation in the context of climate change are already being implemented in the framework of national and state programs, national and regional programs and plans.

Chapter 1 Introduction

1.1 About the TNA Project

The GCF-funded project "Technical Guidance and Support to Conduct a Sectoral Technology Needs Assessment and a Technology Action Plan for the Kyrgyz Republic", implemented by UNEP-CCC on behalf of the CTCN, was launched in 2021. It has three relevant GCF Readiness areas of interest:

- Capacity Building
- Strategic frameworks
- Investment pipeline development.

The project provides assistance to establish a climate technology framework in the country to help it achieve a steady climate-resilient socio-economic development. This will be done through developing a comprehensive Sectoral TNA and ending with a TAP for the technologies prioritised by the Kyrgyz Republic sectoral working groups (SWGs). The work supports the country in achieving its international climate targets stated in the Updated Nationally Determined Contribution (NDC), the Third National Communication and the Green Climate Fund (GCF) Country Programme by utilizing and disseminating and deploying the most appropriate climate technology solutions.

The project targets the country's key economic sectors – agriculture, energy, water and solid waste management, since they can hardly meet the country's socio-economic development and climate resilience objectives due to being dependent on outdated technologies. It addresses a number of barriers preventing the country from utilizing modern technologies in these sectors:

1. A comprehensive system to develop and implement a sectoral TNA is lacking among concerned country's stakeholders. There is no formal coordination mechanism to oversee and structure these efforts.
2. The country lacks a strategic framework to improve sectoral expertise in climate technologies. It needs to identify and prioritise the most appropriate technologies for different sectors of the economy but does not have a methodology to do so and has no action plan to deploy climate technologies on the ground.
3. No robust climate sensitive technology project proposals are being formulated in the country, which leaves it lacking funding inflows into its climate technology projects and further delays climate technology deployment.

At present, the Kyrgyz Republic has a number of country programmes and national strategies to achieve its international climate targets and commitments. However, major sectoral, policy, institutional, financial, technologicaltchnological and capacity challenges prevent the country from strengthening its climate change preparedness. In this context, the TNA project develops an effective mechanism for coordination between key national stakeholders to strengthen the capacity of the private sector stakeholders to deploy climate technologies.

The project complements planned and ongoing GCF supported initiatives in the Kyrgyz Republic. As such, it takes into account activities that address development needs already formulated in national development strategies as well as national policies, existing sectoral plans in the context of the country's economic, social and environmental development priorities. Such synergies with on-going climate work and economies of scale are achieved through a robust stakeholder engagement process, sharing resources and inputs through communication strategies, trainings and round table dialogues, utilizing existing tools

such as GCF monitoring tools, and increasing the engagement with the private sector. A dedicated training will be delivered to the private sector representatives with the objective of facilitating a climate responsive technology market formation in the Kyrgyz Republic.

The TNA project in Kyrgyzstan cover four sectors: Water Resources and Agriculture for adaptation and Energy and Waste for mitigation.

The outputs of the project in each of the sectors will include the following:

1. Technology Needs Assessment Report with identified priority technologies for enhanced deployment deploy and diffusiondiffuse in Kyrgyzstan
2. Barriers and Enabling FrameworkFrames Analysis, providing information on the existing legal, policy, capacity, financial, social and other gaps and constraints that prevent selected technologies being introduced and disseminated
3. Technological Action Plan that presents a set of actions to be undertaken to promote selected technologies in Kyrgyzstan
4. Concept Notes on the project proposals for GCF funding

These outputs comprise a set of strategic, long-term, participatory transformational measures across the four identified and prioritized sectors that contribute meaningfully to climate resilient and low carbon growth planning ongoing in the Kyrgyz Republic.

To implement UNEP-CCC has established a group of national consultants, as well as bringing brought in international expertise.

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

1.2.1 National circumstances

Geography and climate

The Kyrgyz Republic (KR) is located in the centre of the Eurasian continent, in the the northeast of Central Asia. The area of the territory is 199.95 thousand km². It stretches from west to east - 900 km, from north to south - 450 km. The Kyrgyz Republic borders four states: the Republic of Kazakhstan, the People's Republic of China, the Republic of Tajikistan, and the Republic of Uzbekistan.

KR is located within the Tien Shan and Pamir-Alai mountain ranges. All the variety of landscapes and natural and climatic conditions of the Kyrgyz Republic are combined into four natural and climatic zones: valley-foothill - up to 1,200 m, mid-mountain - from 1,200 to 2,200 m, high-mountain - from 2,200 to 3,500 m, and nival - above 3,500 m.

The climate of the Kyrgyz Republic is extremely continental, mostly arid, slightly smoothed by increased cloudiness and precipitation due to the high-mountainous relief. The climate peculiarities are determined by the location of the republic in the Northern Hemisphere in the centre of the Eurasian continent, as well as the distance from significant water bodies and close proximity with deserts.

The average annual temperature of the Kyrgyz Republic for the period from 1885 to 2010 has increased significantly, while the rate of temperature change is nonlinear and has increased significantly in recent decades. Therefore, if the average annual temperature growth rate during the observation period t in the

republic was 0.0104°C/year, then for the period 1960–2010 the rate has more than doubled and amounted to 0.0248°C/year, and throughout the period 1990–2010, the rate has already reached 0.0701°C/year.

In general, precipitation has changed insignificantly, but in recent years, there have been sharp changes in certain regions, both upward and downward. So, over the entire observation period, the amount of annual precipitation in the republic increased slightly (0.847 mm/year), but during the last 50 years, the growth has significantly decreased (0.363 mm/year), and in the last 20 years, there has even been a slight downward trend (-1.868 mm/year).

State Structure

The Constitutions states that the Kyrgyz Republic is a sovereign, democratic, legal, secular, unitary, and social state. State power in the Kyrgyz Republic is based on principles of the division of power between legislative, executive, and judicial branches and their reconciled functioning and cooperation. The President of the Kyrgyz Republic is the head of the State embodying unity of the people and state power. The President is elected every six years. Jogorku Kenesh - the Parliament of Kyrgyz Republic is the supreme representative body implementing legislative power and control functions within their competence. Executive power in the Kyrgyz Republic is implemented by the Cabinet of Ministers, which includes ministries, state committees, administrative and local state bodies. Judicial powers are exercised through constitutional, civil, criminal, administrative, and other forms of legal proceedings. The judicial system of the Kyrgyz Republic consists of the Supreme Court and local courts. The Constitutional Chamber operates within the Supreme Court.

Demography

The population of the Kyrgyz Republic amounted 6 747 323 people (50.4% women) as of January 1, 2022. The share of the population under the working-age (0-15 years) was 34.7%, the portion of the working-age population (men aged 16-62 and women aged 16-57) was 56.8%, and the percentage of the population over working age (men at the age of 63 years and older and women - 58 years and older) was 8.5%. The percentage of the rural population was 66.1% (49.4% of women), and the urban - 33.9% (52.5% of women). The average annual population growth in 2022 was 1.7%.[1] In 2022, the Kyrgyz Republic had 2 cities of republican significance (Bishkek and Osh), 7 provinces, 40 districts, 31 cities, 12 villages, and 453 rural districts. There are 531 administrative-territorial units in total. Due to the mountainous terrain, the population of Kyrgyzstan is extremely unevenly distributed over the territory of the republic. The number of inhabitants per km^2 in the same year was 34 people. Generally, the population lives and carries out most of the economic activity within the low mountains, inter montane basins, and mountain valleys.

Natural resources

Kyrgyzstan is the only country in Central Asia whose water resources are mostly formed on its territory, and this is a hydrological trait and advantage. The republic's water resources are concentrated in glaciers, lakes, rivers, and groundwater. As of 2013-2016, there are 9,959 glaciers with a total area of 6,683.9 km^2 on the territory of the Kyrgyz Republic, including 6,227 glaciers larger than 0.1 km^2, with a total area of 6,494.0 km^2 and 3,732 glaciers smaller than 0.1 km^2, with a total area of 189.9 km^2. Significant water reserves are concentrated in the glaciers of Kyrgyzstan, the volume of which is about 760 billion metresm^3. The area of glaciation has decreased by 16% as a result of climatic influences over the past 70 years.[2]

[1] National Statistic Committee. Population. http://www.stat.kg/ru/statistics/naselenie/
[2] Water Resources Service under the Ministry of Agriculture.
https://www.water.gov.kg/index.php?option=com_content&view=article&id=228&Itemid=1274&lang=ru

There are 1,923 lakes with a total water surface area of 6,836 km^2 on the territory of Kyrgyzstan. The estimated water reserves in the lakes of the republic are 1,745 km^3. Among them, 1,731 km^3 (or 99.2% of the volume of all lakes) is concentrated in the Issyk-Kul Lake, the water of which is salty and unsuitable for water supply. There are more than 3,500 large and small rivers in the Kyrgyz Republic. About 2,000 rivers are over 10 km long, and their total length is almost 35 thousand km. In addition, there are 44 deposits of underground fresh and mineral water. The potential reserves of fresh groundwater in the Kyrgyz Republic are estimated at 13 km^3. In 2021, the volume of water intake from natural sources amounted 7 999.50 million m^3, an increase compared to 2017 by 4.5%. The total water intake from water sources per one inhabitant of the republic in 2021 amounted to 1,185.6 m^3.[3]

Agricultural lands, in 2021, accounted for 33.8% of the country's land balance, lands of settlements - 1.4%, lands of specially protected natural areas - 5.9%, forest lands - 12.7%, water resources - 3.8 %, land for industry, transport, etc. - 1.2% and state reserve lands - 41.2%. In 2022, the area of arable land was 1,287 thousand hectares, with 79.9% of them being irrigated. The area of rangelands accounts 10,604 thousand ha or 84/8% of agricultural lands. [4]

According to the National Forest Inventory, the forest area of the Kyrgyz Republic is 1,116.56 thousand hectares or 5.6% of the total area of the country. Under natural conditions, there are 30 species of wooden vegetation of all groups of tree species typical for middle latitudes: conifers, hard-leaved, soft-leaved walnut, fruit, pome, stone fruit, and more than 17 species of shrubs.

Economy

According to the World Bank classification, Kyrgyzstan belongs to the group of lower middle-income countries. The year 2020 was marked by COVID-19 pandemic impact on GDP, which negatively influenced the development of the national economy. Thus, the GDP in 2020 amounted 7,740.5 million US dollars (12.7% less than in 2019) and the consumer price index was 106.3% of the prices of the previous year. The share of industry in total GDP was 14.5%, agriculture - 13.6%, construction - 10%, trade and catering - 17.5%, transport and communication – 5.9%, state governance, defence and social safety – 7.1%, education – 6.8%, healthcare – 2.8% and 21.8% other.[5] In 2020, GDP per capita was 1,230.9 USD (13.9% less than previous year).

In 2020, Kyrgyzstan's imports amounted to USD 3,718.9 million (25.5 % less than in 2019) and exports remained practically on the same level of USD 1,973.2 million.[6] The employed population in 2020 amounted to 2,445.2 thousand people, and the unemployment rate was 5.8%.

Actual final consumption of households per capita, in 2020, amounted to 79.1 thousand Som (USD 957.1), and monetary income per capita 56.8 thousand Som (USD 687.2) a year. The value of the subsistence minimum on average per capita in 2020, was 5,625.4 Som per month (USD 68.1) and the value of the food basket of the minimum consumer budget - 3,483.1 Som per month (USD 42.1).[7]

[3] NSC, Fuel and Energy Balance of 2020. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[4] National Statistic Committee (NSC). Areas of Agricultural lands as per types of use. http://www.stat.kg/ru/opendata/category/131/
[5] NSC. GDP by types of economic activities. http://www.stat.kg/ru/statistics/nacionalnye-scheta/
[6] NSC. External economic activities. http://www.stat.kg/ru/statistics/vneshneekonomicheskaya-deyatelnost/
[7] NSC. Living standards of population. http://www.stat.kg/ru/statistics/uroven-zhizni-naseleniya/

1.2.2 National development strategies

Further description of the main national strategies focuses on the TNA project targeted sectors.

The main development priorities and directions of the Kyrgyz Republic are presented in the **National Development Strategy for 2018-2040 (NDS).**[8] It is a comprehensive document that defines the goals and vision of social and economic development of the country.

In the introductory section it says that the complex and rapidly changing economic and geopolitical situation in the world and the region, the digital transformation that has embraced the main spheres of social life and sectors of the global economy, the growing pressure of humanity on the Earth's ecosystem, expressed in changes in the global climate and demography, require the formation of a new model of national development.

NDS promotes economic activities that ensure poverty reduction and social progress and do not exceed the limits of environmental sustainability of natural ecosystems require more effective planning and management of the country's transition to sustainable development through various elements of "green development" and the introduction of measures for adaptation to climate change. For this, activities will be aimed at preservation and restoration of natural environment, landscapes, ecosystems and biodiversity through expansion of ecological network. The expansion of green areas is one of the key elements in reducing the risks of climate change, land degradation, air pollution. The last statement indicates that the ecosystems-based adaptation approach will be pursued for next decades.

NDS provides that Kyrgyzstan will have a competitive economy that is focused on the application of innovative and environmentally friendly nature-saving technologies, an economy that is diversified, balanced and inclusive, with a favourable investment environment.

NDS also promotes the idea that Innovative Economy as the only possible way of development. It goes on to say that Kyrgyzstan needs a new type of industry - high-tech, compact, environmentally friendly. The time of giant factories has passed, now smart and mobile enterprises focused on technological solutions are favoured. Priority is given to technological upgrading of all municipal enterprises responsible for the maintenance of basic infrastructure such as lighting, garbage, water and sewage in key cities.

The development of the national agro-industrial complex and cooperation is highlighted as one of the priorities of the country's development. NDS says that the agrarian policy of Kyrgyzstan is aimed at ensuring food security and nutrition, to increase the food independence of the country and entails the physical and economic availability of food in accordance with the minimum standards of food consumption established by the state, while respecting the safety requirements.

The NDS notes that Kyrgyzstan, using its geographical and climatic advantages, will become a leading supplier in regional and international markets for high quality environmentally clean, organic agricultural products. Agriculture commodity processing capacities and logistics centres will be put in place to provide food to the local market and to export products to external markets. Farms will be actively involved in the production process through cooperatives and agglomerations, which will allow producers to gain direct access to agriculture inputs and markets, thus, contributing to an increase in the income of the rural population.

State support will be directed to large rural enterprises, farms and cooperatives that are engaged in the production and processing of agricultural products and creating high added value. Special emphasis will

[8] Endorsed by Presidential Decree as of 31 October 2018 # 221/

be placed on the development of the following clusters: wool production, beekeeping, intensive horticulture, and fish farming. Along with this, the strategic issue is the development of elite seed production and breeding, which will be developed on specially allotted state agricultural lands.

The main direction in the development of the agricultural sector is aimed overcoming the country's limited competitiveness in foreign markets and the low capacity of traditional crop production. A modern system of quality control over production, storage and processing of agricultural products will be deployed and disseminated in the sector.

NDS addresses the need for more effective use of land and water resources. The Integrated Water Resources Management at all levels is in the initial stage of development in Kyrgyzstan. Modern technologies for efficient use of water resources are to be introduced, significantly increasing the coefficient of water use, including active use of the capabilities of reservoirs, daily and ten-day regulation basins. Implementation of the programme for saving glaciers and mountain lakes in Kyrgyzstan is considered as along-term investment and responsibility to future generations.

One of the ways to address food security and poverty alleviation issues in the Kyrgyz Republic is the development of irrigation. By 2023, it is planned to put into operation an additional 27 thousand hectares of new irrigated lands, to increase water supply to 40 thousand hectares, to ensure transfer of conditionally irrigated lands into irrigated ones to the area of 2800 hectares. Twelve water accumulation reservoirs with a total capacity of about 64 million metresm^3 will be built. As part of the efforts to improve the condition of lands, field water supply will be increased. The main measures taken by the state will be construction and rehabilitation of irrigation infrastructure, improvement of water management and regulation, as well as development of a financial model to ensure irrigation systems sustainability.

The priority of the national local development is to improve the infrastructure of settlements. One of the most important tasks is the construction and rehabilitation of water supply systems in 653 villages, including the construction and rehabilitation of drinking water supply and sanitation (DWSS) systems in 26 district centres and 22 towns. The state will bring clean drinking water to 95% of the country's settlements. More than 2.0 million people in rural areas will have access to the centralized water supply.

By 2023, the construction and rehabilitation of wastewater treatment systems will be carried out in 7 provincial and 26 district centres. In doing so, modern technologies will be used to ensure the maximum degree of safety for the environment. The main measures will include construction and rehabilitation of DWSS infrastructure, improvement of the DWSS systems management and enabling frames, as well as development of a financial model to ensure DWSS systems sustainability.

The task to develop waste management systems and recycling infrastructure also clearly mentioned among the priorities for the local development in Kyrgyzstan. Best practices in waste management and recycling will be used in the largest cities of the country. Particular emphasis will be placed on the creation of landfills using technologies that ensure minimal risk to the environment and people. It will provide for the establishment of landfills in nine cities using modern technologies by 2040/

To achieve all above mentioned, the digitalization and modernization process will cover the country's key social (education, health, environment), economic (energy, agriculture, industry, services) and political spheres (prevention of corruption, fair elections).[9]

[9] National Development Strategy of the Kyrgyz Republic for 2018-2040. Section II, chapter 2.2.

In 2021, to implement NDS, the **National Development Program of the Kyrgyz Republic until 2026 (NDP)** was endorsed [10] , setting the national development priorities for the period.

Under the section on setting the scene for development it says that the key task of the state in the medium term will be the formation of an environment necessary and sufficient for the realization of each person's potential. Access to clean water is mentioned among the main components ensuring the quality of life of people in rural areas. Drinking water supply policy will be aimed at creating an economically sustainable, affordable, safe and quality water supply service. The main focus of this policy will be the construction and rehabilitation of physical infrastructure which will bring water to 95% of the country's settlements. About 100 villages of the republic will be connected to clean and safe drinking water facilities every year.

NDP says that Kyrgyzstan has huge water resources - about 47 km^3 of surface river flow, using about 20% of it, mainly for irrigation. The poor condition of irrigation infrastructure requires attention and early rehabilitation and further development. The main problems are the lack of effective water resource management under market conditions, poor technical condition of irrigation infrastructure due to worn-out hydraulic structures, lack of funds for repair and maintenance, and for the construction of new facilities.

NDP points out that since the strategic goal of reforms in the agricultural sector will be to ensure food security, the agro-industrial complex will stimulate the development of medium and large processing complexes, and logistics centres to export products to foreign markets. The state will create conditions for the development of clusters in the production and processing of agricultural products. Mechanisms to stimulate the development of the agro-industrial complex will be revised, including by increasing and structuring financial support from the state, as well as introducing a favourable regime for the import of agricultural technologies and innovations, machinery and mechanized means of production. Digital technologies in agriculture will increase the productivity of the sector, the quality of forecasting, standardization, tracking, marketing attractiveness, improve farmers' access to information.

Specialized centres for agrochemical, animal and veterinary and agro-technical services to farmers are planned to be established in each territorial district. To the maximum extent possible, farmers should use biological fertilizer technologies, fertilizers and medicines to keep agriculture clean and environmentally friendly. The activity of seed and breeding farms will be technologically modernized.

Within the priority on sustainable environment and climate change it is planned to undertake policy measures to minimize the negative environmental consequences of the economic activities, increasing the effectiveness of requirements and incentives for environmental protection. As a cross-sectoral approach it is planned to develop and support environmentally-oriented business, integrate the principles of green economy into the sectoral policies, and to deploy low-waste, resource-saving technologies.

NDP states that addressing disaster risk reduction damaging infrastructure and crops in a changing climate must be comprehensive, taking into account future threats and hazards, the development of new methods of forecasting, warning and recovery.

NDP also stress that the promotion of environmental education, upbringing and awareness on the principles of sustainable consumption and production, starting from kindergartens and schools, will form

[10] Presidential Decree as of 14th October, 2021.
http://www.president.kg/ru/sobytiya/20898_prinyata_nacionalnaya_programma_razvitiya_kirgizskoy_respubliki_do2026_goda

a generation of citizens with a positive environmental outlook and awareness of responsibility for the conservation of natural resources potential of the country.

1.2.3 Legal frameworks, policies and actions related to technological development

Enabling frameworks of Kyrgyzstan for technologies development, deployment and dissemination include laws, policies and technical regulations. Among the laws are the following:

- Law of the Kyrgyz Republic "On Innovation Activities" # 128, 26 November 1999
- Law of the Kyrgyz Republic "On the Fundamentals of Technical Regulation in the Kyrgyz Republic" dated 22 May 2004 # 67;
- Law of the Kyrgyz Republic "On High Technology Park of the Kyrgyz Republic" dated 8 July 2011, # 84.
- Law of the Kyrgyz Republic "On Science and on the Basis of the State Scientific and Technical Policy" # 103 as of 16 June 2017.
- Law of the Kyrgyz Republic “On Electronic Governance” # 127 as of 19July 2017.
- Law of the Kyrgyz Republic “On the Scientific and Technical Information System” # 108 as of 8 October 1999.
- Law of the Kyrgyz Republic “On Competition” # 116 as of 22 July 2011.
- Law of the Kyrgyz Republic “On State Support for Small Business” # 73 as of 25 May 2007.
- Law of the Kyrgyz Republic “On the Protection of Entrepreneurs Rights” # 15 as of February 1, 2001.
- Law of the Kyrgyz Republic "On Secret Inventions" # 79 as of 23 January 2006.
- Law of the Kyrgyz Republic «Patent Law» # 8 as of 14 January 1998.

Among the actual policies relevant for technological development the following could be mentioned:

1. The National Development Strategy 2018 - 2040.
2. The National Development Programme of the Kyrgyz Republic until 2026.
3. The Concept of Scientific and Innovative Development of the Kyrgyz Republic until 2022. [11]
4. The Strategy for Sustainable Development of Industry of the Kyrgyz Republic for 2019-2023[12]
5. The State Programme for Development of Intellectual Property in the Kyrgyz Republic for 2017-2021[13]"
6. The Regulation on the Procedure of Establishment and Activities of Expert Commissions on Technical Regulation"[14]
7. The Concept of Digital Transformation "Digital Kyrgyzstan - 2019-2023.[15]
8. Decree of the President of the Kyrgyz Republic “On urgent measures to enhance the implementation of digital technologies in public administration of the Kyrgyz Republic”[16]
9. The Plan of activities for digitalization of governance and development of digital infrastructure in the Kyrgyz Republic for 2022-2023.[17]

[11] Resolution of the Government dated 8 February 2017 # 79.
[12] Resolution of the Government dated 27 September 2019, No. 502.
[13] Resolution of the Government dated 6 July 2017 No. 424.
[14] Resolution of the Government # 565, 4 August 2006.
[15] Resolution of the National Security Council as of 14 December 2018 # 2.
[16] As of December 17, 2020 UP # 64.
[17] Order of the Cabinet of Ministers of the Kyrgyz Republic № 2-r, dated January 12, 2022.

10. The Programme of the Education Development in the Kyrgyz Republic for 2021-2040"[18]

Thus, the **National Development Strategy for 2018-2040** provides that Kyrgyzstan will actively pursue reforms to create a competitive economy through the creation of a truly attractive framework for entrepreneurs and the application of innovative and environmentally friendly technologies. Presenting the future economy vision, NDS states that Kyrgyzstan will have a competitive economy that is oriented towards the application of innovative and environmentally friendly technologies, an economy that is diversified, balanced and inclusive, with a favourable investment environment.

The National Development Programme till 2026 states that the Government policy will aim to overcome the situation of geo-economic constraints and limited energy, financial and technological resources and this priority is a strategic one for the Kyrgyz Republic. NDP provides for a wide range of digital technologies deployment and dissemination in the state governance systems, economy, banking, education, health care, science, etc.

Among others it points out that adaptation measures need to be applied in the agricultural sector in the face of climate change. In addition to the use of climate-resilient technologies and varieties, wide implementation of climate risk insurance instruments in agricultural activities is advisable. It also says that, given the global trends associated with a warming climate, projections of declining freshwater resources, and the uneven distribution of freshwater throughout the country, the development of sustainable irrigation is particularly urgent, as well as potable-water supply and sanitation.

Technical regulations establish various product-safety indicators, while the application by the manufacturer of the standards included in the relevant lists ensures that the requirements of the technical regulations are met. The technical regulation documents relevant for the TNA targeted sectors include the following:

1. Technical regulation "On Drinking Water Safety". [19]
2. Technical Regulation "On Safety of Building Materials, Products and Constructions". [20]
3. The Action Plan for the Application of Technical Regulations of the Customs Union in the Kyrgyz Republic. [21]
4. The Technical Regulation "On Safety of Medical and Veterinary Products for Laboratory Diagnostics in Artificial Conditions (In-vitro)". [22]
5. Technical regulation "On safety of veterinary medicines". [23]

The National Information Fund of Technical Regulations and Standards of the Kyrgyz Republic contains 28,952 active standardisation documents.

1.2.4 Policies and actions related to climate change adaptation

The latest national communication to UNFCCC, NATCOM 3 of the Kyrgyz Republic, was submitted in 2016, when a set of climate change adaptation policy documents was in place and operational. It should be noted that all of them were developed under the effective lead of the UNFCCC focal point with UNDP support. That set included the following:

[18] Resolution of the Government # 200 as of 4 May 2021.
[19] Law of the Kyrgyz Republic # 34 as of 30 May 2011.
[20] Law of the Kyrgyz Republic # 18 as of 29 January 2010.
[21] Resolution of the Government dated 29 March 2017 # 184.
[22] Resolution of the Government dated 5 April 2013 #173.
[23] Resolution of the Government dated 6 August 2013 #441.

The Climate Profile of the Kyrgyz Republic (2013) analysed and presented the first step to climate change adaptation. Namely, the level of observed and expected climate changes and the degree of their impact on the Kyrgyz Republic for the subsequent effective implementation of the next planned adaptation actions. This paper contributed to vulnerability assessment in Agriculture and Disaster Risk Reduction, which was proposed in many ways for other sectors. It was not a policy document; however, it brought the research basis for the following climate change adaptation policy document.

The Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic until 2017[24] was prepared in 2013. The document defines the key vulnerable sectors (water resources, agriculture, energy, health, disaster risk reduction, forestry and biodiversity) and the indicative actions for the country overall. The Priorities goal was to establish a national policy to mobilize resources aimed to minimize the negative risks and to use the potential of climate change for the sustainable development through the adaptation measures implementation in the sectors most vulnerable to climate change.

It stated that development strategies and the economic sectors activities should be harmonized with adaptation to climate change. The adaptation measures should be developed based on the analysis of the climate change risks, vulnerability assessment of the economic sectors, environment and population. It promotes an inter-agency and cross-sectoral approach, involving all stakeholders in the adaptation projects development.

It has also defined that the main elements of adaptation activities include:

- the legal framework improvement;
- the institutional framework improvement and ensuring cross-sectoral integration in adapting to climate change;
- financial and economic mechanisms improvement, including the mobilization of external funding for the priority adaptation measures;
- improving information tools to provide monitoring of the climate change process and climate risk assessment;
- involvement of civil society in the climate change adaptation process;
- increasing the scientific capacity to adapt to climate change; and
- organization and promotion of cross-border cooperation on climate change adaptation.

The priorities development process identified the highest priority sectors for adaptation, given the already observed and the expected climate change. Quantitative vulnerability estimates were obtained for each priority sector and adjusted to a specific amount of damage, i.e., expected economic losses in an absence of timely adaptation actions (Tab. 1.1)).

Table 1.1. Estimated economic losses without adaptation measures under A2 scenario in 2100.[25]

Sector	Losses, mln. USD (2005)
Water resources	718
Agriculture	70
Energy	200
Emergency situations	38
Healthcare	110
Forest and biodiversity	94.8

[24] Adopted by the Resolution of the Government of the Kyrgyz Republic on October 2, 2013 #549
[25] Government of KR. Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic till 2017. Bishkek. 2013

Total:	**1230.8**

The Priority Directions were developed with the involvement of specialists from all key ministries and institutions of the Kyrgyz Republic, scientific and academic community, business and NGOs.

The "Priorities" development was followed by the next stage of adaptation planning for the most vulnerable sectors. Upon the decision of the Coordination Commission on the Climate Change Problems headed by the first deputy Prime Minister in February 2013, all key ministries and agencies developed sectoral adaptation programs based on those "Priority Directions". As a result, the following adaptation programs were developed covering all the vulnerable sectors, except "Energy"[26]:

- Water Resources and Agriculture Adaptation Programme;
- Adaptation Programme for the sector of Emergency Situations;
- Adaptation Programme for the Health Sector; and
- Adaptation Programme for the Forest and Biodiversity Sector.

The four sectoral plans and programs include an assessment of the sectors' current state, vulnerability assessment and justification of the adaptation measures and the actual plans with the estimated costs required for the implementation. (See tab.1.2).

Table 1.2 Sectoral adaptation programs and plans [27]

No	Ministry/agency	Sector	Order on approval
1.	Ministry of Agriculture and Land Reclamation	Water resources and agriculture	# 228,31.07.2015
2.	Ministry of Emergency Situations	Emergencies	# 692, 7.07.2015
3.	Ministry of Healthcare	Healthcare	# 531, 31.10.2011
4.	State Agency for Environment Protection and Forestry	Forest and biodiversity	# 01-9/110, 17.04.2015

However, the implementation terms of the separate measures in the sectoral policies were not addressed, as the performance of most of them depends not only on the domestic actions, but also on the external support timing. Thus, only the validity periods of the sectoral strategies (3-5 years) were identified. The strategies are expected to be reviewed regularly taking into account the updated information, primarily by the climatic, demographic and macroeconomic scenarios, as well as the country's experiences on the vulnerability assessment, the economic losses and the adaptation measures implementation.

All those documents were implemented to a different expend (from 30 to 80%) being evaluated during NDC update process in 2021.

They were not duly revised and updated since, in 2017, the UNFCCC focal point and GCF NDA signed an endorsement letter to GCF AE – UNDP to attract GCF Readiness Programme financing for NAP development in order to organize next national NAP development process. However, due to different reasons the project was launched effectively only in 2021.

Thus, currently, there is no specific national climate change policy for adaptation in the Kyrgyz Republic. Nevertheless, climate change is well integrated into the main adopted national strategic development documents described above, i.e. NDS and NDP.

[26] The energy sector adaptation measures were not developed, the majority of them being planned to be addressed via mitigation programmes.

[27] State agency for Environment Protection and Forestry. UNEP, GEF. Third National Communication of the Kyrgyz Republic to UNFCCC. Bishkek. 2016

Thus, NDS section "Establishment of Favourable Environment for Development", subsection "Environment, Adaptation to climate Change and Disaster Risk Reduction" presents the future vision as follows: "Kyrgyzstan is a country that is conducive to human life and is developing in harmony with nature, preserving unique natural ecosystems and ationally using natural resources for climate resilient sustainable development. Ensuring environmental sustainability alongside the country's economic growth will be achieved by minimizing negative environmental impacts, increasing the effectiveness of environmental protection requirements and incentives and the use of reliable data for making ecologically significant decisions."[28]

Evidently, the Government paves the way to undertake effective adaptation actions in this country. Further on, it elaborates that there is a need to consider climate change in economic activity assuring poverty reduction and social progress, which requires better effectively planning and management the country's transition to sustainable development through various elements of green development and implementation of adaptation measures to climate change.[29]

NDP also points out that the climate change impacts on natural resource management exacerbating their degradation. It also promotes the development of economic priorities (hydropower, agriculture climate resilient insurance schemes, and efficient use of water resources) with regard to adaptation to climate change. Climate change adaptation should also be well addressed in education. In the section entitled "Special Development Priorities", the role of increasing the forest covered area is stressed as reducing climate change risks, as well as land degradation and air pollution. Addressing disaster risk reduction in the context of climate change, new forecasting methods and comprehensive response actions should be developed to take into account future threats and hazards.

Among the concrete projects which will be implemented for this, the following were mentioned as seeming feasible as far as climate change adaptation is concerned:

1. Approval and implementation of the National Adaptation Plan
2. Expansion of the ecological network of specially protected natural territories and increase its potential through effective scientific sound approach to management planning;
3. Implementation of the national programme "Forest" (afforestation and reforestation);
4. Implementation of the Interstate Target Programme "Reclamation of the territories of states affected by uranium mining industries";
5. Implementation of works on the reclamation of Soviet heritage uranium sites in the settlements of Shekaftar, Min-Kush and Mailuu-Suu;
6. Implementation of the project "Landslide risk management in Kyrgyz Republic";
7. Strengthening the capacity to counteract natural disasters, including those related to climate change, through comprehensive assessment and consideration of disaster risk reduction opportunities.

The **Concept of Comprehensive Protection of the Population and Territories of the Kyrgyz Republic from the emergencies for 2018-2030**[30] fully aligned to Sendai Framework for Disaster Risk Reduction 2015-2030 is another document, no doubt, providing for climate resilience in this country. The Concept defines different kinds of disaster risks, also including hydro meteorological ones, and provides for the situation analysis. It sets the goal, priorities and objectives of comprehensive protection of population and territory of the Kyrgyz Republic from emergencies. The goal of the Concept is to increase the level of

[28] NDS 2040. Government. Bishkek. 2018. P.47.
[29] NDS 2040, p.48
[30] Adopted by the Governmental Resolution as of 29 January 2018 #58.

protection of the population and territories from emergencies in order to create conditions for sustainable development of the country. In order to achieve the goal of the Concept to improve the level of protection of the population and territories from emergencies, it is necessary to implement a set of measures in the following four priority areas identified by the Sendai Framework Program:

- Increasing knowledge of disaster risk;
- Improvement of the institutional and legal framework for disaster risk management;
- Investing in disaster risk reduction measures to strengthen resilience;
- Improving disaster preparedness for effective response.

The **Concept of the Forestry Sector Development until 2040**[31] adopted by the Government in 2019 integrates considerations on climate change among its main forestry provisions. The most important measure to address climate change impacts is considered to be further promotion of the Sustainable Forest Management in all types of Kyrgyz forests, including support to afforestation and reforestation, as well as to collaborative forest management engaging local communes and agroforestry.

The Concept of Green Economy in the Kyrgyz Republic[32] was lobbied and enacted in 2018 by the Ministry of Economy highlighting the intention to transit to green development in this country. It has rather broader coverage of green agenda aspects than only GHG reduction, but to also to address natural resource depletion and degradation, biodiversity loss, environment pollution, unsustainable production and consumption, unsustainable governance practices, as well as corresponding gaps in legal and policy frames, capacity and technologies.

For the transition to a green economy, it is proposed to develop "green" areas in the following sectors:

1. Green transport in green cities
2. Green energy and energy-saving
3. Green agriculture
4. Green industry
5. Green waste processing
6. State policy, green procurements and ecosystem payments
7. Biodiversity conservation
8. Green mentality, green nurturing and green education
9. Green investment and sustainable financing for green economy promotion

The main goal in the development of a green economy is to achieve sustainable socio-economic growth in the country.

To implement the concept, the **Programme of Green Economy Development for 2019-2023** [33]was enacted. It focuses on 7 priority sectors, including green energy, green agriculture, green industry, low carbon and environmentally friendly transportation, sustainable tourism, waste management, and green cities. In support to the transition process to a green economy, it is envisaged to promote sustainable financing, fiscal incentives, sustainable public procurement and capacity building and awareness raising.

The Programme sets the goals and objectives for all those priority sectors. Thus, the goal of the Green Agriculture sector is seen in increasing the availability of environmentally friendly food through sustainable resource management and development of resource-saving, organic and climate-resilient agriculture. Evidently, here we see the complex character of the approach uniting mitigation and

[31] Endorsed by the Governmental Resolution as of 7 May 2019, # 231.
[32] Endorsed by the Parliament Resolution as of 28 July 2018 # 2532-VI.
[33] Endorsed by the Governmental Resolution as of 14 November 2019 # 605.

adaptation aspects together. Achieving sustainable resource management in the agricultural sector and the development of resource-saving, organic and climate-resilient agriculture, contributing to increased agricultural productivity, is planned through the implementation of the following tasks: (1) achieving sustainable land and water resource management in the agricultural sector through proper planning; (2) development of technologies to increase productivity and efficient use of all production factors; (3) developing and introducing modern technologies to increase productivity and efficient use of all production inputs; (4) improving the legal and regulatory framework governing the development of green agricultural production; (5) financing green agriculture (6) capacity building through informing and training rural producers about green farming practices; (7) adapting to climate change and mitigating its negative effects. As we see water resources for irrigation are integrated into agriculture sector.

Protection of water resources in general is addressed in section “Stable Natural Ecosystems” and “Green Industry” in terms of good governance improvement, too.

Today Kyrgyzstan is undergoing considerable governance reforms resulting from the Constitution amendments in 2021, a new President coming into power, a newly elected Parliament beginning its activities and a new Cabinet of Minister appointed. This is the period of national policy revisions. Thus, no other formally adopted polices related to the targeted project sectors are available. However there are several drafts containing such policies: Draft Concept of the Agriculture Development till 2026; National Water Strategy till 2040, Ecological Code. A National Action Plan on Sustainable Consumption and Production is under discussion and is envisioned to recommend amendments to current legislation and frameworks that would promote a circular economy approach to the green transition, particularly in the agri-food and construction sectors.

Although the National Adaptation Planning (NAP) process has only recently begun in the country, the Kyrgyz Republic expressed its political commitment and ambition in its climate change adaptation agenda while updating the Kyrgyz Republic **Nationally Determined Contribution (NDC)** to the Paris Agreement of the UNFCCC in 2021.

NDC adaptation measures were developed and presented in accordance with the three constituent elements of the global adaptation goal of the Paris Agreement (Article 7): (1) strengthening adaptive capacity, (2) strengthening resilience to the adverse impacts of climate change and (3) reducing the vulnerability of people and systems to the impacts of climate change effects. The Kyrgyzstan NDC adaptation section includes sectoral and cross-sectoral measures that prioritize investments in adaptation. All of them have been developed based on updated risk and vulnerability assessments, review of national and sectoral development policies, as well as on the results of an extensive stakeholder consultation process, including representatives of the private sector, civil society, academia, women's associations and youth NGOs.

The adaptation measures developed for the current NDC form the basis and orient the NAP process, the results of which will be integrated into the subsequent NDC in 2025. In this regard, the time horizon for the adaptation measures of the current NDC has been set to 2025.

The updated NDC contains a list of generic adaptation measures that will reduce the economic losses identified in NATCOM 3 and covers all the most vulnerable sectors: (1) water resources, (2) agriculture, (3) energy, (4) disasters, (5) public health, (6) forests and biodiversity. Additionally, two cross-sectoral components in adaptation were presented there, entitled “Climate Resilient Areas and Green cities”, which evidently also need adaptation. And the second one, which is specifically devoted to adaptation M&E entitled “Improving an Adaptation Reporting System” (see table 1.3.).

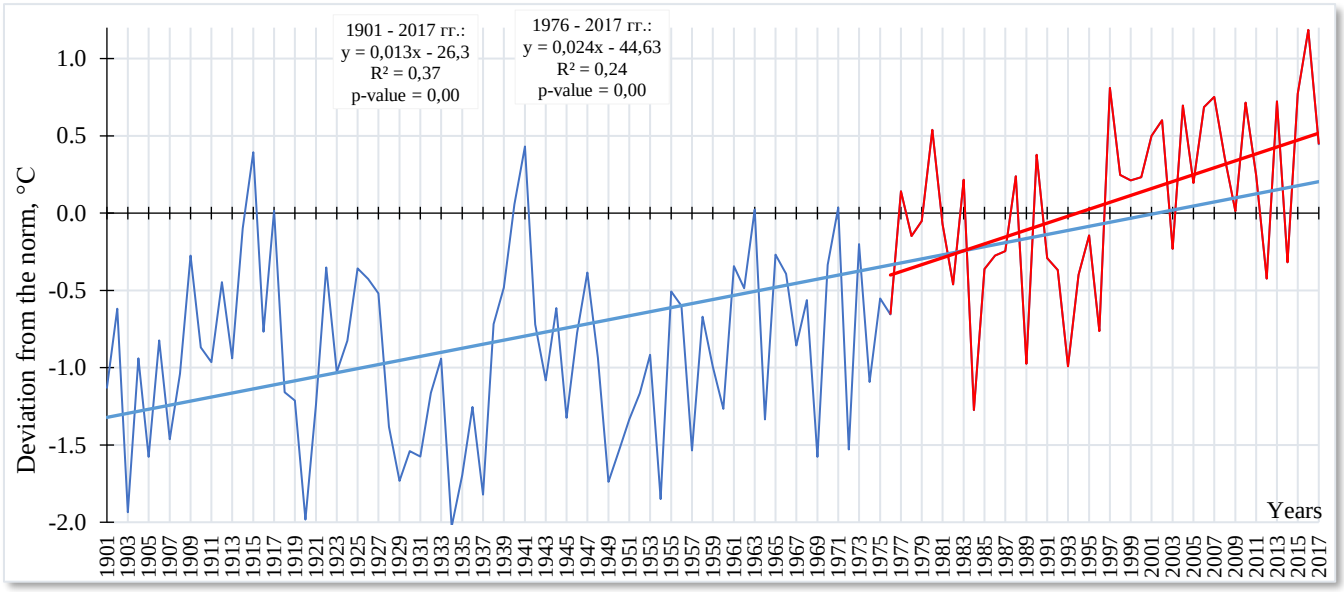
Table 1.3. Kyrgyzstan NDC adaptation goals and measures in TNA target sectors.

#	Sector	Adaptation goals	Measures	Expected results
1	Water Resources	1.1. Increased adaptation capacity	Measure 1.1.1. Conducting scientific research on the impact of climate change on water resources Measure 1.1.2 Formulation of water sector development policy taking into account adaptation to climate change, gender aspects and interests of vulnerable groups	A science-based policy of integrated water resources management has been formed
		1.2. Strengthened climate resilience	Measure 1.2.1. Improving climate resilience of irrigation infrastructure Measure 1.2.2. Improving climatic resilience of drinking water supply and sanitation infrastructure	Increased climate resilience of water infrastructure.
		1.3. Reduced vulnerability to negative impacts of climate change impacts	Measure 1.3.1. Stimulating more efficient use of water resources	Reduced by 10% the volume of losses and use of water resource
2	Agriculture	2.1. Increased adaptation capacity	Measure 2.1.1. Conducting scientific research on the impact of climate change on agriculture Measure 2.1.2. Developing agricultural development policies that take into account climate change, gender and vulnerable groups Measure 2.1.3. Raising climate awareness and adaptive knowledge of employees of state bodies, local self-government and land users	A science-based policy for climate-sustainable development of agriculture and ensuring food security of the country has been formed
		2.2. Strengthened climate resilience	Measure 2.2.1. Improving land use practices in the face of climate change Measure 2.2.2. Strengthening climate resilience in crop production Measure 2.2.3. Strengthening climate resilience of pasture infrastructure Measure 2.2.4. Development of climate resilient livestock breeding	Reduced losses in agriculture from the impact of climate change
		2.3. Reduced vulnerability to negative impacts of climate change impacts	Measure 2.3.1. Creation of climate-smart financial services and products in agriculture Measure 2.3.2. Development and launch of the state programme of climate-oriented support for agriculture, based on the results of the implementation of the programme «Financing of agriculture», taking into account the needs of vulnerable groups	Provided farms with access to concessional finance to support the implementation of climate resilient technologies

1.3 Vulnerability assessments in the country

The actual climate change trends analysis was conducted with the support of the IFAD in 2017, indicates a significant increase in air temperature on the territory of the Kyrgyz Republic. Therefore, the average annual temperature during the period from 1901 to 2017 has increased significantly in the Kyrgyz Republic (see Figure 1.1). If the average annual temperature in the republic from the beginning of the last century was 0.013 °C/year (or 0.1 °C every 10 years), then during the period from 1976 to 2017 the growth rate almost doubled and amounted to 0.024 °C/year (or 0.2 °C every 10 years). Both trends are statistically significant with a 95% confidence level.

Figure 1.1. Dynamic of anomalies of the average annual air temperature (°C) over the territory of the Kyrgyz Republic[34]

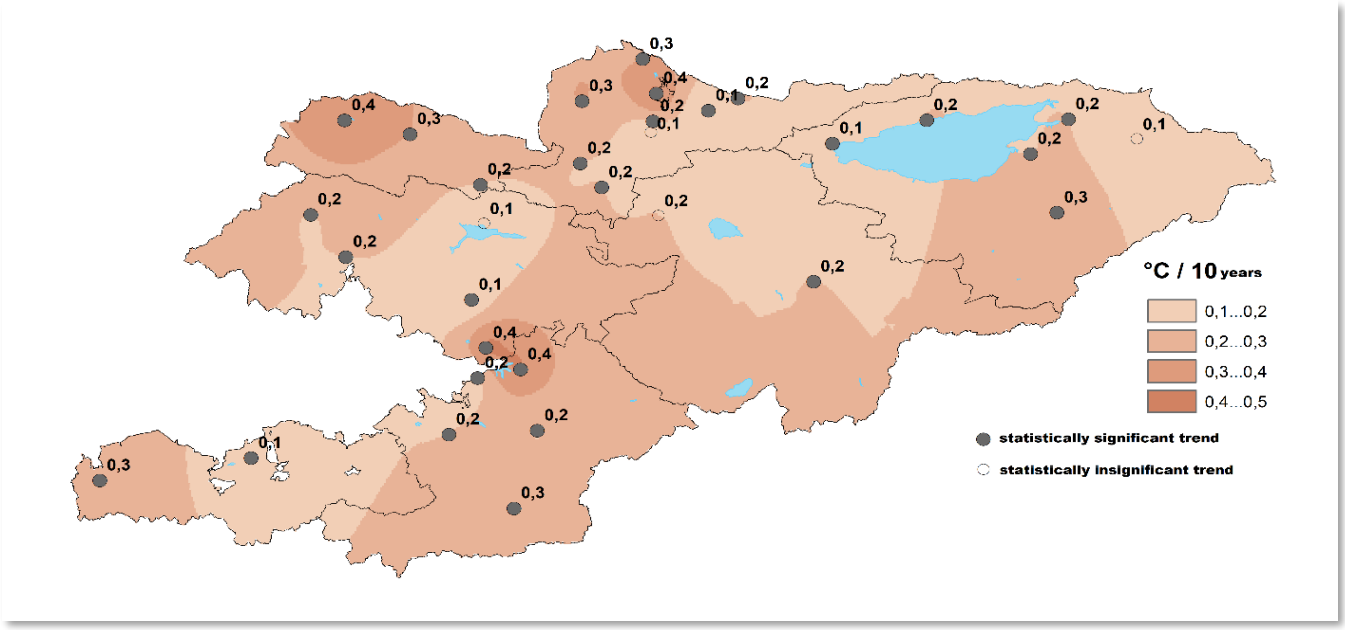


Anomalies are calculated relative to the baseline period 1981-2010. Blue line - a linear trend for 1901-2017, red line - a linear trend for 1976-2017.

The highest growth rates of the average annual temperature (an increase of 0.4 °C every 10 years) are observed in large cities of Kyrgyzstan - Bishkek, Jalal-Abad, Kara-Suu (Osh), as well as Kyzyl-Adyr - in the area of the Kirov reservoir (Figure 1.2).

[34] Ministry of Natural Resources, Ecology and Technical Supervision. GEF-UNEP. Draft NC 4. 2022.

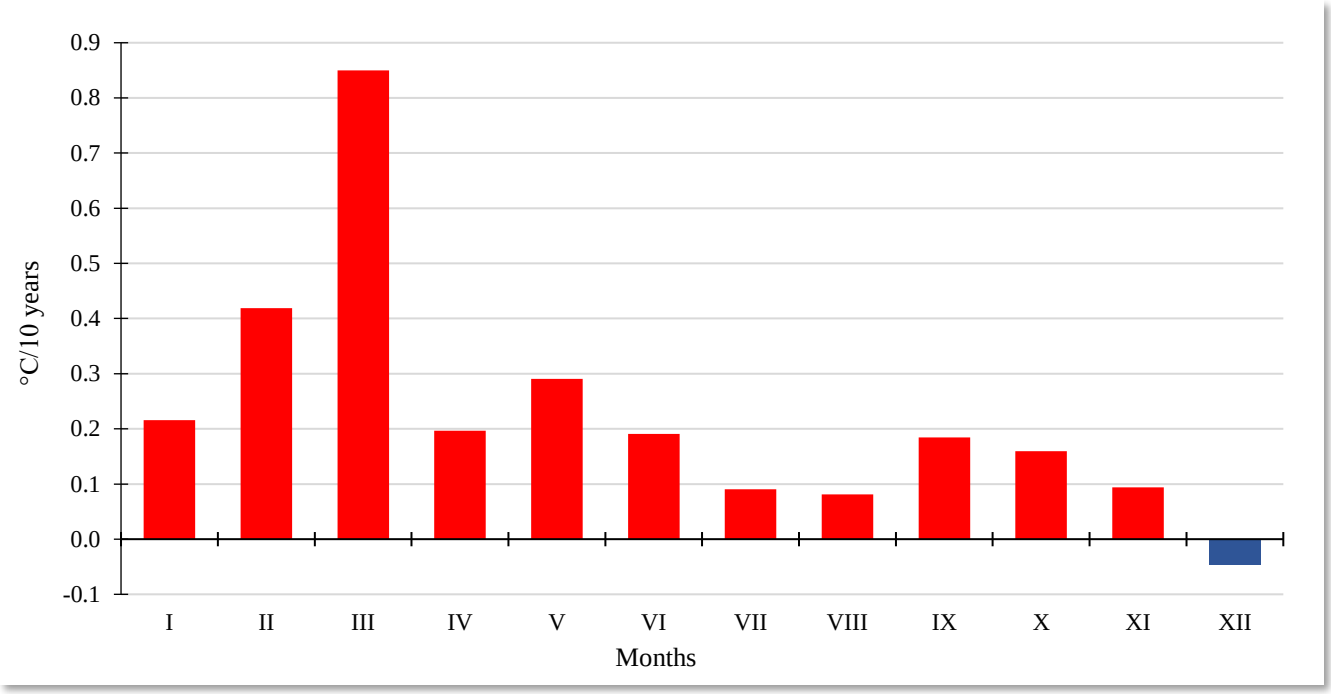
Figure 1.2. The change rate in air temperature (in °C for every ten years) in Kyrgyzstan at the locations of meteorological stations during 1976-2017 (linear trend coefficient)[35]



Considering the nature of the air temperature changes seasonally, the highest growth rates (statistically significant) for the entire republic are observed in the spring period - by 0.45 °C every 10 years; in winter, summer, and autumn periods, the temperature change is statistically insignificant and is 0.22 °C, 0.12 °C, and 0.14 °C every 10 years, respectively. Every month, the largest increase in temperature for the republic as a whole is observed in March and estimated at 0.85 °C every 10 years and in February - by 0.42 °C every 10 years (fig. 1.3). In the warm period of the year (from May to September), there is a tendency for an increase in the number and duration of heatwaves, mainly in the valley zones of the country and in the southeast of the Issyk-Kul region.

Figure 1.3. The rate of change in monthly temperature on average in Kyrgyzstan (linear trend coefficient) for the period 1976 - 2017[36]

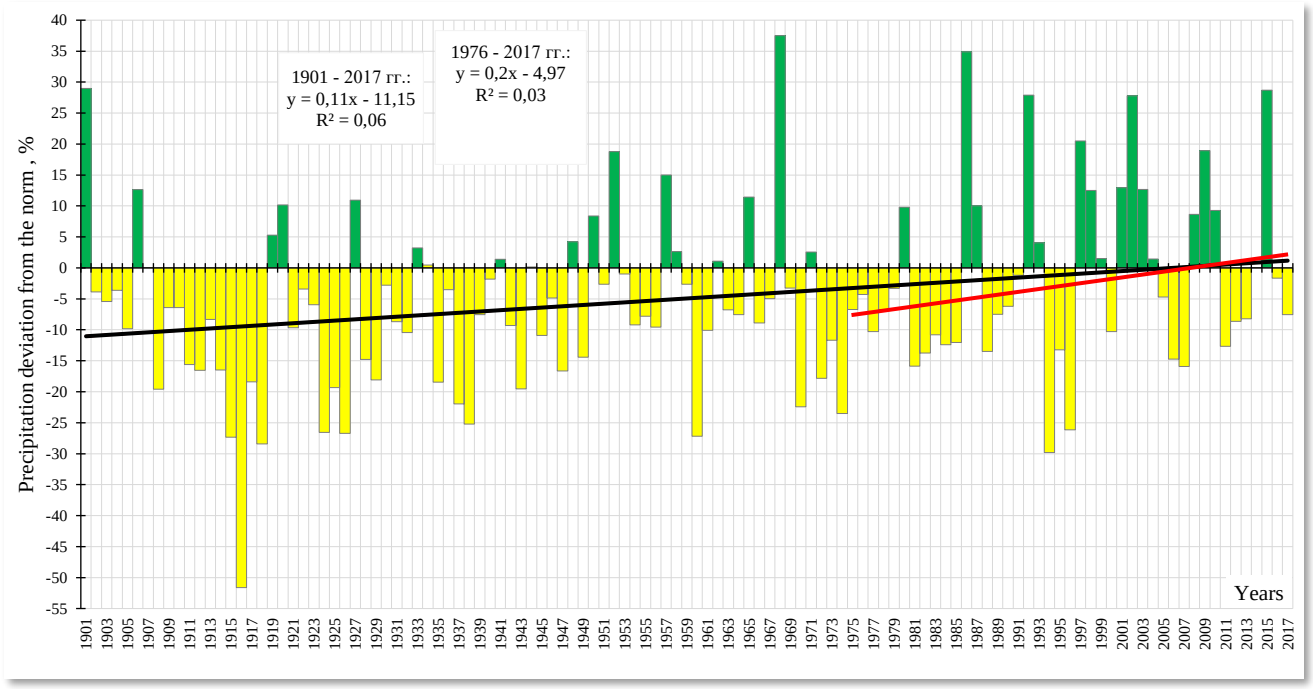
[35] Ibid.
[36] Ministry of Natural Resources, Ecology and Technical Supervision. GEF-UNEP. Draft NC 4. 2022.



The precipitation regime in the Kyrgyz Republic, apart from significant territorial and seasonal variability, is also characterized by inter-annual variability and cyclicality. Overall, in the republic, since the beginning of the last century, there has been an insignificant tendency towards an increase in the annual amount of precipitation - by 0.11%/year (or by 1% every 10 years). Since the mid-1970s, the rate of annual increase has been increasing and amounts to 0.2%/year (or 2% every 10 years). Both trends are statistically insignificant. The largest tendencies for an increase in precipitation are observed in the summer and winter periods (the trends are statistically irrelevant). However, local changes in monthly precipitation have an individual character of change: from significant reductions to significant increases. During the research, precipitation anomalies for deviations from the norm were calculated relative to the base period 1981-2010. (See fig. 1.4). Black line - a linear trend for 1901-2017, red line - a linear trend 1976-2017)

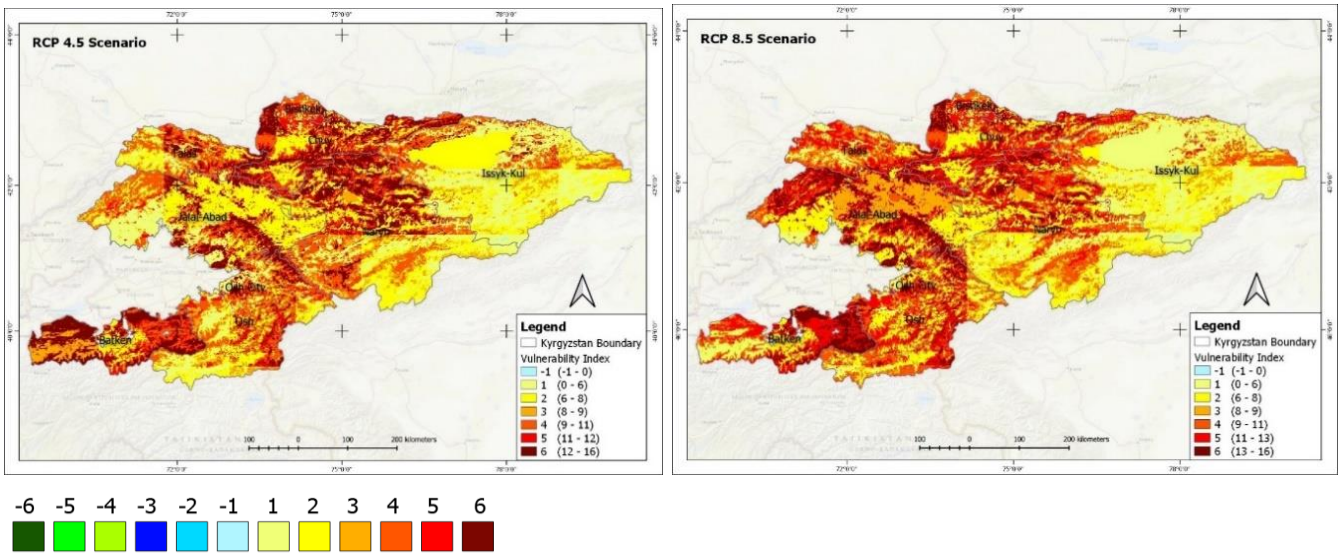
Figure 1.4. Dynamic of annual precipitation anomalies (%) over the territory of the Kyrgyz Republic[37]

[37] Ibid.



A comprehensive assessment of climate change impacts on the territory of the Kyrgyz Republic was conducted[38] in order to develop adaptation measures in the process of NDC update. This assessment was based on a comparison of the average value of parameters for the period 1960-1990 and simulated data for two scenarios of evolution of anthropogenic emissions of greenhouse gases into the atmosphere RCP 4.5 and RCP 8.5 for 2050 under the "Business as usual" scenario (see Vulnerability Maps below fig.1.5.).

Figure 1.5 Vulnerability locations as per RCPs 4.5 and 8.5



[38] CAREC 2021. Assessment of risks and vulnerability to climate change. National Report for Kyrgyzstan's NDC.

The grading is given using a percentile grade system. The score ranges from 6 to -1 for the most negative (increased vulnerability) impact to -1 to -6 for positive (decreased vulnerability) impact with gradations on the maps by colour:

For the first time, mapping of the risk and vulnerability assessment of the territory of the Kyrgyz Republic to climate change was carried out based on both climatic parameters and parameters not directly related to the climate, i.e. geophysical and socio-economic ones. Comprehensive assessment of vulnerability to climate change was obtained through summing up the scores obtained in the three main assessments: comprehensive climate impact assessment, comprehensive geophysical sensitivity and socio-economic sensitivity.

The vulnerability assessment outputs for the TNA targeted sectors include the following clearly defined impacts of climate change which should be well addressed by the coming adaptation actions:

Table 1.4. The main climate change impacts in Agriculture and Water Sectors.

Agriculture	Water
1) Deterioration of the processes of biochemical regulation of the soil ecosystem.	1) Changes in the water content of river basins.
2) Changes in the productive capacity of pastures and the resistance of domestic animals to meteorological impacts.	2) Decrease in water supply for the population and economy.
3) Increased vulnerability of food self-sufficiency.	3) Deterioration of the quality of surface and ground waters.

An NDC Implementation Plan will be developed to define the timeline, responsibilities and financial requirements for each measure to ensure the effective implementation and appropriate monitoring of the achievement of the adaptation measures.

1.4 Sector Selection

Previous analysis of climate risks and vulnerability in the Kyrgyz Republic provided by the National Communications to UNFCCC did not present a clearly defined structured list of climate change impacts on different sectors. This was considered in the narrations on the specific vulnerabilities within the sectors under analysis with little attention to formulations.

In the Initial National Communication (2003) Chapter entitled "Vulnerability Assessment and Adaptation", the following sectors were attributed as vulnerable to climate change impacts: Water Resources; Energy; Public Health; Biodiversity and Forest Resources; and Agriculture. Three baseline scenarios were used to assess vulnerability: climatic, demographic and economic. Those scenarios were applied to assess vulnerability and define adaptation measures, to forecast national GHG emissions and to identify mitigation measures for climate change. At the same time, it should be noted that in assessing vulnerability of a specific sector, only the worst possible scenarios were considered.

In the Second National Communication (2009), the Global Climate Models application for Kyrgyzstan was described and based on international experience and previous national studies, the following sectors were considered as the most vulnerable to climate change impacts:

- Water resources (parameters of glaciers, surface waters runoff, parameters of lakes);
- Public health (morbidity and mortality);

- Agriculture (wheat supply, productivity of various types of agricultural crops and pastures);
- Natural disasters (frequency of mudflows, landslides, breakthroughs in high-mountain lakes, avalanches).

The well-known physical links (water sector) and statistical methods (health, agriculture, climate-induced emergencies) were used to obtain justifiable quantitative assessments of vulnerability as per climatic, demographic and economic parameters.

In the Third National Communication (2016) there was a new chapter "General Information" presenting the conceptual issues of adaptation that arose from the need to align the vulnerability assessment and adaptation studies of Kyrgyzstan to the global models and scenarios according to the IPCC Assessment Reports (AR4). Therefore, that chapter described the adaptation process according to the adaptation cycle by the UNFCCC, which includes four main steps: vulnerability assessment, adaptation planning, implementation of the adaptation plan and monitoring and evaluation of adaptation.

Differences in the mechanisms for assessing the impact arise from the need to take into account not only the climate factors and the uneven development processes. These differences form a differentiated vulnerability arising from climate change. The bottom line is that vulnerability is rarely caused by one single reason. It is rather a product of intersecting different processes that generate inequality in socioeconomic status and income levels, as well as in the degree of the systems exposure to climate impacts. Therefore, further on the vulnerability assessment would, where possible, take into account additional non-climate factors.

Such attention to the concept of the vulnerability assessment in NATCOM 3 was conditioned by the urgent need to develop a methodology for the vulnerability assessment, which is still a relevant issue today. Especially, in the situation when different projects of the various international development partners introduce different approaches and methods of vulnerability assessment and following adaptation actions development, thus, confusing beneficiaries and expert communities.

Methodological approaches to the assessment of the sectoral vulnerability in NATCOM 3 were presented in a separate chapter, which stated the need to improve the effectiveness of monitoring and to shift to quantitative vulnerability assessments. To enable comparative analysis of different sectors, specific indicators of vulnerability of each sector were brought to the estimation of economic losses. A similar approach was applied to climate risk assessments, which are largely based on vulnerability assessments.

All in all, NATCOM 3 presented vulnerability assessment for the following sectors:

1. Water Resources
2. Agriculture
3. Climate induced disasters management
4. Health care
5. Forest and biodiversity

As mentioned above, the Kyrgyz Republic expressed its political commitment and ambition in its climate change adaptation agenda while updating the NDC in 2021, where those sectors plus Energy are key priorities areas in the climate change adaptation of the Kyrgyz Republic, therefore, domestic and external financial, technological and capacity building support is to be directed at them. The TNA process carried out for two of the prioritised sectors with all corresponding subsectors, including:

1. Water Sector: Drinking water supply and sanitation, irrigation and comprehensive water management.

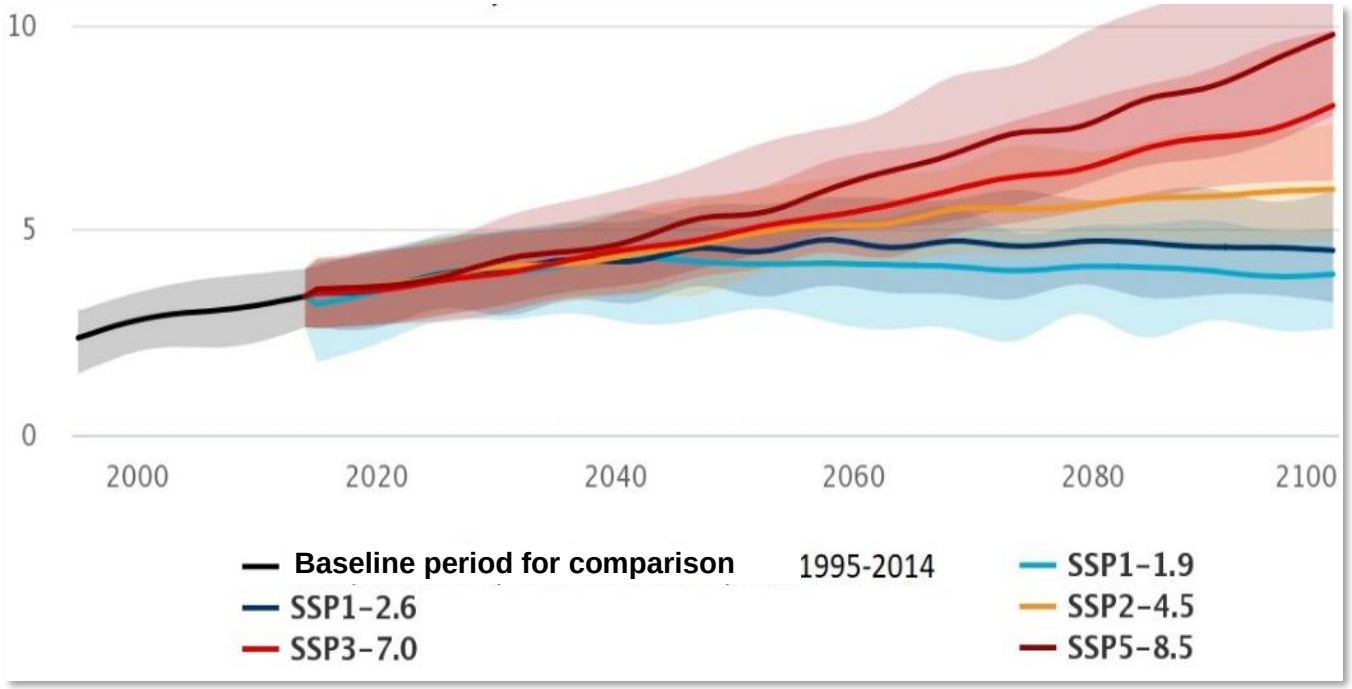
2. Agriculture: Crop Farming, Livestock breeding and sustainable pasture management and Sustainable Land Management

That sector selection for adaptation component of the TNA has been defined during the stage of GCF project design by the group of specialists from CFC in 2017.

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

To analyse the future climate change on the territory of Kyrgyzstan, calculations of general atmosphere and ocean circulation models (AOGCM) of the international project CMIP6 (Consolidated Model Intercomparison Project. Phase 6) were used. Results of an assessment of future changes in air temperature and precipitation were used based on an ensemble of 11 models for temperature and 30 models for precipitation. According to the ensemble of CMIP6 models, a further increase in air temperature should be expected over the territory of Kyrgyzstan in the 21st century under all five SSP scenarios (fig. 1.6). [39]

Figure 1.6. Projected average annual air temperature for Kyrgyzstan in relation to 1995-2014 period based on the multi-model ensemble.[40]



In the medium scenario SSP2-4.5, assuming maintenance of current greenhouse gas emissions, temperature in Kyrgyzstan by 2030 would increase by 1.1 °C from the current level (1995-2014 average), by 2050 by 1.8 °C, by 2070 by 2.5 °C and by the end of the century by 2.9 °C. In the high emissions scenario, average annual temperatures will increase more rapidly. Thus, in the next 20 years the temperature increase will be 1.2 °C higher than today, by 2050 by 2.5 °C, by 2070 by 4.1 °C and by 2090 by 5.8 °C. Under both scenarios for Kyrgyzstan as a whole, the greatest increase is expected in the summer

[39] Ministry of Natural Resources, Ecology and Technical Supervision, GEF. Draft Fourth Nation Communication of the Kyrgyz Republic under UNFCCC". 2022.
[40] Ministry of Natural Resources, Ecology and Technical Supervision, GEF. Draft Fourth Nation Communication of the Kyrgyz Republic under UNFCCC". 2022.

and autumn periods. In the spring period, the growth is projected to be less, which contradicts to the observed trends (currently, the temperature growth in spring is faster than in other seasons).[41]

Projected changes in annual and seasonal temperatures in Kyrgyzstan for the 2030s, 2050s, 2070s and 2090s against baseline period of 1995-2014 for two scenarios of shared socio-economic pathway (SSP) using per multi-model ensemble is presented in tab. 1.4. (Range of 10th and 90th percentiles is given in brackets).

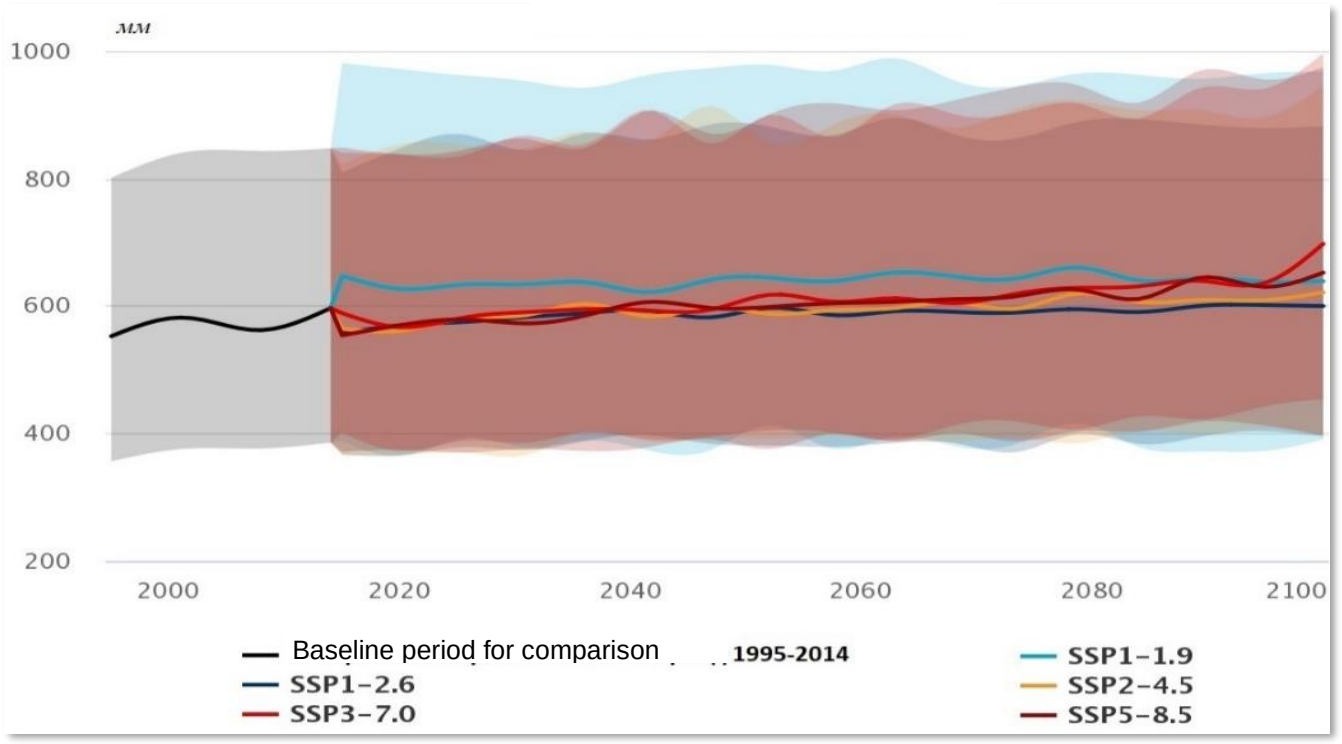
Table 1.5. Projected changes in temperature (C°) as per seasons until 2100 and SSP2-4.5 and SSP5-8.5.[42]

SSP	Year	Winter	Spring	Summer	Autumn
2020-2039					
SSP2-4.5	1,1 (-0,7…2,9)	1,0 (-1,2…2,9)	0,8 (-0,9…2,5)	1,2 (-0,3…3,0)	1,2 (-0,3…3,0)
SSP5-8.5	1,2 (-0,6…3,0)	1,3 (-1,0…2,9)	1,0 (-0,9…2,7)	1,4 (-0,3…3,3)	1,3 (-0,2…3,2)
2040-2059					
SSP2-4.5	1,8 (0,1…3,8)	1,8 (0,0…3,8)	1,4 (-0,3…3,2)	2,0 (0,2…4,4)	2,0 (0,4…3,9)
SSP5-8.5	2,5 (0,6…4,5)	2,5 (0,4…4,4)	2,3 (0,3…3,9)	2,7 (0,8…4,9)	2,5 (0,9…4,7)
2060-2079					
SSP2-4.5	2,5 (0,7…4,5)	2,4 (0,5…4,3)	2,2 (0,4…3,8)	2,7 (1,0…5,2)	2,8 (0,9…4,7)
SSP5-8.5	4,1 (2,0…6,3)	4,0 (2,3…6,0)	3,6 (1,5…5,6)	4,5 (2,2…6,9)	4,2 (2,2…6,8)
2080-2099					
SSP2-4.5	2,9 (1,0…5,1)	2,9 (1,1…4,9)	2,4 (0,7…4,5)	3,3 (1,3…5,8)	3,1 (1,1…5,2)
SSP5-8.5	5,8 (3,4…8,6)	5,9 (3,8…8,5)	5,2 (2,9…7,7)	6,4 (3,8…9,1)	5,6 (3,2…9,2)

According to CMIP6 multi-model ensemble calculations for Kyrgyzstan in the 21-st century, the current precipitation regime is generally expected to remain the same with a slight upward trend (fig. 1.7).

Figure 1.7. Projected sums of annual precipitation for Kyrgyzstan in relation to 1995-2014 period based on multi-model ensemble.[43]

[41] Ministry of Natural Resources, Ecology and Technical Supervision, GEF. Draft Fourth Nation Communication of the Kyrgyz Republic under UNFCCC". 2022.
[42] Ibid.
[43] Ibid.



Based on the medium-range scenario SSP2-4.5, a modest increase of 3% in annual precipitation over Kyrgyzstan from the baseline period 1995-2014 is expected in the next 20 years. In the period 2040-2059 a marginal increase of 4% from the present is expected, in the period 2060-2079 - 6% increase, and by the end of the century - 8% increase. [44]

In the "fossil fuel development" scenario, precipitation is expected to remain at current levels for the next 20 years, increasing by 6% by 2050, 8% by 2070, and 11% by the end of the century. [45]

In both scenarios, the largest increases are expected in winter, a slightly smaller increase in spring and a decrease in summer. However, at present, the greatest increase in precipitation for the whole country is observed in the summer period, a slightly smaller increase in the winter period, and precipitation in the spring period shows practically no change in trends.

It is worth noting that the precipitation forecast has a greater degree of uncertainty and variation in the models than the temperature forecast. The positive predicted value of precipitation indicates that most of the models are predicting an increase in precipitation. In general, we should expect that precipitation in Kyrgyzstan will remain variable from year to year.

Projected changes in annual and seasonal precipitation (in % of the baseline period 1995-2014) in Kyrgyzstan in the 2030s, 2050s, 2070s and 2090s for two scenarios of shared socio-economic path (SSP) with multi-model ensemble is given in tab. 1.5. (Range of 10th and 90th percentiles is given in brackets).[46]

[44] Ministry of Natural Resources, Ecology and Technical Supervision, GEF. Draft Fourth Nation Communication of the Kyrgyz Republic under UNFCCC". 2022.
[45] Ibid.
[46] Ibid.

Table 1.6. Projected changes in annual and seasonal precipitation against baseline period of 1995-2014 until 2100 (%) [47]

SSP	Year	Winter	Spring	Summer	Autumn
2020-2039					
SSP2-4.5	3	9	5	-6	1
	(-44…65)	(-32…75)	(-35…44)	(-75…94)	(-48…73)
SSP5-8.5	1	8	2	-6	-1
	(-45…63)	(-34…67)	(-36…67)	(-72…89)	(-48…75)
2040-2059					
SSP2-4.5	4	14	4	-3	2
	(-43…68)	(-28…73)	(-31…47)	(-79…100)	(-47…79)
SSP5-8.5	6	19	6	-6	3
	(-42…71)	(-28…80)	(-32…51)	(-75…97)	(-44…85)
2060-2079					
SSP2-4.5	6	20	7	-7	3
	(-42…71)	(-26…82)	(-31…52)	(-77…95)	(-50…82)
SSP5-8.5	8	27	8	-8	6
	(-41…75)	(-21…90)	(-30…56)	(-81…88)	(-46…89)
2080-2099					
SSP2-4.5	8	20	9	-6	4
	(-42…75)	(-25…85)	(-31…56)	(-83…96)	(-44…86)
SSP5-8.5	11	40	11	-14	8
	(-39…78)	(-12…108)	(-28…60)	(-84…82)	(-43…87)

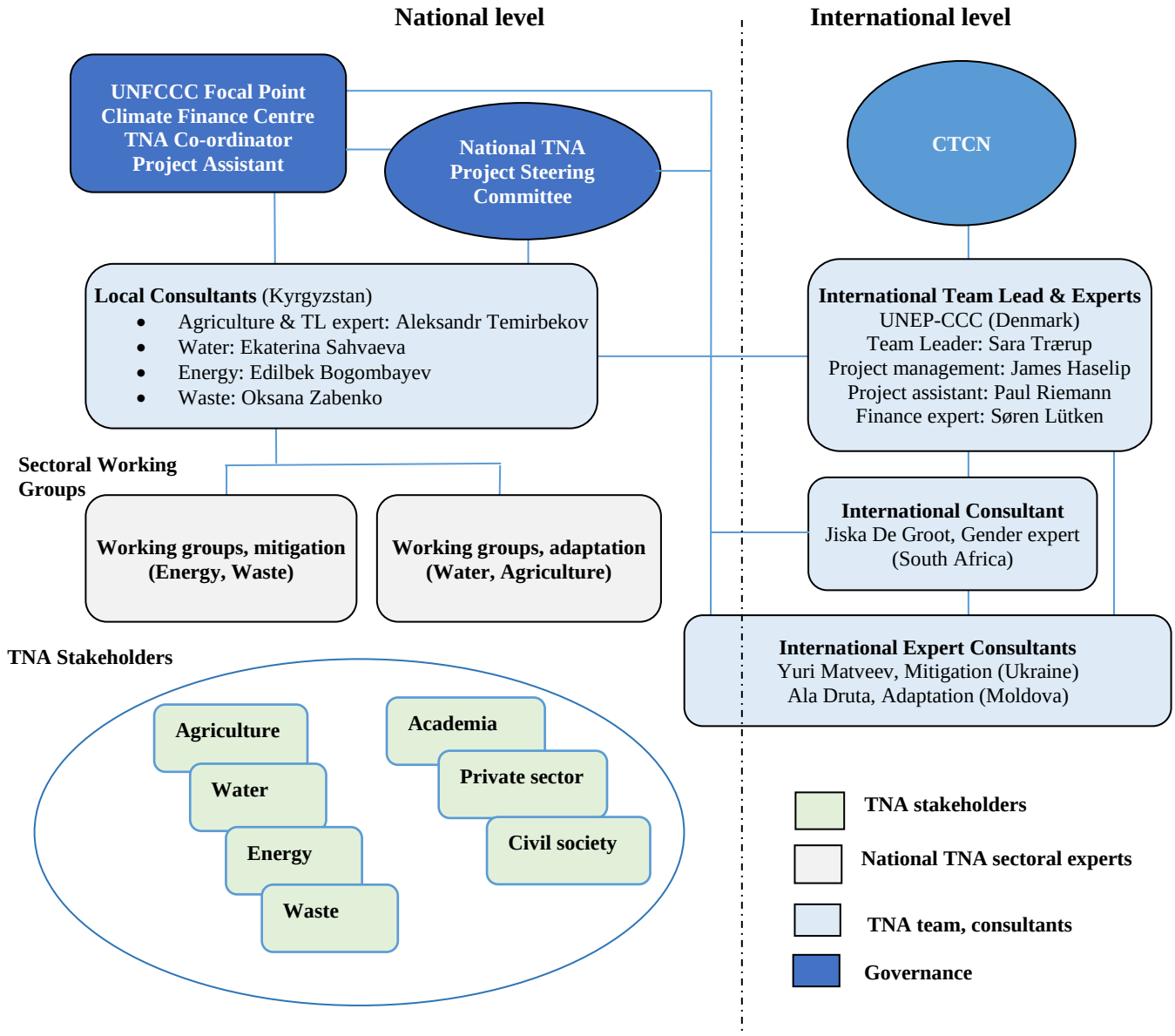
Evidently under such conditions new innovative resource efficient and climate resilient technologies

[47] Ministry of Natural Resources, Ecology and Technical Supervision, GEF. Draft Fourth Nation Communication of the Kyrgyz Republic under UNFCCC". 2022.

Chapter 2 Institutional arrangement for the TNA and the stakeholder involvement

Institutional arrangements for the TNA project implementation in Kyrgyzstan are presented on the figure 2.1.

Figure 2.1. Institutional arrangements for the TNA project[48]



[48] Developed by authors.

2.1 National TNA team

To facilitate effective activities of the project, Term of References were developed for the National Steering committee and the Sectoral Working Groups in the initial stage of the project (see Annex III and IV).

2.1.1 The National Steering Committee

To provide oversight of the process ongoing the National TNA Project Steering Committee (NSC) has been formed including all the main stakeholders as members:

1. Ministry of Natural Resources, Ecology and Technical Supervisions
2. Ministry of Energy
3. Ministry of Transport and Communications
4. Ministry of Agriculture (MoA)
5. Ministry of Economy and Commerce
6. Water Resources Service
7. State Agency for Architecture, Construction and Communal Utilities
8. Bishkek City Hall.
9. Climate Finance Centre.

The NSC acts as an advisory and oversight body to coordinate TNA Project activities at sector and national levels to ensure a comprehensive approach. The NSC has the responsibilities to monitor and conduct quality control over timely implemented activities under the Project and guide it at the highest level.

Throughout the project's implementation, the Steering Committee's role will be to discuss and deliberate on project outcomes and results, provide recommendations, technical oversight and strategic advice to the GCF NDA on various Project-related subjects, ensuring Project alignment to the national and sectoral level development and climate-related priorities. It will also ensure TNA Project contribution and complementarity to the overall national low carbon and adaptation planning processes of Kyrgyzstan, while avoiding overlap or duplication with other under implementation initiatives.

The NSC provides the functional management in performing the responsibilities under the project through:

- Assuring the project implementation according to its Project Document and work plans.
- Ensuring transparency in the use of funds;
- Examination of other activities that may occur in coordination with the implementing agency.

Table 2.1. The TNA project National Steering Committee members.[49]

#	Name	Position	Contacts
1.	Beksultan Ibraimov	Deputy Minister of Natural Resources, Ecology and Technical Supervisions, NSC Chair, UNFCCC Focal Point	Tel. E-mail: ibraimov.beksultan@gmail.com
2.	Kanat Abdrahmanov	Deputy Minister of Economy and Commerce, NSC Member	Tel:+996 (0312) 62-41-76, Fax:+ 996 (312) 66-18-37, mail@mineconom.gov.kg
3.	Sabyrbek Sultanbekov	Deputy Minister of Energy, NSC Member	(0312) 904040 (+1006)

[49] Developed by authors.

#	Name	Position	Contacts
			0 551 109 776 t.aitaliev@nehk.ehergo.kg
4.	Almaz Turgunbekov	Deputy Minister of Transport and Communications, NSC Member	Tel. 996 (312) 314 385/ Fax:996 (312) 312811, 315071 315090
5.	Murat Baidyldaev	Deputy Minister of Agriculture (MoA), NSC Member	0555 220723 (помощник)
6.	Mirbek Akmataliev	Deputy Director of the State Agency on Architecture, Construction and Communal Utilities, NSC Member	Tel. 610305, e-mail: drpv00@mail.ru
7.	Adbybai Dzhailobaev	Deputy Director of the Water Resources Service under MoA, NSC member.	E-mail: djailobaev1961@mail.ru basssein@mail.ru
8.	Maksatbek Sazykulov	Deputy Bishkek City Mayor, NSC Member	Tel. (0312) 97-91-95 (+1025). E-mail: bishkek@meria.kg
9.	Ruslan Iliasov	Director of the Climate Finance Centre	E-mail: iliasovruslann@gmail.com

2.1.2 The National TNA Coordinator

The function of the National TNA Coordinator has been assigned by the UNFCCC Focal Point to the Climate Finance Centre (CFC) under the Ministry of Natural Resources, Ecology and Technical Supervision (MNRETS). Mr Ruslan Iliasov, CFC Director, performs as project coordinator implementing day-to-day synchronization of the different sectors targeted by the project in terms of organization of the national stakeholder engagement and organization of project events, including national workshops, sectoral working group sessions, expert team coordination meetings and communications with other governmental, municipal, academia, business, and civil society organizations. To better organize facilitation of the project implementation on behalf of the Ministry a group of sectoral counterparts has been established within CFC. (See tab. 2.2).

Table 2.2. Project Implementation Coordination Group of MNERTS.[50]

#	Name	Sector	Contacts
1.	Mr Aibek Karabaev, CFC Specialist	Agriculture	E-mail: aibekusa@yahoo.com T. (+996) 776831189
2.	Mr. Ermek Esengeldiev, CFC Specialist	Energy	E-mail: ermek.esengeldiev90@gmail.com T. (+996) 556 08 40 00
3.	Ms. Ainura Dzhumalieva, CFC Specialist	Waste	T. (+996) 555 56 20 00 E-mail: ainuradjm@gmail.com adjumanaliyeva@gmail.com
4.	Ms. Nurlan Adyshev, CFC Project developer	Water	E-mail: nabdyshev@gmail.com T. (+996) 556 831189
5.	Ms. Zamira Naimanbaeva, CFC Gender Specialist	Gender equality and inclusion	T. (+996) 770 058 505 E-mail: zamiranaimanwork@gmail.com
6.	Mr. Dostukbek Obodoev, CFC Specialist	Project coordinator	T. (+996) 704464646 Email: dostuk.obodoev.88@mail.ru

[50] Developed by authors.

2.1.3 The Sectoral Working Groups

Sectoral Working Groups (SWGs) on Agriculture and Water Resources were established according to the request letter of the UNFCCC focal point and in close consultation of TNA Coordinator and Team with the Ministry of Agriculture. The SWGs included representatives of the line ministry, academia, private sector, national farmers' organizations and NGOs, and international development partners supporting agricultural sector of Kyrgyzstan. (See tab.2.3. and tab. 2.4).

Table 2.3. The list of the Agriculture Sectoral Working Group.[51]

#	Full name	Organization, position	Contacts
1.	Sooronova Nuria Rakhmanberdievna	Deputy Minister of Agriculture	Tel. 0550 061-333
2.	Kozhogulov Nurlanbek Zhamalidinovich	Director of the Department of agricultural mechanization, cooperation and innovative technologies	Tel. 66 44 81 0555678740
3.	Rasul kyzy Aigerim	Leading Specialist of the Department of Organic Agriculture under the Ministry of Agriculture of the Kyrgyz Republic	Tel. 0550 353709 Email:aruslankyzy10@gmail.com
4.	Kydykmanov Emilbek Sagyndykovich	Head Department of Agrarian Policy and Forecasting of the Ministry of Agriculture	Email:kydykmanov58@mail.ru
5.	Karabaev Aibek Nurudinovich	Ministry of Natural Resources, Ecology and Technical Supervision. CFC Specialist.	Email:aibekusa@yahoo.com, Tel. 0776831189
6.	Mambetov Kumushbek Bekitaevich,	Dean of the Faculty of Agronomy and Forestry of the Kyrgyz National Agrarian University	Tel +996(312)540535 Email: kumushbek.mambetov@mail.ru
7.	Aidaralieva Nuraiym	Chief Specialist of the Agricultural Policy and Forecasting Department of the Ministry of Agriculture	Email:aydar7676@gmail.com
8.	Egemberdiev Adymalik Abdykarovich	General Director of the National Association of Pasture Users	Tel. 550 500 002, E-mail:pasturekj@gmail.com
9.	Burkhanov Aitkul Mustafaevich	General Director of the Association of Forest and Land Users	T. 555 704878, 770 844 844 Email:a.burkhanov58@gmail.com
10.	Kadyrkulov Nurlan Maratovich	General Director of LLC EcoAgro	Email: ecoagros@yandex.ru kyrghyz1@yandex.ru
11.	Ukubaev Turatbek Galiyarovich	General Director of the Agro-Industrial Holding "Atalyk Group".	Email: office@atalyk.kg Tel.+996 (312) 91-99-99
12.	Vedenev Alexey Gavrilovich	LLC Fluid, biogas equipment	Email: agvedenev@yandex.ru Tel.: 0559000104
13.	Tuleev Tamchybek Karybekovich	Director of Agriculture Projects Implementation Unit of IFAD	Tel. (312) 665 625 / 975 974
14.	Zhusupov Matraim	FAO Project Manager	Tel. 0777 909-001, E-mail:matraim.jusupov@fao.org

[51] Developed by authors.

Table 2.4. The list of the Water Resources Sectoral Working Group.[52]

#	Full name	Organization, position	Contacts
1.	Mr. Abdybai Jailoobaev	Water Resources Service of the Ministry of Agriculture, Deputy Director, Member of the NOC, Chairman of SWG	djailobaev1961@mail.ru basssein@mail.ru
2.	Mr. Dostukbek Obodoev Abdygaparovich	Project and Programme Coordinator of the CCF MNRETS	0999664646
3.	Ms. Asel Raimkulova	Head of the Department of Water Resources Protection of the Department of Water and Land Resources of the Ministry of Economic Development and Trade of the Kyrgyz Republic, SWG member	0552761576 raimkulova.asel@mail.ru
4.	Mr. Bozgunchiev Talai	Water Resources Protection Unit under the Department of Water and Land Resources of the Ministry of Economic Development and Trade of the Kyrgyz Republic	0509 007299 talaiboz@mail.ru
5.	Ms. Orozbakieva Shayyrgul Galievna	State Agency for Architecture, Construction and Communal Utilities. Leading Specialist of the Department for the Development of Drinking Water Supply and Sanitation. SWG Member	312810 orozbakieva@mail.ru
6.	Mr. Bekzhan Mamytov	Senior Specialist of the Water Resources Sector of the Ministry of Agriculture.	625350, 0555301964 mamytov-b@bk.ru
7.	Ms. Gulmira Satymkulova,	Chief Specialist of the Water Resources Department of the Water Resources Service of the Ministry of Agriculture, Head of the Secretariat of the Chu-Talas Interstate Water Commission. SWG Member	541409, 0550401304 gulmirasatymkulova@gmail.com
8.	Mr. Buzurmankul Toktonaliev	Design, Construction and Technology Institute for Water Metering “Vodoavomatika", Director	541150 pkti@elcat.kg
9.	Mr. Dmitry Borisenko	Design, Construction and Technology Institute for Water Metering "Vodoavomatika", Director	541150
10.	Mr. Amanzhol Atakhanov	Kyrgyz Research Institute for Irrigation, Deputy Director	0770672252 aatakanov@mail.ru
11.	Mr. Vitaly Shablovsky	Head of Laboratory, Kyrgyz Research Institute of Irrigation. SWG member.	541164, 0555187771 wishab@mail.ru
12.	Mr. Kanat Omurzakov	Kyrgyz National Agrarian University, Deputy Dean of the Faculty of Hydroreclamation, Ecology and Land Management	0773571535 kanat3884@gmail.com

[52] Developed by authors.

#	Full name	Organization, position	Contacts
13.	Mr. Tashmukhamed Khalmukhamedovich Karimov	Kyrgyz State University for Contruction and Architecture, Honorary Professor, Department of "Water supply, sanitation and hydrotechnical construction"	0555520521 tashmukhamied@mail.ru
14.	Mr. Erkinbek Imaralievich Kozhoev	Chairman of the National Union of Water Users Associations of the Kyrgyz Republic	0778214421 e.kozhoev@gmail.com
15.	Mr. Azizillaev Salavat	LLC CIC Community International Consulting	0770 902 842 cic.llc@mail.ru
16.	Mr. Matraim Zhusupov	FAO CACILM 2 Project Manager	0777 909-001,matraim.jusupov@fao.org

On the first sessions of both SWGs it was decided that any additional resource persons could be invited to SWG as members if expressing the interest and providing relevant information of the technology innovations.

2.1.4 The Consultants Team

The National Consultant Team included experts in adaptation possessing considerable experience in the targeted sectors, also having experience in the development of the latest NC, BUR and NDC of Kyrgyzstan, thus fully aware on the current climate action of Kyrgyzstan. (See. Tab.2.5).

Table 2.5. National consultants list.[53]

#	Name	Position	Contacts
1.	Aleksandr Temirbekov	Team Leader, Agriculture Sector Adaptation	Tel. +996 700974847 E-mail: atemirbekov@mail.ru
2.	Ekaterina Sahvaeva	Adaptation of the Water Sector	Tel. +996 555354656 E-mail: tadar51@mail.ru

2.2 Stakeholder engagement process followed in the TNA – Overall assessment

A broad stakeholder consultation process involving technical experts from different sub-sectors considered for adaptation and mitigation was initiated at the beginning of the TNA process. The first session of the National Steering Committee for TNA project was conducted on 20 July 2022 and the Inception workshop engaging all the relevant stakeholders was conducted 21 July 2022.

The National TNA Coordinator, National Implementation Group and National Consultant Team conducted regular coordination meeting to debate TNA project ongoing, emerging issues and steering measures. The minute of all the events were developed as appropriate and filed in the CFC archive.

The whole TNA process envisages stakeholders as major contributors towards the implementation of the TNA. Hence every step involved large share of consultation with the stakeholders for making valuable decisions in finalizing the report. The list of relevant stakeholders was identified by national consultants in close cooperation with the National TNA Coordinator and line Ministry. Identified stakeholders include government institutions and departments with responsibility for policy formulation and regulation in

[53] Developed by authors.

relevant sectors (i.e. Agriculture and Water), private and public sector industries, business associations, technology end users and/or suppliers within private sector, relevant academic institutions and experts, as well as international development partners' organizations. The extended list of stakeholders represents in the Annex I The pool of stakeholders involves policy-making governmental agencies (Ministry of Natural Resources, Ministry of Economy and Commerce, Ministry of Energy, Ministry of Transport and Communications, Ministry of Agriculture, State Agency for Architecture, Construction and Communal Utilities under the Cabinet of Ministers, Agency for Communities Development and Investment), research institutions (Kyrgyz National Agrarian University, Kyrgyz Research Institute for Irrigation, Design, Construction and Technology Institute for Water Metering, Institute for Economy and Energy, Kyrgyz State University for Construction and Architecture, Institute of Water Problems and Hydropower and the Institute of Automatics and Informational Technologies of the National Academy of Sciences), national farmers organizations (National Association of Water Users Associations, Kyrgyz Association of Forest and Land Users, National Union of Water Users Association), NGOs (Federation of Organic Movement BIOKG, Association of Renewable Energy, Centre for Energy Efficiency and Renewable Energy Sources, Association of Wind and Solar Electrical Stations), Municipal organizations (City Hall of Bishkek, Bishkek Sanitation Polygon (waste landfill), Bishkek Tazalyk (waste collection and transportation), Bishkek Vodokanal (drinking water supply and sanitation)), private sector organizations (LLC EcoAgro, Agro-Industrial Holding "Atalyk Group", LLC Fluid Biogas, JSC Electrical Stations Bishkek Heat and Energy Plant, LLC Bishkek Solar, JSC Kyrgyz Wind Systems).

The TNA process included stakeholder engagement activities.. The dialogue with stakeholders engaged in the TNA process was built upon:

- the functioning of the Sectoral Working Groups and project Steering Committee was carried out according to the developed and validated ToRs, including overall sectoral TNA process coordination, additional relevant stakeholders engagement, discussion and quality assurance of all the delivered drafts by the national consultants and their final approvals as well as alignment of all deliverables to the national development priorities. (Annexes III and IV)
- conducting regular Sectoral Working Group sessions, workshops to discuss the implementation of the state policy in the field of climate change adaptation, along with consultation and validation of documents and decision taken under TNA process;
- international and national consultants consulting and providing methodological support to the TNA team and other engaged in the TNA process representatives of governmental, academic and business organizations
- developing common communication platforms among all relevant projects aimed to contribute to climate change initiatives such as the UNDP project on the development of the NDC Implementation Plan and Long-Term Strategy for Carbon Neutrality till 2050, UNDP/GCF National Adaptation Planning project.

Technology Fact Sheets prepared by the national consultants with support and in consultation with sectoral stakeholders were circulated among the Sectoral Working Groups members and relevant stakeholders for comments , recommendations and addressed in the final version of produced TFSs shared with SWG members and considered during the technology prioritisation exercise.

The implementation of the first phase of TNA in climate adaptation of Agriculture and Water Resources sectors was maintained highly participatory for ensuring a country-driven process. Throughout the TNA process, the engaged stakeholders interacted and discussed topics supporting TNA process in an objective fashion, directed towards identification, appraisal and selection of relevant to prioritised sectors' climate adaptation technologies. The national consultant team received effective support from stakeholders in

gathering sectoral data, getting needed expertise in the discussed topics, making decisions to meet the objectives of TNA project.

2.3 Consideration of Gender Aspects in the TNA process

The Kyrgyz Republic has achieved near gender parity in education enrolment and literacy rates. However, it fares poorly in the key global indicators of women's labour force participation, women's leadership, and maternal mortality ratio. Women's economic participation remains low at 48.2% compared to 75.7% for men. Women's political empowerment is also low with only 16% of seats in the Parliament in 2018. The maternal mortality ratio is extremely high at 76 deaths per 100,000 live births. These persistent areas of gender inequality resulted in a ranking of 91st in a total of 189 countries in the 2017 gender inequality index (GII). The country has an overall composite score of 0.392 based on its progress in the key indicators on maternal mortality, adolescent birth rate, gender parity in secondary education, and political representation. This puts the country behind many other former Soviet Union countries in the region: for example, Kazakhstan is 43rd in the GII, Armenia is 55th, and Uzbekistan is 59th.[54]

The Kyrgyz Republic has ratified several key international human rights conventions on human rights and gender equality. These include the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) on 10 February 1997, and the Optional Protocol of CEDAW (OP-CEDAW) on 22 June 2002. In 2000, the country submitted its first report on the implementation of the CEDAW Convention to the CEDAW Committee.

The Constitution of the Kyrgyz Republic, amended in 2010, enshrines the principles of inalienable human rights and gender equality but fails to recognize discrimination on the grounds of sexual orientation, gender identity, or disability.

The Law "On State Guarantees of Equal Rights and Equal Opportunities for Men and Women" was passed in August 2008. This law is the most significant, comprehensive piece of legislation designed to ensure equality between women and men. The law prohibits acts based on traditional or customary laws that contravene the principles of equality it enshrines. It also sets out provisions for ensuring its effective implementation, including requiring state bodies and local government authorities to submit annual evaluation reports for the systematic collection of statistical data, and for enforcement processes where alleged breaches of the law can be formally reviewed.

The Kyrgyz Republic's first long-term **National Gender Strategy (NGS) on Achieving Gender Equality by 2020** was adopted in 2012 in compliance with CEDAW. The NGS outlines the following five pivotal areas for achieving gender equality: (i) strong, effective institutional mechanisms; (ii) economic empowerment; (iii) an education system that promotes gender equality; (iv) access to justice for women; and (v) gender-equitable political participation. The NGS is further elucidated through national action plans on gender equality.

The Gender Policy Department of the Ministry of Labour and Social Development oversees the implementation of the NGS. The National Council for Gender Development was established in May 2012 as an advisory body chaired by the Deputy Prime Minister. It comprises ministers, deputy ministers, and heads of provinces.

[54] ADB. Kyrgyz Republic country gender assessment. 2019.

Integrating a gender approach into the analysis and decision-making processes in the field of climate change is important due to the fact that women and men react differently to changes in the state of the environment and may be affected in different ways according to the consequences of climate change. In households, especially those in rural areas, the main burden in the field of the availability and delivery of water for domestic needs and the provision of fuel for heating and cooking falls primarily on women and children. As climate change increases, these challenges become more complex. Women often face difficulties when it comes to accessing financial resources, capacity building activities and technology transfers. At the same time women are often underrepresented in climate change decision-making at all levels. This severely limits their ability to contribute to the implementation of solutions and apply their knowledge.

However, existing statistics and research do not fully identify gender aspects in all climate change related areas. It is necessary to consider the role of women in the development of policies, not only as recipient of policy, but also as important agents of its development and implementation. At the institutional level, activities are carried out to achieve gender equality, including gender analysis and the development of gender-responsive measures as part of the movement towards sustainable development. During the development of NATCOM 3 and 4 and NDC, the following issues were identified that need to be addressed:

- The indicators of the effectiveness of government policies are gender and environmentally insufficient and, ultimately, lead to asymmetry in the concentration of wealth and greater inequality, including gender inequality;
- There is a gap in living conditions between urban and rural areas, and persistent trends in the dilapidation of infrastructure in the regions. The increase in social inequality as a result of these problems will lead to the inequitable distribution of the risks associated with climate change, and increase the burden on the most vulnerable populations, including women.
- Women are often a key part of communities, families and the local economy. As a result, it is women who primarily feel the devastating effects of environmental changes, and to a large extent on the ability of communities to adapt to them;
- Women play a crucial role in biodiversity conservation and the management of water, land and other natural resources at local level. While environmental degradation has severe consequences for everyone, it primarily affects the most vulnerable, who are mostly women and children;
- At local government level, the exclusion of women from decision-making on access to natural resources, such as water, land, etc. is observed;
- Institutional arrangements for the transfer of knowledge and security in local communities (medical obstetric stations, hospitals, schools, etc.) are financed by a leftover principle and not ready for the challenges of climate change;
- The lack of gender analysis of the consequences of climate change and other aspects of environmental crisis leads to the absence of a clear picture of the risk distribution for different social groups;
- Lack of constructive mechanisms for equitable access to natural and social resources in the context of the challenges of climate change will lead to a sharp increase in social conflicts. According to the research in the national communications, the peak of reducing water availability in the region is predicted for the period from 2050 to 2100. Thus, we already need

to see women as important participants in the resource governance system and reduce conflicts to lessen the dramatic effects of climate change.[55]

Therefore, on the path to sustainable climate resilient development and «green growth», the long-term development programs should be developed on the basis of inter-agency cooperation, taking a minimization of environmental risks, the natural ecosystems conservation and the gender component into account.

There is a different level of gender influence in the process of technology implementation for the adaptation in agriculture sector and water management, since the engagement of the stakeholders was fully coordinated by the sectoral CEO and less by TNA Coordinator. Therefore, preparation of the TNA report and setting of the entire TNA process included different involvement of women, and the entire process of the TNA report preparation was gender balanced.

Thus, the National Consultant Team comprises two national female experts for the Water and Waste sectors, i.e. 50%. The Project Implementation Coordination Group includes 3 women (30%).

The composition of the SWG on Agriculture was not so gender sensitive, evidently due to the fact that the invitation to participate there was fully under sectoral governmental bodies' responsibility. Thus, participation of women in the SWG was 21 %. At the same time the share of women in total sectoral stakeholders' engagement list made up 30%. The SWG on Water Resources had 19% of women and the total women's involvement into TNA in the Water Sector made up 30%.

Nevertheless, the actual composition of groups engaged into TNA process has allowed free expression of thoughts and ideas by both men and women experts and sectoral specialists and fair participation in the decision-making process of TNA for adaptation component.

Additionally, to provide for a gender-sensitive approach in TNA activities and more over results, a special criterion "Gender Equality and Social Inclusion" was included in the sets of option selection criteria for all the sectors.

[55] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

Chapter 3 Technology prioritisation for the Agriculture Sector

Identifying, assessing and evaluating technologies for climate change adaptation is a complex, dynamic process that cuts across scales, sectors, and levels of intervention. Adaptation itself is characterized by many uncertainties, and it extends long past usual project cycles.

Technology development and transfer is an area of increasing priority on the international agenda on adaptation to climate change. Methodological and operational aspects of technologies in the area of adaptation to climate change are relatively underdeveloped with a number of prevailing challenges, including (a) defining and operationalizing the concept of technologies for adaptation much clearer; (b) developing the methodologies for how to assess and prioritize technologies for adaptation further and (c) ensuring that the relevant available information and knowledge is fully utilized and integrated in the processes.

In the transfer of adaptation technologies it is imperative to ensure that they address the underlying stressors to vulnerability to climate change stressors (like access to basic resources such as water, infrastructure and public facilities) and that they are suited to local conditions. Therefore it is vital to identify and assess technologies against appropriate criteria when prioritizing technologies. [56]

It should be noted that the main guiding factors for the adaptation technology needs assessment for agriculture in Kyrgyzstan were determined by the set of climate change impacts on the sector as defined in NATCOMs and NDC, as well as indicative adaptation measures enlisted there.

Thus, NDC defines the following key climate change impacts on agriculture to address in the near future:

1. Deterioration of the processes of biochemical regulation of the soil ecosystem.
2. Decrease in the productive capacities of pastures and the animals' adaptation to climatic changes.
3. Increased vulnerability of national food security.

According to NATCOM the key adaptation and resilience-related areas in the agricultural sector are as follows:

- Optimization of the agriculture production localization and specialization;
- Breeding work for the cultivation of drought-resistant and salt-tolerant crops;
- Phytomeliorative actions on pastures;
- Sustainable Pasture Management , including adaptation to climate change and development of the meat industry;
- Improvement of the agricultural infrastructure to increase the sector's resilience to the adverse impacts of climate change;
- Improvement of the monitoring of food security and the establishment of a yield forecasting system.

[56] Sara Trærup and Riyong Kim Bakkegaard. 2015. Determining technologies for climate change adaptation/ UNEP DTU Partnership.

3.1 Key climate change vulnerabilities in the Agriculture Sector

3.1.1 General information

Despite its decreasing contribution to GDP (13.6% in 2020), the agricultural sector remains vital to community livelihoods and subsistence (66 % of population is rural), as well as formal employment (18.6% of the total employed population in 2020) in the Kyrgyz Republic. [57]

Notably, the Kyrgyz Republic has relied significantly on food imports since the turn of the 21st century, operating an annual food trade deficit of around $150 million in the period 2008–2013. In addition, the food and agriculture sector has suffered from significant damage from natural hazards. At least $14 million in average annual agricultural losses to hazards in the period 1991–2011. These are almost entirely attributable to drought and water shortages, focused particularly on wheat.[58]

Climate change will influence food production via direct and indirect effects on crop growth and development processes. Direct effects include alterations to carbon dioxide availability, precipitation and temperatures. Indirect effects include through impacts on water resource availability and seasonality, soil organic matter transformation, soil erosion, changes in pest and disease profiles, the arrival of invasive species, and decline in arable areas due to desertification. On an international level, these impacts are expected to damage key staple crop yields, even on lower emissions pathways. Shifts in the optimal and viable spatial ranges of certain crops are also inevitable, though the extent and speed of those shifts remains dependent on the emissions pathway. In the context of the Kyrgyz Republic's dependence on food imports these international trends are likely to present challenges to food security.[59]

The existence of the wide-ranging mountainous areas determined the development areas of agriculture. However, only a small part of the territory (about 7%) can be used for the crops cultivation, and these are mostly the valley and foothill areas. More than half of the land stock is agricultural land. Of this, 85% are pastures and 15% are arable land and hayfields.

The agricultural sector has undergone a deep restructuration since the 1990s: through a land and agrarian reform, previously state-owned agricultural land was privatized. Currently, there are 462,129 economic entities in agriculture sector, including 31 state owned farms 349,159 or 75.5% of the total number accounted for peasant farms, 112,422 or 24.3% - individual entrepreneurs engaged in agricultural production, 108 collective farms and 378 agricultural cooperatives.[60] The total average of arable land per person in 2010 was 0.24 ha/person, and in 2020. - 0.2 ha/person.

Agricultural land, divided among small-scale agricultural producers, is very fragmented, and this is one of the main reasons for the low productivity and unsustainable use of agricultural land. The continuing upward trend in the number of peasant farms, owners and tenants of agricultural land is the determining factor for this fragmentation. With smallholding farms domination, in 2020, on average there were - 2.3 ha of land per farm, including arable land - 2 ha (1.4 ha - irrigated), 0.04 ha of perennial plantations and 0.18 ha of hayfields.[61]

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[57] NSC. Employed population by type of economic activity. http://www.stat.kg/ru/statistics/zanyatost/

[58] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

[59] Climate Risk Profile: Kyrgyz Republic (2021): The World Bank Group and Asian Development Bank.

[60] NSC. The Statistics of Agriculture. 2016-2020. Bishkek. 2021.

[61] Ministry of Agriculture. Draft Concept of Agrarian Development of the Kyrgyz Republic until 2025.

According to the Ministry of Agriculture, the physical volume of production of agriculture, hunting and forestry of the Kyrgyz Republic during 2015-2020 grew by 112.5%, by sectors: in livestock - 113.3%, in plant growing - 112.7%. With total gross output in 2020 of 247,298.2 million KGS the share of livestock production was 47.2%, crop production - 50.2%. Fishery is a rapidly developing sector of production, but, so far, its share is only 0.3%.[62]

During 2015-2020 both animal production and crop production increased, with the exception of wheat, oilseeds and potatoes, which decreased by 10.7%, 51.3% and 6.3%, respectively. The production of sugar beet was also unstable.[63]

The data provided by the NSC based on 2020 year analysis show that personal subsidiary farms and peasant farms, i.e. family farms, produce 98.5% of the gross output of agricultural products in the Kyrgyz Republic. (See tab. 3.1).

Table 3.1. The structure of agricultural output by categories of farms (%) [64]

Agriculture producer category	2016	2017	2018	2019	2020
All agriculture producers	100	100	100	100	100
State owned and collective farms	1.8	1.8	1.6	1.9	1.5
Private household farms	35.4	35.6	35.2	36.2	36.4
Peasant farms	62.8	62.6	63.2	61.9	62.1

Index of productivity per unit area (value of gross output per 1 hectare of crops) in crop production is significantly differentiated depending on crops grown. Thus, in 2019 this indicator for crop production as a whole amounted to 90.8 thousand Som (USD 1,099.2), for grain and leguminous crops - 47.3 thousand Som (USD 572.6), for vegetables - 589 thousand Som (USD 7,130.3).[65]

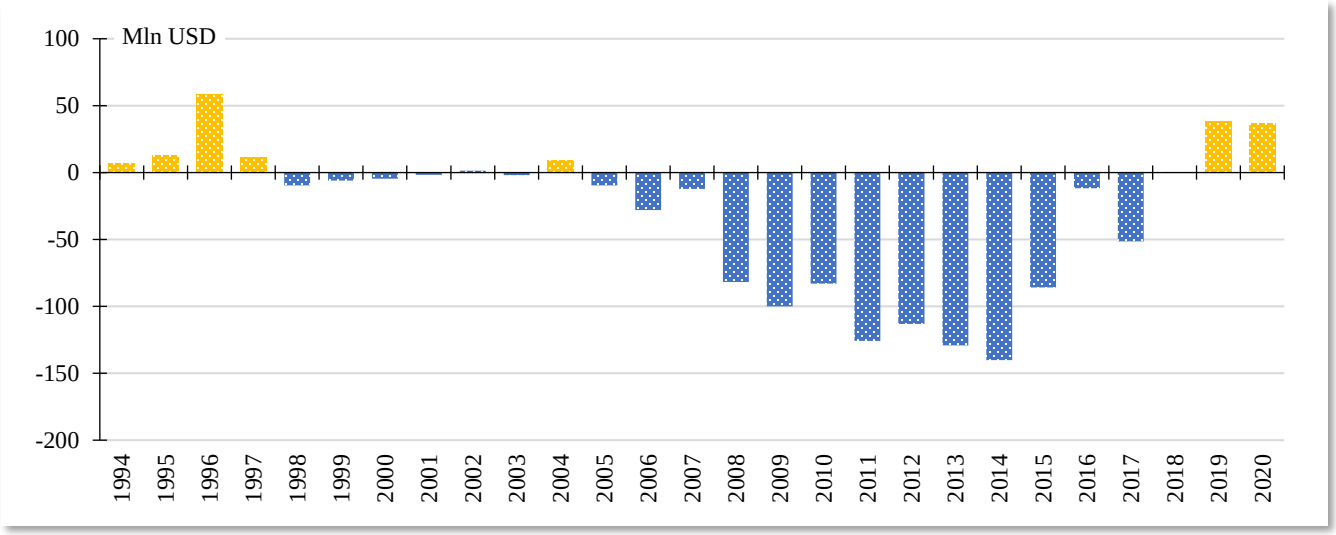
To improve access of farmers to good quality seeds, 12,177 ha of additional lands were allotted from the State Fund of Agricultural Lands to the seed-growing farms in 2019 by the Government.

Aquaculture and fishery currently make insignificant contribution to total gross output of agriculture, at the same time the Kyrgyz Republic has huge resources for the aquaculture development. The total area of lakes, reservoirs, ponds in which aquaculture and fishery activities can be carried out is more than 701,100 hectares. And the potential of pond fish farming in the country with the existing water fund of ponds and observance of fish-biological norms can be 600 tons of commercial fish per year. [66]

Agro-climatic conditions in the country are favourable for the cultivation of wheat, corn, barley, potatoes, cotton and other crops, as well as to livestock breeding. These production systems however often suffer from unsustainable management practices, mainly poor pasture management practices, which can potentially trigger or accelerate land degradation and jeopardize income for small-scale farmers who still rely on livestock for living. The dynamic of the food products external trade showed different trends (fig. 3.1.) reflecting, among others, the climate change impacts.

[62] Ministry of Agriculture. Draft Concept of the Agriculture Development in the Kyrgyz Republic until 2025.
[63] Ibid.
[64] NSC. Kyrgyzstan in figures. 2020. Bishkek. 2021.
[65] NSC. Kyrgyzstan in figures. 2020. Bishkek. 2021.
[66] Ibid.

Figure 3.1. Import and export balance of food products. [67]



Out of nine formal foodstuff indicators, which determine the food security state in Kyrgyzstan as per Governmental Regulations,[68] including bread and bread products, fruit and berries, potatoes, sugar, vegetable oil, meat and meat products, milk and milk products, vegetables and melons and eggs, Kyrgyzstan has sufficient supply only with three: vegetables and melons, milk and milk products and potatoes. Its own market supply with meat and meat products make up 62.8%, supply with eggs – 47.1%, sugar supply – 89.2%, and the supply with fruit and berries – 21.6%.[69]

Unfavourable weather conditions (late spring and early autumn frosts, high temperature, etc.), pollution and uncomplimentary land reclamation conditions in some areas limit the comprehensive utilization of the agro-climatic and land resources.

3.1.2 Climate change impacts on crop farming

Climate change will lead to different effects on agriculture (quantitative impact assessment is taken from the report of the World Committee on Food Security):

1. Changes of average temperatures with constant precipitation level.

In general, higher average temperatures can accelerate plant growth and development. However, the temperature rise in combination with a preserved precipitation level reduces stagnant moisture. Higher temperatures also identify higher concentrations of ground-level ozone. Ozone is harmful to all plants, but especially susceptible are soybean, wheat, oats, beans, peppers and some types of cotton.

The impact on livestock essentially depends on the climatic conditions of the region. The comfort zone for most cattle is 10-30 °C. At a higher temperature the animals feed intake is reduced by 3-5% per

[67] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[68] Regulations "On Monitoring and Indicators of Food Security in the Kyrgyz Republic". Approved by Resolution of the Government # 138 as of 3 March 2009.
[69] Programme of Food Security and Nutrition of the Kyrgyz Republic for 2019-2023. Resolution of the Government # 320 as of 27 July 2019.

temperature degree rise. In addition to reducing the animals' productivity, the higher temperatures adversely affect fertility. Additionally, climate change affects the animal indirectly through the impact on the food base;

2. Changes of temperature extremes.

The temperature raising during the night can reduce the rice yield by 10% for each 1 °C increase in minimum temperature in the dry season. The increase in maximum temperatures can lead to a substantial reduction of yields and reproductive function of many cultures. For maize, e.g., every day with a temperature above 30 °C may reduce the yield by 1.7% in drought conditions.

3. Change of carbon dioxide concentration in the atmosphere.

Many studies show some increase of yield with increasing CO_2 concentrations in the atmosphere. However, this effect is not observed for all cultures. For such plants, as corn, sugar cane, and sorghum, the rising yields effect is limited. The impact of higher CO_2 concentrations on plant growth under typical field conditions also remains considerably uncertain. It is necessary to take into account a negative impact of increasing CO_2 concentrations to the nutrients composition in certain food crops. The studies have established that the wheat protein content is reduced at high CO_2 levels, and carbon dioxide also substantially reduces the minerals content, such as iron and zinc.[70]

According to the data on the different climatic extremes, agriculture is severely affected by drought and water shortage (Table 3.2).

Table 3.2. The average annual damage caused by climatic emergencies (including drought and water shortage) for the main agricultural crops in 1991-2011. [71]

#	Culture	Damage from all emergencies, thous. $2005	Damage from drought and water deficit, thous. $2005	Share %
1	Wheat	6560.26	5826.35	88.81
2	Barley	934.68	728.46	77.94
3	Rice	237.82	182.96	76.93
4	Corn for grain	996.04	820.10	82.34
5	Pulses	28.16	26.68	94.74
6	Oats	2.68	2.07	77.24
7	Tobacco	251.66	202.54	80.48
8	Sugar beets	2216.86	2066.22	93.20
9	Oil seeds	202.36	165.50	81.78
10	Potato	249.57	143.40	57.46
11	Vegetables	2358.09	1817.60	77.08

The damage economic cost (tab. 3.2) was determined by accounting the different costs of the production unit and the different productivity of the crops. Therefore, with the same physical volumes of the crop losses (debited acreage), the damages are higher for the crops with higher a production unit cost.

[70] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[71] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

3.1.3 The assessment of humidification conditions under climate change

As a quantitative assessment, the humidification factor was used, defined as a ratio of summed precipitation to evaporability. According to N.N Ivanov, correspondence between moistening areas and landscape features is as follows:

- Arid desert area - humidification 0 - 0.13;
- Semi-arid area of the semi-desert zone - 0.13 - 0.30;
- Steppes and dry savanna (zone of insufficient humidification) - 0.30 - 0.60;
- Moderate humidification zone (steppe, savannah) - 0.60 - 1.0;
- Sufficient humidification zone (forest) - 1.0 - 1.50.[72]

The humidity assessment was performed similarly to the water resources assessment based on the elevation advanced digital models DMR and the humidity features DMHum (tab. 3.3-3.5). The annual precipitation level is assumed to be unchanged re 2010.

Table 3.3. Average humidity of the provinces under the climatic scenarios in 2100 [73]

#	Province	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	Chui	0.620	0.568	0.544	0.462
2	Issyk-Kul	0.797	0.713	0.674	0.544
3	Naryn	0.744	0.669	0.635	0.523
4	Osh	0.568	0.519	0.497	0.422
5	Talas	0.607	0.557	0.533	0.455
6	Djalal-Abad	0.633	0.583	0.560	0.483
7	Batken	0.465	0.428	0.410	0.351
8	Kyrgyz Republic	0.663	0.602	0.574	0.482

Table 3.4. Share (%) of humid (below 0.13) areas (desert) of the provinces in 2000 and under the climatic scenarios in 2100 [74]

#	Province	Area, km^2	2000	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	Chui	20025	0.00	0.000	0.000	0.001	0.016
2	Issyk-Kul	36823	2.51	3.557	4.240	4.579	5.838
3	Naryn	44958	0.01	0.000	0.000	0.000	0.466
4	Osh	29100	0.11	0.393	0.549	0.674	1.422
5	Talas	11441	0.00	0.000	0.000	0.000	0.131
6	Djalal-Abad	33273	0.00	0.030	0.070	0.149	0.792
7	Batken	16984	9.34	12.343	13.848	14.622	17.658
8	Kyrgyz Republic	192604	1.32	1.818	2.096	2.270	3.137

Table 3.5. Share of areas (%) with humidity ranging from 0.13 to 0.30 (semi-arid) in the provinces in 2000 and under the climatic scenarios in 2100 [75]

#	Provinces	Area, km^2	2000	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	Chui	20025	15.48	27.91	30.64	32.01	37.19

[72] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[73] Ibid.
[74] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[75] Ibid.

2	Issyk-Kul	36823	8.86	12.19	13.68	14.47	17.78
3	Naryn	44958	8.29	13.31	16.41	18.05	24.82
4	Osh	29100	14.30	19.98	24.20	26.31	34.23
5	Talas	11441	23.94	29.51	32.53	34.03	39.56
6	Djalal-Abad	33273	14.07	18.99	21.50	22.80	27.85
7	Batken	16984	27.75	31.64	33.24	34.01	36.70
8	Kyrgyz Republic	192604	13.70	19.18	21.86	23.24	28.63

The estimates show that under the unfavourable climate scenarios the process of desertification will speed up and the actual total arable land will turn into desert and semi-desert areas.

3.1.4 Assessment of the climate change direct impacts on crop yields

The assessment was based on the Standardized Precipitation Index (Standardized Precipitation Index, SPI). By means of the SPI index the potential climate change impact on crop yields was determined with applying a standardized classification of the drought intensity. (See tab. 3.5).

Table 3.6. Classification of the drought intensity based on SPI [76]

Categories	SPI Value	Potential impact
D0, abnormal	-0.5; -0.7	Short-term drought – minor impact slowing down the vegetation
D1,mild	-0.8; -1.2	Insignificant damages for vegetation without significant crop loss
D2, significant	-1.3; -1.5	High probability of crop loss
D3, severe	-1.6; -1.9	Weighty crop loss
D4, extreme	-2.0 or less	Significant or total loss of crops

The estimates of the climate change direct impact on crop yields is based on the datum that the SPI index assesses drought, based on the rainfall data only. Hence, the correlation coefficient may be important only for the crops more dependent on rainfall rather than on the water resources availability for irrigation. The following crops yields were assessed:

- Grains (weight upon processing);
- Wheat (weight upon processing);
- Barley (weight upon processing);
- Corn for grain;
- Rice (weight upon processing);
- Sugar beet (factory);
- Tobacco (recorded weight);
- Oilseeds;
- Potatoes;
- Vegetables;
- Melon-plantation;
- Fruit and berry crops;
- Grapes.

The review time series cover 1991-2010 regarding the NSC official data on the yield. The SPI indices were calculated for the same period. The deadline for the index estimation (in months) and the accounting

[76] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

scope of moisture conditions (in months) have also been ranged. These parametres were changed to clarify the calculation methodology.

The NATCOM 3 studies key findings are as follows:

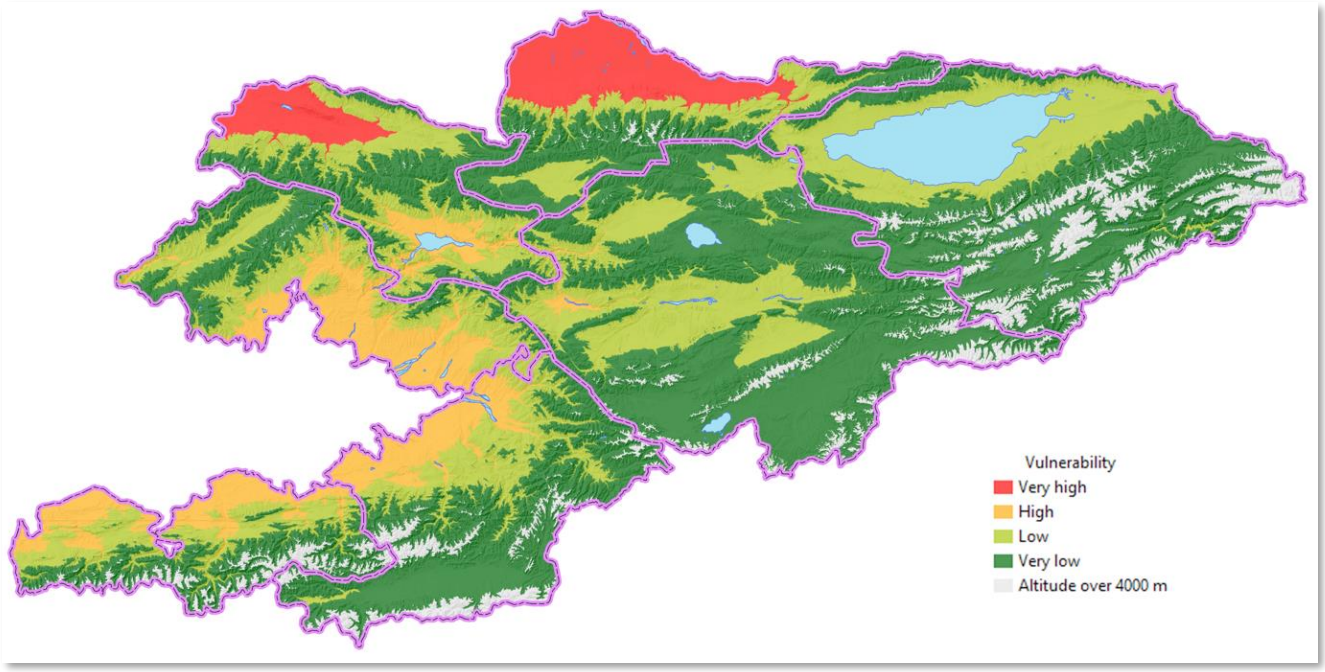
a. The SPI index provides the statistically valid estimates for the yield changes of four crops:
    - Grains (weight upon processing);
    - Wheat (weight upon processing);
    - Sugar beet (factory);
    - Barley (weight upon processing).
b. There is no statistically significant relationship between the SPI index and productivity for other crops tested. There may be such a connection to other crops, such as oats and buckwheat, for which the certified data on productivity lacks.
c. October is an optimal period to assess the index.
d. The highest relationship takes place under a use of the index calculation scope of 9-10 months.
e. The SPI index can serve as a baseline during the crop insurance system implementation for the above crops.
f. From a methodological point of view, it is more rational to use in the future the Standardized Precipitation Index and Evapotranspiration (SPEI) instead of SPI. It is based on a two-dimensional distribution and takes into account transpiration, additionally to precipitation. This feature of the index may be valuable in the analysis of the aridity changes under the global warming. The assessment based on the available observations showed no significant difference between SPI and SPEI, possibly due to the small changes of the climatic factors in the current time interval.[77]

The overall outlook for crop production and agricultural livelihoods in the Kyrgyz Republic is mixed. Broadly, studies suggest a positive outlook in sub-humid environments (wetter areas), and a negative outlook in arid environments. While higher carbon dioxide concentrations and warmer temperatures are expected to boost yields in key crops such as wheat, potential increases in the frequency of drought events and extreme heats could cancel out these gains. Demand for irrigation is likely to grow significantly, potentially leading to water deficits, for example for the production of cotton and winter wheat.[78]

Temperature increase, according to the Agency of Hydrometeorology - Kyrgyzhydromet observations, differs both spatially and seasonally, which significantly affects the agricultural sector and especially crop production for the following reasons: (1) the highest temperature increase (0.4°C) over the 10 years of observations was observed in Chui and Ferghana valleys (Figure 3.2), (2) during the last 10 years temperature increase has increased significantly, especially in the springtime. Due to such distribution of temperature regime, soil degradation processes are aggravated and crop yields and rates of plant growth are changed. [79]

Figure 3.2. Vulnerability and risk levels of crop lands and pastures.[80]

[77] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. 2016. Third National Communication of the Kyrgyz Republic under UNFCCC.
[78] Climate Risk Profile: Kyrgyz Republic (2021): The World Bank Group and Asian Development Bank.
[79] Ministry of Natural Resources, Ecology and Technical Supervision. UNEP. GEF. 2022. Draft Fourth National Communication of the Kyrgyz Republic under UNFCCC.
[80] Ibid.



As seen in the figure 3.2 the main crop farming areas of Kyrgyzstan are under the high temperature impacts.

The data on changes in precipitation is controversial and requires further measurement and study according to the materials of the Intergovernmental Panel on Climate Change. Meteorological observations on the territory of the country do not provide statistically significant data on the change in precipitation, although it is given for some areas with a negative trend. With decreasing precipitation, in particular in the areas of Zhaiyl (2%/10 years), Sokuluk (1%/10 years) and Tyup (1%/10 years), yields are decreasing due to episodic precipitation at the threshold values applicable to specific crops.[81]

In order to maximize yields farmers will require 'climate-smart' infrastructure and technologies. Without intervention these resources are likely to be available only to wealthier farmers. Notably, access to credit and necessary agricultural inputs represent major barriers to adoption of adaptation technologies. Reflecting the country's proportionately lower wealth levels, uptake of climate-smart technologies in the Kyrgyz Republic is currently believed to be very significantly lower than in other Central Asian nations. Studies also suggest there remains a significant yield gap in the region.[82] This means that there may still be scope to increase agricultural production, or at least offset climate losses, through improvements in practices, technologies and crop choices.

3.1.5 Climate change impacts on livestock breeding

As of 2020 an estimated 46,6% of value added in the agricultural sector derived from livestock breeding[83] and the industry remains significant in its contribution to GDP, employment, and subsistence. The livestock industry can both be susceptible to climate risk, and drive climate risk and both of these

[81] Ministry of Natural Resources, Ecology and Technical Supervision. UNEP. GEF. 2022. Draft Fourth National Communication of the Kyrgyz Republic under UNFCCC.
[82] Climate Risk Profile: Kyrgyz Republic (2021): The World Bank Group and Asian Development Bank.
[83] NSC. Agriculture of the Kyrgyz Republic. 2017-2021. Bishkek. 2022.

processes are in need of further research. Poorly managed pastoral land, where soils and ecosystems are allowed to degrade, can compound climate risks such as flooding, drought, and biodiversity loss. At the same time, climate changes can impact both on the net primary productivity of the land which feeds livestock, and in some cases on the physical health of the animals themselves, particularly through hazards such as droughts, but also through second-order impacts such as increased prevalence of disease. Pastoral husbandry is the dominating form of livestock breeding in Kyrgyzstan.

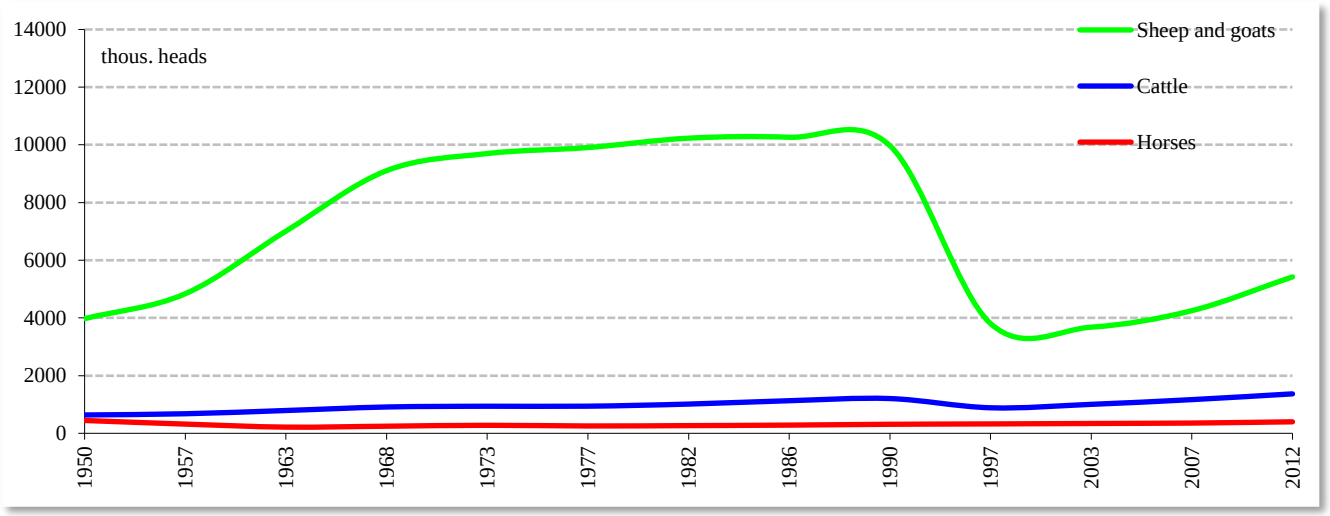
Agro-ecological conditions of the country are to a large extent determined by the land use for pastures, not for cropping. The livestock sector accounts for more than half of the total cost of the agricultural products, therefore, the efficiency of the livestock sector is very important for the national economy.

The climate change impacts on livestock are quite diverse. Unfortunately, reliable local data is not available for all the aspects of the climate change impacts. Thus, the analysis of the already observed vulnerability assesses only the yield productivity. Data on the yields of dry edible green mass and hayfields mass, spring and autumn pastures, and summer and winter pastures is submitted by the Kyrgyz State Design Institute of Land Management "Kyrgyzgiprozem".

Detailed data on productivity was limited to the province and district level. In addition to the yield productivity, the data on climate observations (temperature and rainfall) and the animal number - cattle, sheep and goats, horses was used.

It should be noted that over the observation period (1950-2012), among all factors affecting the pastures productivity, the animal number changed most significantly (fig. 3.2).

Figure 3.3. Trends of a number of basic farm animals in the KR.[84]



In all provinces and the whole country a similar growth trend of the basic farm animals is observed till the 80s (till 1990 for some areas), followed by a sharp decline in 2003, and then a rise again. Most vividly this tendency is expressed with sheep and goats. Further, under the pasture load estimation, the animal number was assessed with a transfer factor to a nominal head (one cattle head is equal to five sheep heads, and a horse head is equal to six nominal sheep heads).

The following conclusions were drawn from the statistical analysis:

[84] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

1. The hayfield and pasture yield is low on the whole in the Kyrgyz Republic. The maximum yield of green mass was observed in the Dzhalal-Abad province - 25 kg/ha for the summer pastures in 2012, which is well below the developed countries' yield. For example, in the Netherlands, the hay yield – on rangeland is 120 kg/ha, in France - 45-50, in Germany – 60, Belgium – 80, and Denmark - 90 kg/ha of dry matter. Naturally, this situation is largely determined by a difference in climatic conditions, significantly less favourable in the Kyrgyz Republic. However, the more effective pasture-management organization (grazing planning, and rotation) in the developed countries contributes significantly to an increased yield.
2. Changes in the provinces' yields differ considerably (Table 3.7), but in the country as a whole there is a slight increase in the yield from hayfields and pastures of all kinds (0.007-0.4 kg/ha per year). The highest growth is observed in the Batken and Chui provinces, and the largest decrease in crop yields is in the Naryn province. The yield absolute value is not very high: the maximum increase of the yield is less than 0.1 t/ha per year (the Batken province), and the maximum reduction - less than 0.09 kg/ha per year (the Naryn province).[85]

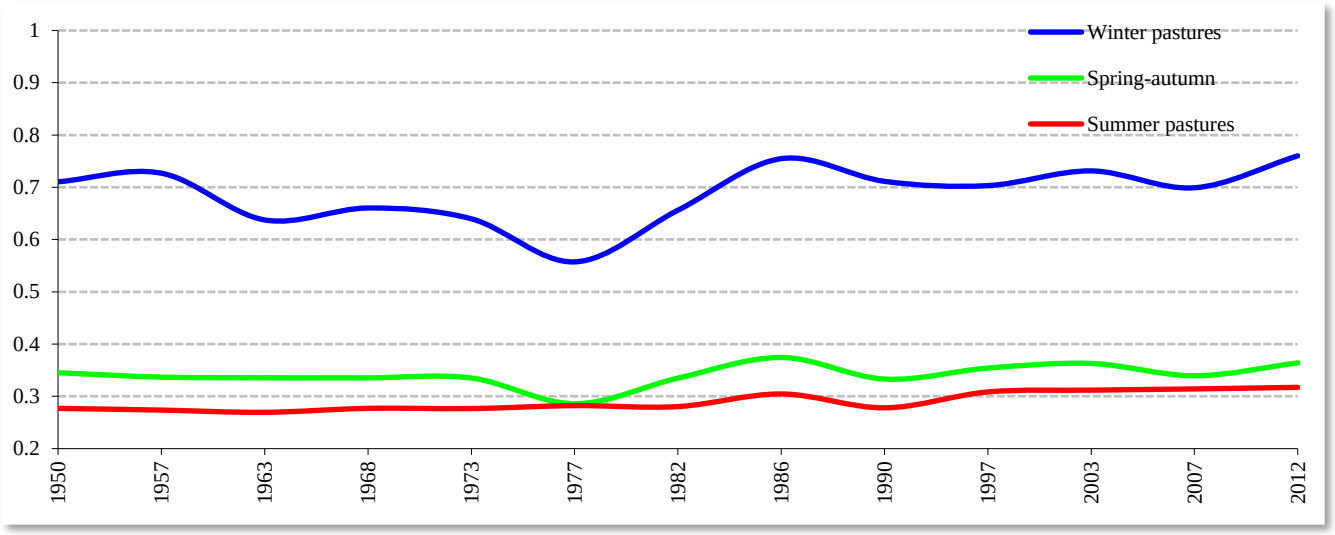
Table 3.7. Changes of yields by pasture and hayfields types for different areas. Legend: + increase, - decrease.[86]

Province	Productivity of dry edible mass				Productivity of green mass		
	Hayfields	Spring-fall pasture	Summer pasture	Winter pasture	Hayfields	Spring-fall pasture	Summer pasture
Batken	+	+	+	+	+	+	+
Djalal-Abad	+	+	+	+	+	+	+
Issyk-Kul	-	-	-	-	-	-	-
Naryn	+	-	-	-	-	-	-
Osh	-	+	-	+	+	+	+
Talas	+	+	+	+	-	+	+
Chui	+	+	+	+	+	+	+
Average in the republic	+	+	+	+	+	+	+
Average productivity, c/ha	14.40	3.15	5.32	2.36	9.18	18.32	3.43

3. A clear growth trend in share of edible mass to green mass is observed for all types of pastures and all provinces. Fig.3.3 shows this trend for the Kyrgyz Republic. The possible reasons of such a trend are a decrease of the pastures load after the 1980s and the climatic changes.

Figure 3.4. Trends in the ratio of edible mass to green mass [87]

[85] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[86] Ibid.
[87] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.



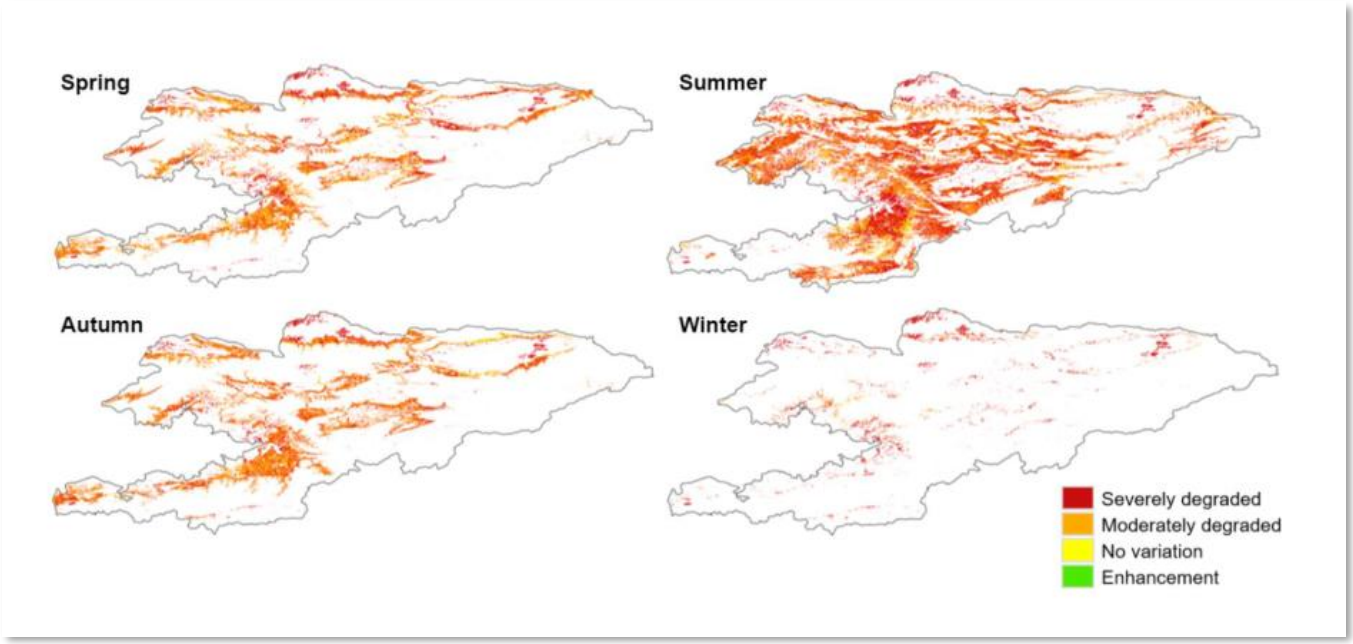
4. Two factors impact the yield negatively - the pasture load, expressed in the nominal sheep head number, and temperature. Besides, the pasture load has a more significant impact compared to temperature. For winter pastures the temperature increase is not a negative impact for all regions.
5. Assessing the pasture load in more detail, then the greatest impact is made by the sheep number out of all livestock. This is an expected result, as while grazing sheep hooves crush the ground with a force of 5.4 kg/cm^2, the figure for cattle is 5.1 kg/cm^2, and for horses - 2.6 kg/cm^2.[88]

A recent study of the productivity of the Kyrgyz Republic's grasslands[89] show that climate changes have been negatively impacting the productivity of grasslands across the majority (96%) of the country's land surface area. This is primarily linked to shifts in precipitation patterns and as a result, different trends have been seen in all the parts of the country and significant uncertainty about future changes remains. In contrast, the impact of livestock grazing practices reduced over the last decade, as a result of improved enforcement of environmental protection policies over most of the country. [90]

Many pastures are subject to degradation caused by overgrazing and exacerbated by climate change. Statistics on pasture conditions at country level are outdated. The recent IFAD technical note[91] summarizes the results of a study that compared the average pasture conditions of 2000–2004 and 2016–2020 using remote sensing imagery and presents maps and statistics that show that large areas of pasture were degraded moderately or severely between the start of the century and 2016–20. IFAD study estimates that 94% of pastures (in total 69,971 km^2) have been degraded at least during one season (see fig. 3.4).

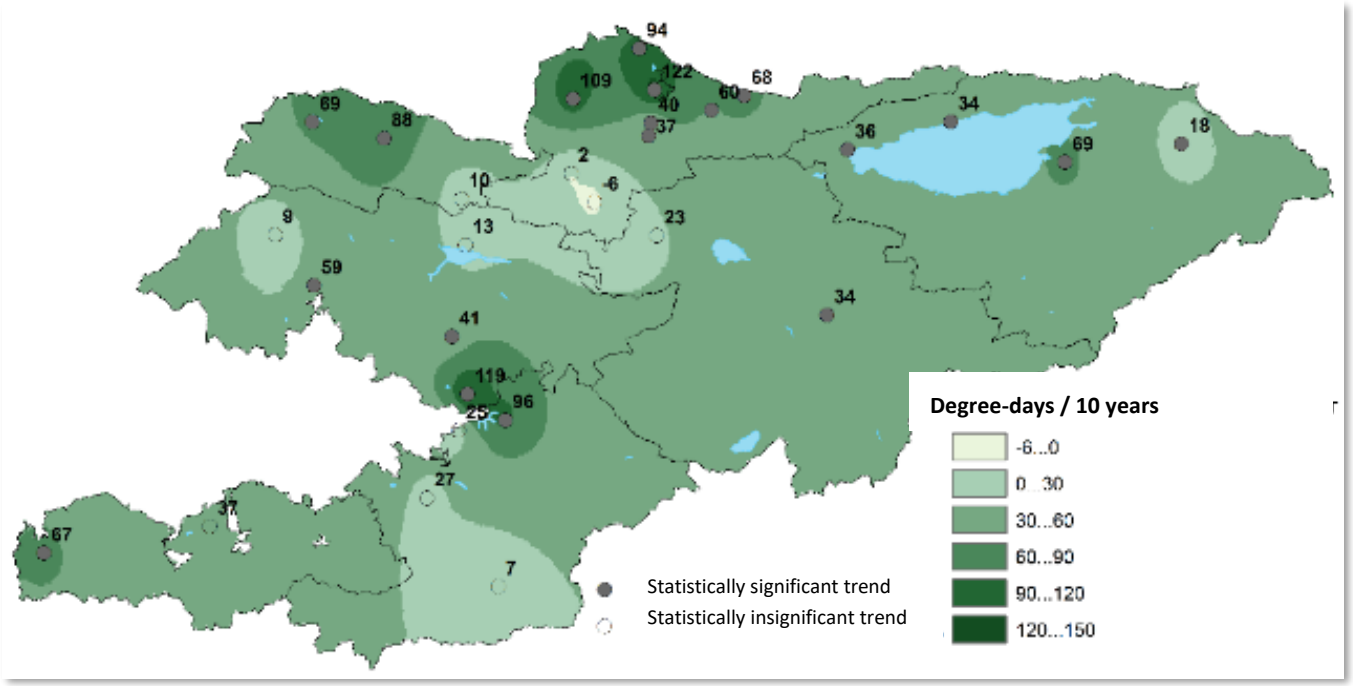
Figure 3.5. Seasonal maps of rangeland condition changes between the periods of 2000–2004 and 2016–2020 according to IPCC Guidelines of 2006.[92]

[88] Ibid.
[89] Wang, Y., Yue, H., Peng, Q., He, C., Hong, S., & Bryan, B. A. (2020). Recent responses of grassland net primary productivity to climatic and anthropogenic factors in Kyrgyzstan. Land Degradation \& Development, 31(16), 2490–2506. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/ldr.3623
[90] Climate Risk Profile: Kyrgyz Republic (2021): The World Bank Group and Asian Development Bank.
[91] IFAD. 2021. Technical note. Pasture condition maps in Kyrgyzstan/
[92] Ibid.



Rising temperature caused by the changing climate affects the livestock sector, in particular, with summer pastures. Between 1986 and 2016, the area of degraded summer pastures increased by 14%, particularly affected in Talas and Chui oblasts (fig. 3.6). Due to the increase of temperature, particularly in the zones mentioned above and in Jalalabad oblast, the reduction of fodder base and migration of pests is observed there now.

Figure 3.6 Changes in the sum of active temperatures



With both slow and rapid-onset climate risks threatening communities dependent on pastoral livelihoods attention has turned to adaptation options. Observations have shown the benefits of supporting

communities with knowledge-building activities, access to technologies, diversified income streams, and devolving decision-making power in building adaptive capacity in remote communities.

3.1.6 Climate change impact on soils

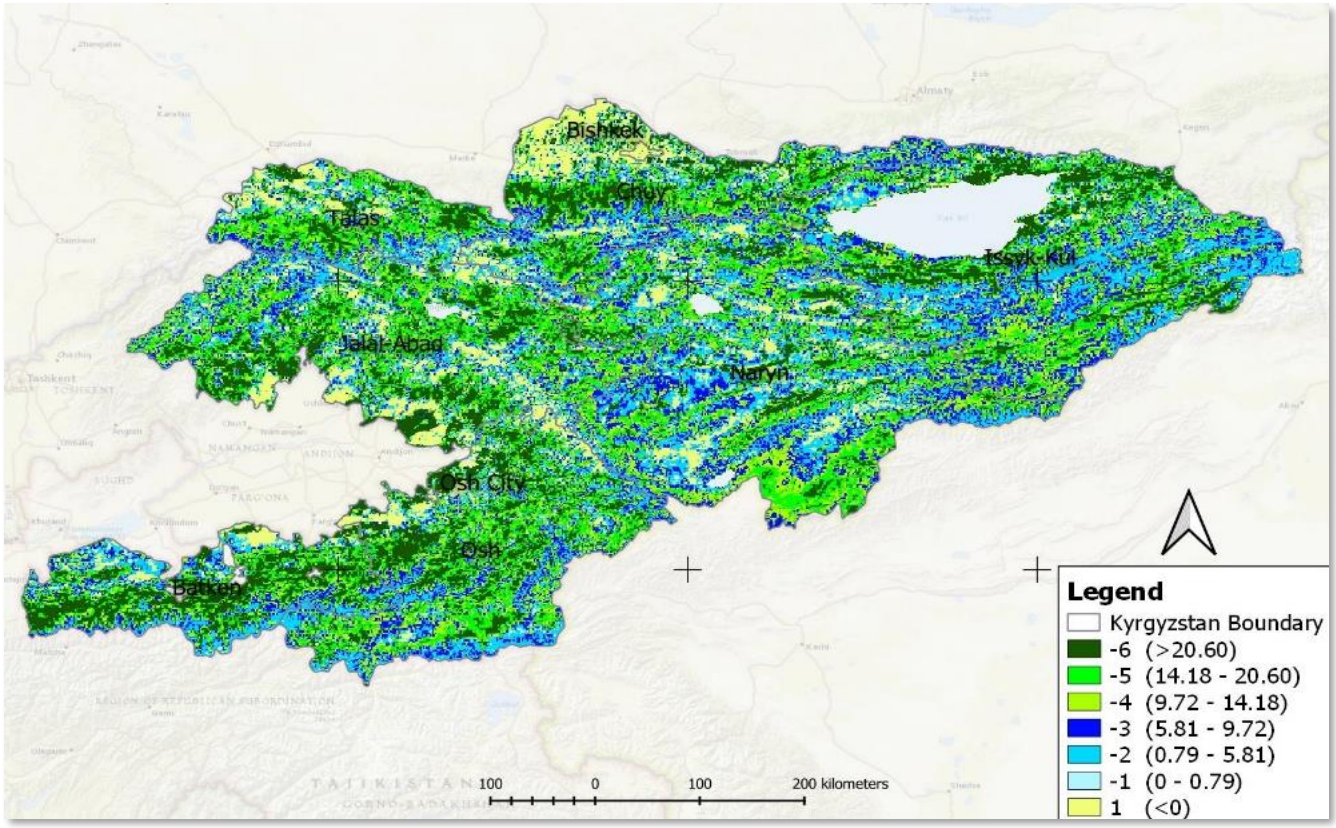
Historical warming has already had a local impact on vegetation health in the Kyrgyz Republic. Rising temperatures and increased water deficits driven primarily by greater evapotranspiration resulted in stunted plant growth and desiccation. The Kyrgyz Republic's lowlands are among the areas already being affected by increased aridity. Persistent drought periods degrade grassland areas causing a transition to sparsely vegetated lands and shrubs. Forested areas, and tree species such as juniper, have also been documented struggling with increasing aridity. However, the interplay between climate change and direct human pressures is complex; in general, direct human influences remain the most significant driver of ecosystem degradation locally.[93]

According to meteorological observations, the largest temperature increase (0.4°C) over the last 10 years has been observed in the valley zones of Chui and Ferghana valleys, especially in Sokkuluk, Moskva and Alamudun districts with an impact of 489.2 thousand people and Suzak, Bazar-Korgon and Uzgen districts with approximately 470.3 thousand people, respectively, where most of the crops - cereals, fruits and vegetables - are produced. It should be noted that this is the area with the highest concentration of female-headed farms, the number of which has increased since 2010 by 28.7 times in the Jalal-Abad, 67.2 times in the Osh and 29.2 times in the Chui regions. Consequently, they will face more problems of soil degradation due to increased evaporation and, consequently, salinization and decreased soil osmotic potential, reduced levels of soil organic carbon, soil micro-elements, reduced crop yields and plant growth, emergence of new pests and infections and increased growth of phytophages. In the 10 years since 2007, the amount of crop failure (crops), although varying, has been stable, e.g. 4457 hectares in 2011 (the highest) and 5 hectares in 2018 (the lowest).[94]

An assessment of soil fertility change over the last 20 years shows that there has been a decrease in soil fertility in northern Chui oblast, as well as in large areas of Jalalabad oblast. This phenomenon is related both to climate change and land degradation due to inefficient pasture management practices which significantly reduce land fertility. The change in Normalised Relative Vegetation Index (NDVI) as an indicator of soil fertility change over 2000-2020 according to NASA LP DAAC at USGSEROS is shown in fig. 3.7.[95]

Figure 3.7 Change in Normalised Relative Vegetation Index (NDVI) as an indicator of soil fertility change from 2000-2020.[96]

[93] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016
[94] Ministry of Natural Resources, Ecology and Technical Supervision. UNEP. GEF. 2022. Draft Fourth National Communication of the Kyrgyz Republic under UNFCCC.
[95] Ibid.
[96] Ibid.

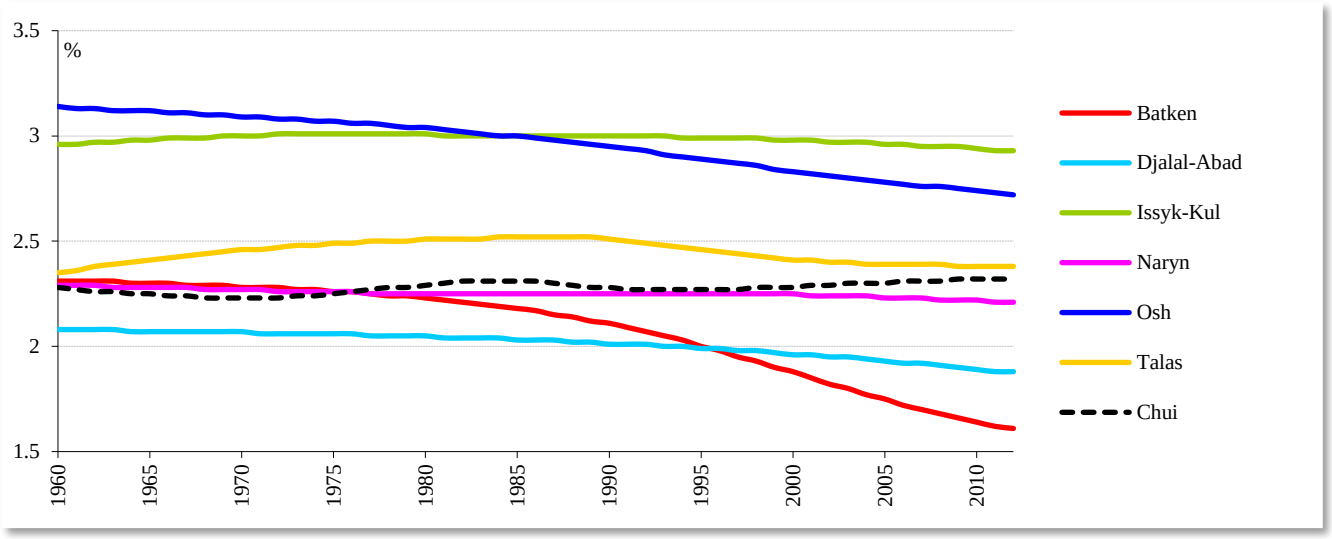


The state of soil is of great importance to agriculture. Usually, in the climate change context, the soil's role in tmitigation is stressed due to the carbon sink function. Unsustainable management of agricultural soil may result in soil carbon emission to the atmosphere as carbon dioxide and become a factor affecting climate change. In its turn, the climate is one of the most important factors in soil formation and geographic distribution of soils.

Changes in temperature and precipitation can have a huge impact on the organic substance and the processes in soil, as well as on the plants and crops growing on it. The climate affects the soil formation both directly (by determining the soil energy level and hydrothermal regime), and indirectly through the vegetation, animal life and micro-organisms.

Figure 3.8. Change trends of the soil humus by province.[97]

[97] Ibid.



Analysis showed that, due to the observed climate change impact and the soil cultivation technologies, the soil humus content decreased in all provinces except for the Chui (fig. 3.8).

The future of land and soil health in the Kyrgyz Republic will depend strongly on local land management and development practices, such as biomass burning and soil conservation, but sustainability challenges are likely to be exacerbated by climate change. These changes, in combination with issues such as glacial melt and drought will likely result in significant shifts in species' viable ranges.

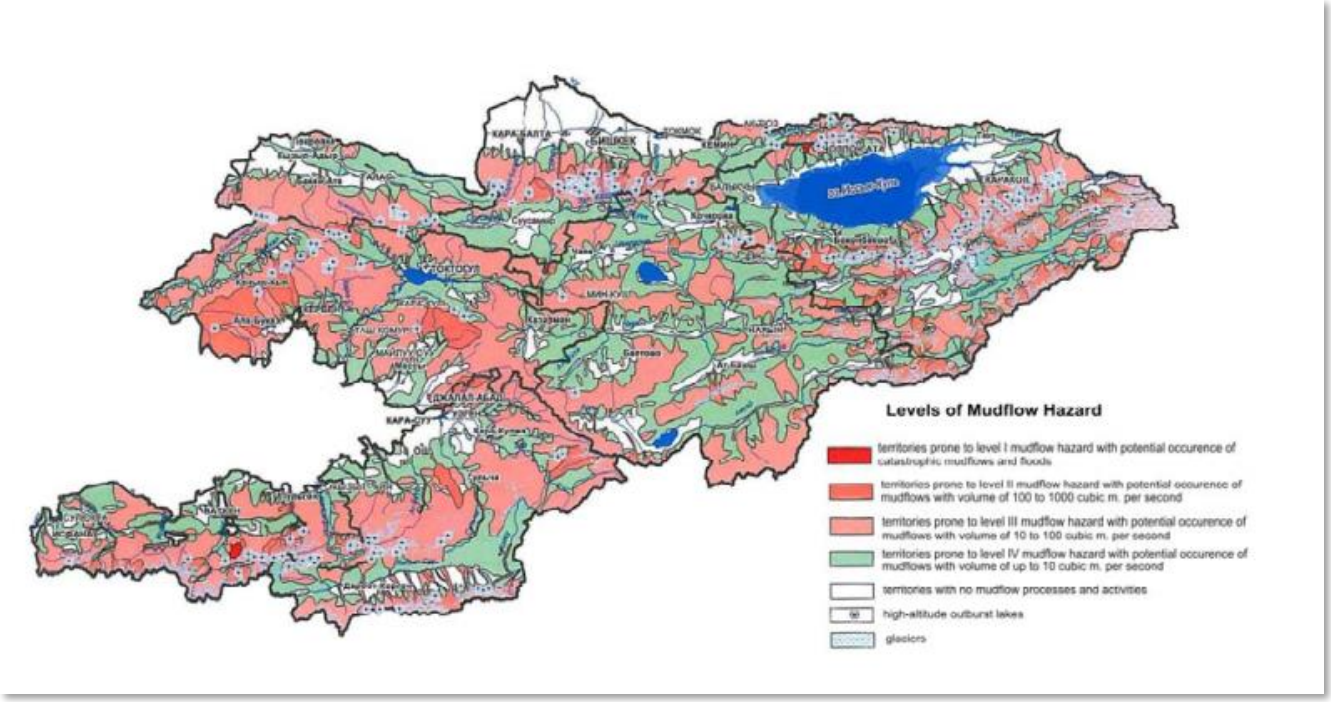
The observed situation is a serious challenge for food security. To solve it, the agricultural practices and land management should be profoundly changed. In this aspect, the advanced technologies in agricultural production and the soil resources management, such as agroecology, organic farming, conservation agriculture and agroforestry, provide numerous benefits to improve the organic carbon content in the soil. These methods provide soil fertility by increasing the organic substance content, contribute to the plant cover preservation on the soil surface, require less chemical fertilizers and promote crop rotation and biodiversity.[98]

As a mountainous country, the Kyrgyz Republic is particularly exposed to numerous natural disasters. Out of 70 types of dangerous natural processes and phenomena worldwide, causing significant damage to the population, economic activity and infrastructure, more than 20 occur on the territory of the republic (fig. 3.9). In addition, population growth and the urbanization process have contributed to an increase in the frequency and severity of related losses caused by natural disasters in the last two decades. Among these, hydrometeorological disasters, floods and mudflows, are the most frequent in Kyrgyzstan.

Virtually the whole territory of the Kyrgyz Republic is prone to high risks from floods and mudflow hazards, – there are 3,103 rivers in the country, which are considered as highly dangerous in terms of potential mudflow and flood hazards.

Figure 3.9. Mudflow hazard forecast map of the Kyrgyz Republic

[98] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. 2016. Third National Communication of the Kyrgyz Republic under UNFCCC.



Nearly all of Kyrgyz Republic is vulnerable to flood and mudflow hazards, which occur frequently across the country. As glaciers continue to melt due to rising temperatures, more intense flooding events in the wintertime (and reduced water flow in the summer) are expected. The Jalal-Abad, Osh, Batken, Chui, Issyk-Kul, and Talas regions face the highest risk of floods and mudflows.

Kyrgyz Republic has 5,000 potentially active landslide sites, the majority of which are found in the south. Intense rainstorms trigger landslides within minutes, as do snowmelts. More than 10,000 homes are located in landslide prone areas; of all natural hazards, landslides cause the most deaths.[99]

Thus, to conclude this section the following key agriculture sector vulnerabilities could be enlisted:

- Exposure of the main crop-farming areas to rising temperatures challenging sensitivity of crops resulting in the reduction of crop yields.
- High dependency of Kyrgyzstan crop farming on irrigation make agriculture vulnerable to climate change impacts: shrinking water runoff in summer and shifts in precipitations regime, heat waves and long periods without rains.
- Practically full dependency of livestock breeding on natural grasslands and unsustainable pasture use is now aggravated by the climate change hazards like lack of spring rains and hot summers, which undermine pasturelands capacities to regenerate grass cover. This has led to growing degradation of grass lands reducing rural communes' livelihoods.
- The growing occurrence of spring floods and mudflows affects crops and causes considerable loss for rural households in climate-induced disaster-prone areas.
- Inadequate land-management practices coupled with climate change impacts poses a threat to overall food security of this country

[99] The World Bank Group and Asian Development Bank. 2021. Climate Risk Profile: Kyrgyz Republic. https://climateknowledgeportal.worldbank.org/country/kyrgyz-republic/vulnerability

Among the main climate change related risks the following were identified:

- Increased risk of drought and water scarcity;
- Increased irrigation requirements;
- Increased pastureland degradation;
- Soil erosion, salinization, desertification;
- Wheat, sugar beet and barley yield decrease;
- Increased risk of spring floods and mudflows.

3.2 Decision context

At the moment the above-mentioned vulnerabilities are not duly addressed due to lack of relevant sector-tailored adaptation policy. However, certain activities strengthening adaptive capacities and elaborating conducive enabling environment to promote green and climate resilient development are ongoing. Thus, the amendments are under discussion to reduce custom duties on the import of resource-efficient and low-emission equipment, materials and vehicles, as well as tax exemption or reduction for economic entities transitioning to green production and consumption.

Kyrgyzstan also receives certain international support to increase climate change resilience, the long list of projects relevant for climate change adaptation of Kyrgyzstan is presented in Annex V to this report.

Among these, two ongoing UNDP projects deserve special attention, being closely linked to the TNA process and should be definitely taken into account in decision making on agriculture adaptation technology prioritisation.

The GCF-funded UNDP-implemented project entitled “Advancing development of a National Adaptation Plan (NAP) process for medium and long-term adaptation planning and implementation in the Kyrgyz Republic” supports the Government of Kyrgyzstan in establishing its National Adaptation Plan process and is consistent with the government’s strategic vision for climate change adaptation. The project objective is to strengthen institutions and enhance vertical and horizontal coordination for climate change adaptation planning, facilitate mainstreaming of climate risks at sectoral and subnational levels, and identify a programme of priority climate change adaptation investments.

No doubt, the final NAP should include actions to promote the prioritized climate technologies to reduce vulnerabilities and foster resilience of the agriculture sector, which will be described in the TAP. Representatives of that project participated duly in the TNA project events contributing with information. Moreover, close partnership was established between two national expert teams to facilitate information sharing.

Another UNDP Climate Promise II, NDC Partnership is providing support currently to develop an enhanced NDC Implementation Plan and Long-Term Strategy for Carbon Neutrality (LTS) until 2050. The first consultation with the experts on agriculture engaged in that process showed high interest and willingness to be involved into TNA process too. Evidently, agriculture, water resources, energy and waste-sector solutions as far as technologies development, transfer, deployment and dissemination should become an integral part of both documents. Thus, it was decided to coordinate the TNA project also with the NDC Implementation Plan and LTS on carbon neutrality 2050 development.

The process of technology selection in the TNA project in Kyrgyzstan was divided into the following stages:

1. Analysis of the climate change vulnerability assessments of the agriculture sector conducted so far.
2. Analysis of the enabling frameworks, specific characteristics of the agriculture sector operations, also mapping stakeholders to determine the demand on technology.
3. Identification of priority subsectors vulnerable to climate change impacts to deploy climate adaptation technologies there.
4. Overview of past experience in technologies need analysis of EBRD and FAO.
5. Study of existing technologies in agriculture based on international and relevant national experience.
6. Selection and creation of the extended list of technologies by the national consultants, also gathering proposals from the sectors' stakeholders and compiling long list of adaptation technologies from open sources.
7. Detailed discussion of each technology with a team of national experts and in the sessions of Sectoral Working Groups.
8. Formation of the short lists of technologies recommended for the MCA exercise and preparation of Technology Fact Sheets.
9. Criteria selection for prioritization and validation on the WG session.
10. Prioritisation of short-listed technologies using MCA Matrixes Tool.
11. Discussion of the MCA result and corresponding recommendations of the SWG and preparation of the TNA Reports.
12. Presentation of the selected technologies to the TNA Project National Steering Committee.

The national context of the decision-making process on technology prioritization has some specific features:

- Domination of smallholding farmers in agriculture sector;
- Crop production and animal husbandry have practically equal shares in total national agriculture production output.
- Pasture management in performed by the Associations of Pasture Users under Municipalities.
- Full dependency of agriculture on irrigation.
- Agriculture machinery widely used is outdated and inefficient.
- Low technical capacities of the majority of farmers and lack of information on modern crop farming and livestock breeding technologies
- Low investment capacities of the majority of farmers.
- Limited financial resources allocated to farmers by the Governmental Programme "Financing to Agriculture Phase 9" for low interest credits.
- The process of clustering of agrifood systems has been launched by the Government.
- Local municipalities and Associations of Pasture Users (APU) lack adequate financial resources to maintain and pasture infrastructure.
- Pasture Committees under APU have limited technical capacities for sustainable pasture management and to address pastureland degradation aggravated by climate change.

All above listed features were duly considered by the members of SWG during the decision-making process on technology prioritisation.

It should be noted that one of the major factors in decision making about the technology assessment was determined by the NatCom 3 and NDC defined climate change impacts on the agriculture sector, as well as adaptation measures enlisted there.

3.3 Overview of existing technologies in the Agriculture Sector

It should be noted that adaptation is the first priority in the climate action agenda of Kyrgyzstan, being a low GHG emitting country. On the other hand, while emission-reduction techniques and technologies are already known and proven, adaptation measures tend to require significant additional research and financial resources and can be very diverse with uncertainty in expected results due to the high degree of uncertainty surrounding the magnitude and timing of climate change impacts.

Currently Kyrgyzstan has rather poor evidence data and underdeveloped enabling frameworks for agriculture adaptation to climate change. Development of recommendations for agriculture adaptation to climate change is underway within the NAP development process and NDC proposed adaptation measures.

Changing climate impacts on agriculture are already mentioned in the national development strategic document, and the development of a clear sectoral adaptation strategy to sustain food security of the country is ongoing.

The agricultural sector is the largest employer in the Kyrgyz Republic, with about 40 percent of the labour force participating in the sector. And while it accounts for an estimated 14 percent of GDP, the second largest component of GDP, it is disorganized and undercapitalized, and the Kyrgyz food processing industry remains underdeveloped. Most agriculture is family-based on small plots of land. Larger production, particularly in apples, apricots, cherries, sugar beets, beans, cotton, tobacco, and walnuts, is regional and still small-scale. Most families grow small amounts of fruits and vegetables that are consumed locally, though the Kyrgyz Republic did export more than $155 million of produce in 2020. [100]

Agricultural land governance and tenure practices, and traditional crop production systems using soil tillage, mineral fertilizers, locally available seeds and gravity irrigation techniques result in depleting soil fertility, low yields and poor livelihoods of farmers, which cause internal migration of rural youth to urban areas and abroad.

Seed farms, predominantly owned by the state, regardless of the rather conducive legal frameworks and state subsidies, do not meet local market demand for high-quality seeds. Only 60% of farmers are provided with certified seeds. Thus, the government recently issued Regulations on Seed Farming in Kyrgyzstan to foster quality seed production.[101]

Grasslands occupy almost half of the territory. These extensive resources represent the basis for seasonally mobile animal husbandry, which is relevant for both individual households and the national economy.

With the dissolution of the Soviet Union and Kyrgyzstan's transition to a market economy, these formerly state-owned grasslands were parcelled out and privatized. Considerable socio-economic distortions and ecological problems occurred during this process. In order to meet such unintended effects, a legal

[100] US Department of Commerce. International Trade Administration. https://www.trade.gov/country-commercial-guides/kyrgyz-republic-agriculture

[101] Minister of Agriculture interview. https://24.kg/vlast/235424_vkyirgyizstane_budut_razvivat_semenovodcheskie_hozyaystva/

framework for user-based pasture management[102] was established in the course of an institutional learning process.

This package of measures corresponded to a decentralization of responsibilities for natural resource management through the stronger involvement of rural communities and, thus, aligns with a central paradigm of the national development discourse at the time. Positive examples can be observed in terms of increasing equal access to grazing land, the empowerment of rural communities, and reduced ecological damage. At the same time, there are local cases of pasture-related ecological problems and overstrained management institutions.[103]

A growing number of livestock, causing advancing degradation of natural pastureland happens as a result of low productivity of cattle, sheep, and other species of local domestic animals. Local seed and livestock breeding farms, as well as agriculture extension services hardly meet the growing need of farmers, technical capacities of many leave much to be desired.

Smallholder farmers have not been able to maintain the genetic stock of cattle from the Soviet era. Instead, they shifted to lower-productivity breeds that were readily available. Ongoing animal health problems are also keeping the husbandry sectors from reaching their full potential. The country is still trying to source the optimal genetics for its herd and keep its cattle stocks healthy. There are four drags on Kyrgyzstan's livestock productivity: poor genetics, animal health challenges, low-quality feeds and inefficient pasture and farm management.

Nearly 60% of Kyrgyzstan's grasslands have experienced degradation. Climate change, in particular change in precipitation, was the dominant factor driving grassland degradation in the north but human pressures also contributed.[104]

Pasture infrastructure (bridges, roads, livestock routes, stopping and watering places, sheep barns, paddocks and fenced-off areas for grazing livestock, seasonal accommodation, appropriate structures for shepherds and other immovable property necessary to graze local livestock), needs much improvement and repair, which is quite difficult due to limited investment capacities of herder communes. In general, given the low technical capacities of local Associations of Pasture Users, implementing pasture management is addressed through several international development project providing modern management tools for pasture conservation and management, as well as value-chain development and better access to markets.

According to the Ministry of Agriculture, the availability of the agricultural machinery in 2020 was the following: tractors – 21,519, grain harvesters – 2,191, corn harvesters - 59, fodder harvesters - 387 units.[105]

In 2019, there were 57 hectares of arable land per tractor. Planted areas per harvester were for grain crops - 250 hectares, for corn – 1,457 hectares. However, the majority of agricultural machinery is largely

[102] Government of the Kyrgyz Republic 2018. Resolution 'Procedure for Use and Disposal of the State Forest Fund' #192; Government of the Kyrgyz Republic 2016. Budget Code of the Kyrgyz Republic #59; Government of the Kyrgyz Republic 2009. Law of the Kyrgyz Republic 'On pastures' #30; Government of the Kyrgyz Republic 2002. Resolution 'On Pasture Lease and Use' #360; Government of the Kyrgyz Republic 1999. Land Code of the Kyrgyz Republic #45; Government of the Republic of Kyrgyzstan 1991. Land Code of the Kyrgyz Republic (#574-XII).

[103] Dörre, Andrei; Kasymov, Ulan. 2021. User-based Pasture Management in Kyrgyzstan: Achievements, Challenges, and Trends

[104] Wang, Y., Yue, H., Peng, Q., He, C., Hong, S., & Bryan, B. A. 2020. Recent responses of grassland net primary productivity to climatic and anthropogenic factors in Kyrgyzstan.

[105] Ministry of Agriculture. Draft Concept of the Agriculture Development in the Kyrgyz Republic until 2025.

physically worn out and morally obsolete, the renewal of the fleet of machinery and equipment is very slow. [106]

This indicates a very low energy input, hence low labour productivity and an extensive form of farming and low profitability. Due to the lack of own financial resources, the high cost of credit resources and the low profitability of agricultural production, farmers in Kyrgyzstan today, tomorrow and in the near future are not able to buy modern technical equipment and conduct profitable agricultural production. Naturally, farmers need effective government policy and support in technical re-equipment.

Collaborative forest-management practices in a few communes in the walnut-fruit forest belt on the southern Kyrgyzstan have proved to be an effective adaptation tool, efficiently guiding forest use and conservation. Upon the initiative of the President, tree planting seems to become a permanent activity for the next coming years, with about 6 million saplings being planted in 2022.

Insurance against climate-induced disasters and hazard risks for crop farming and husbandry have been proposed and are currently debated in the sector. Insurance in the Kyrgyz Republic is carried out on the basis of property contracts or personal insurance concluded by an individual or a legal entity (insured) with an insurance organisation (insurer). Insurance is one of the most dynamically developing spheres of the Kyrgyz business. The volume of operations in the insurance services market is steadily growing. However, low awareness of farmers about this opportunity and frequent lack of finance limit wider application of this adaptation measure in Kyrgyzstan.

3.4 Adaptation technology options for the Agriculture Sector

The overview of relevant existing technologies and international best practices for the adaptation of agriculture to climate change drew on several sources of information: https://www.ctc-n.org/collection/climatetechwiki and technology handbooks, factsheet examples from previous national TNAs, and other materials available at the UNEP-CCC TNA website www.tech-action.org. (See Chapter 6. List of References).

An initial Long List of Technology Options[107] was developed (tab. 3.8) and presented on the first session of the Sectoral Working Group including 18 options from the CTCN and UNEP-CCC and 12 already considered for Kyrgyzstan by FAO/EBRD FINTECC project implemented in Kyrgyzstan in 2018.[108]

A total of 30 options of adaptation technologies for agriculture in Kyrgyzstan were circulated among the members of SWG for informing and afterwards presented at the first session of Agriculture Sector SWG. Fruitful debate resulted in the preselection of 18 technology options for the next round of analysis and engagement of the additional sectoral specialists for consultations to compile a Short List and to further develop Technology Fact Sheets. (Minutes of the SWG Meeting as of 31 October 2022).

[106] Ibid.
[107] CTCN site: https://www.ctc-n.org/collection/climatetechwiki?f%5B0%5D=taxonomy_term_page_objective_facets%3A14912&f%5B1%5D=taxonomy_term_page_sectors_facets%3A14957.. UNEP-CCC site: https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_fact_sheet
[108] del Mar Polo, M., Santos, N., Berdikeev, S. 2022. Adoption of climate technologies in the agrifood system: Investment opportunities in the Kyrgyz Republic. Rome, FA

Table 3.8. The Provisional List of Technology Options debated by SWG on Agriculture.

#	Technology	Short description	Remarks
1.	Applying water-saving technologies such as drip or spray irrigation	Drip irrigation is based on the constant application of a specific and targeted amount of water to the soil. The system uses pipes, valves, and small drippers or emitters to transport water from sources (i.e., wells, reservoirs, and/or reservoirs) to the root zone and supply it at a certain amount and at a certain pressure. The system must maintain adequate soil moisture levels in the root layer, facilitating the best use of available nutrients and creating the right environment for a healthy plant root system. By providing the exact (or nearly exact) water requirement of each plant, the system significantly reduces water wastage and promotes efficient water use. Compared to surface irrigation, Drip irrigation technology will help farmers adapt to climate change by making efficient use of their water supply. Especially in areas affected by climate change, such as seasonal droughts, drip irrigation reduces water demand and ensures efficient water use. This irrigation also reduces evaporative water loss (since evaporation increases at higher temperatures). The planned application of water will provide the necessary water resources directly to the plant when it is needed. In addition, fertilizer application is more efficient as it can be applied directly through the pipes.	Considered by Azerbaijan, Belize, Grenada, Moldova, Granada
2.	Sprinkler irrigation	Sprinkler irrigation is a type of pressure irrigation that involves applying water to the soil surface using mechanical and hydraulic devices that mimic natural rainfall. These devices replenish water consumed by crops or provide the water needed to soften the soil to make it suitable for agricultural activities. The purpose of irrigation is to ensure that each plant provides each plant with the required amount of water. Sprinkler irrigation is a method in which water is distributed from above using high-pressure sprinklers, sprayers, or cannons mounted on risers or moving platforms. Technology advantages: One of the main benefits of sprinkler irrigation technology is the more efficient use of water for agricultural irrigation. Sprinkler systems eliminate water transport channels, thereby reducing water loss. Water is also distributed more evenly across crops, helping to avoid wastage. The sprinkler system also improves yields and is suitable for most row, field and tree crops that are grown close together such as cereals, legumes, wheat, sugarcane, peanuts, cotton, vegetables, fruits, flowers, spices and seasonings, as well as for growing rice crops. Sprinkler irrigation technology is well adapted to various topographies and is suitable for all soil types except heavy clay. Sprinkler systems can be installed as stationary, as well as mobile devices. Sprinklers provide a more even distribution of water on agricultural land, promoting sustainable crop growth. Likewise, soluble fertilizers can be guided through the system for easy and even application. The risk of soil erosion can be reduced as the sprinkler system limits the soil disturbance that can occur when gravity irrigation is used. In addition, Sprinkler irrigation can provide additional protection for plants from freezing at low temperatures. Secondary Benefits: Increasing crop yields includes income generation, job creation and food security, and promoting sustainable crop growth. Likewise, soluble fertilizers can be guided through the system for easy and even application. The risk of soil erosion can be reduced as the sprinkler system limits the soil disturbance that can occur when gravity irrigation is used. In addition, Sprinkler irrigation can provide additional protection for plants from freezing at low temperatures. Secondary Benefits: Increasing crop yields includes income generation, job creation and food security, as well as promoting sustainable crop growth. Likewise, soluble fertilizers can be guided through the system for easy and even application. The risk of soil erosion can be reduced as the sprinkler system limits the soil disturbance that can occur when gravity irrigation is used. In addition, Sprinkler irrigation can provide additional protection for plants from freezing at low temperatures. Secondary Benefits: Increasing crop yields includes income generation, job creation and food security, which can occur when gravity irrigation is used. In addition, Sprinkler irrigation can provide additional protection for plants from freezing at low temperatures. Secondary Benefits: Increasing crop yields includes income generation, job creation and food security, which can occur when gravity irrigation is used. In addition, Sprinkler irrigation can provide additional protection for plants from freezing at low temperatures. Secondary Benefits: Increasing crop yields includes income generation, job creation and food security.	Azerbaijan, Moldova, Belize
3.	Rainwater collection from the surface of the earth - Small	Because there are water-poor regions in many areas, small-scale collection infrastructure can make a significant contribution to increasing the amount of fresh water available for human use. This is especially true in arid and semi-arid regions where minimal rainfall is usually very intense and often seasonal.	Azerbaijan

#	Technology	Short description	Remarks
	reservoirs and micro watersheds	Thus runoff and river flow can be abundant for short periods and absent during the rest of the year. during the whole year. Advantages of the technology: The technology can help store and use water during dry periods and therefore increase its efficient use of water as the system collects water from nearby areas and prevents it from flowing into rivers or other areas or from evaporating. Technology Disadvantages: The initial cost of these systems can be higher than other systems. Higher costs are usually associated with infrastructure and installation costs. Unexpected precipitation may affect system operation.	
4.	Wireless real-time soil moisture monitoring system IRISTAR Pro2 Plus. (Technologies for planning of irrigation on the farm using real-time monitoring of electronic devices)	Irrigated agriculture uses large volumes of water compared to cities and industry, and competition for good water quality is very high in many regions. It is now recognized that improved agricultural water management practices can lead to important benefits in terms of water availability for agricultural expansion and other uses, and can also reduce many environmental problems. However, it is difficult to successfully implement effective practices without field measurements and analytical tools that allow water managers to have a good estimate of crop water use, this situation hinders water management. Regular feedback to obtain information from the field when making decisions on water management can significantly improve the efficiency of water supply services. However, obtaining repeatable, objective assessments of actual field conditions is difficult, so operational tools are needed to help water managers make sound decisions about crop water use and water delivery. Among the new technologies	Moldova
5.	Integrated production and protection(IPP) of greenhouse crops	IPP is a modern concept or system of agriculture that deals with production in a holistic approach, integrating the planting system, good agricultural practices, integrated pest management and other means of production, management of crop production at the farm level. This technology includes a sequence of hard and soft technologies, from adapting the structure and material of the greenhouse to harvesting. IPP is considered to be a high cost technology (initial capital) compared to with open field cultivation or even traditional protected agriculture. The IPP uses combined soft and hard technologies with variable costs: • Adapted greenhouse design and plastic cover for insulation, insulation and aeration, as well as to trap condensate with a plastic roof. • Insect screens • Appropriate plant material with selected rhizomes and varieties resistant to climatic and soil problems (drought, salinity, nematodes, fungal diseases) • Suitable planting density for optimum yield and aeration • Extended planting season: higher yields, longer production season and greater resilience to environmental and market risks. • Climate control in the greenhouse (heating/cooling/aeration/drainage) • Pollination by insects: increased fruiting without the use of chemicals • Integrated pest management: maintaining product quality while minimizing the use of chemicals • Fertilization system: highly efficient use of water and fertilizer.	Lebanon
6.	Composting of solid organic waste from agriculture	Vermicomposting (using compost worms) is used to decompose fresh cow manure at the National Agricultural Research Institute (NAREI). However, its use remains limited among farmers and virtually non-existent among households. There are also no commercial composting businesses. In general, there is a wide range of composting systems/technologies available on the international market, from simple homemade containers to industrial aerated static compost systems. A typical Vermi compost bin at NRATI has an approximate area of 6.0 m2. Every 2-3 months an average of 400 kg of vermi compost is produced when the bins are cleared.	Guyana

#	Technology	Short description	Remarks
7.	Covering steep slopes with trees to prevent soil erosion and retain moisture in the soil	Planting various types of trees in contour rows to retain moisture. Use of special traps to collect sediment in steep areas to prevent soil erosion.	Vietnam
8.	Agroforestry and wind breaks	Agroforestry is a land use system that aims to make the best use of available land resources through diverse and beneficial agricultural and forestry practices. The main goal of agroforestry is to maintain soil fertility by replacing fertilizers required by intensive agriculture. Agroforestry incorporates the benefits of both intensive scientific farming practices and forestry activities that provide essential commercial and fuel wood and non-timber forest products. Agroforestry models focus on both the short-term returns to agriculture and the long-term returns to forestry. This ensures the long-term economic security of farmers and communities involved in such activities. In agroforestry systems, every piece of land is considered suitable for growing plants. Perennial, multi-purpose crops that are planted once but provide benefits. Priority is given to perennial, multipurpose crops that are planted once but provide benefits over a long period of time. When designing agroforestry systems, priority is given to beneficial interactions between crops, for example, trees can provide shade and reduce wind erosion. Agroforestry systems require serious management. Combining trees and crops into one system can create competition for space, light, water, and nutrients and can discourage agricultural mechanization. Management is needed to reduce competition for resources and maximize environmental and production benefits. Cultivated crop yields may also be lower than usual. However, agroforestry can reduce the risk of total crop failure	Butane, Belize, Azerbaijan
9.	Conservation tillage system without herbicides for winter wheat	The mouldboard plow was replaced by a combinator, which helps to reduce soil erosion, soil erosion and uncompensated mineralization losses. By reducing soil erosion and mineralization loss of soil organic matter, we reduce global warming by increasing carbon sequestration. The reduction in fuel consumption resulting from the replacement of a mouldboard plow with minimum tillage can be adapted to the limited non-renewable energy sources, to fluctuations in the prices of non-renewable energy sources at the international level. By keeping the mulch on the soil surface, soil moisture evaporation can be reduced and future crop stability can be increased. With the help of a combinator, we can replace a mouldboard plow or a chisel. After both, as a rule, disking is carried out. Thus, with the help of a combinator, we can replace three technological operations with one. This is followed by direct sowing.	Moldova
10.	Optimization of the placement and structure of agricultural land with the introduction of diversified agricultural crops of crop types that are resistant to expected climate changes	New plant varieties that are more tolerant of heat and drought will enable farmers to maintain or increase productivity. The introduction of new cultivars and improved plant varieties is a technology aimed at increasing the productivity, quality, health and nutritional value of plants and/or increasing crop resistance to diseases, pests and environmental stresses. Crop diversification means adding new crops or cultivation systems to agricultural production on a particular farm, taking into account different income from value-added crops and additional marketing opportunities. New and improved crop varieties can be introduced by farmers experimenting with new varieties. Agricultural researchers and consultants can help farmers identify new varieties that can be better adapted to changing climate conditions and help farmers compare these new varieties with those they already produce. In some cases, farmers may be involved in cross-breeding seeds of plant varieties that exhibit the qualities they seek to disseminate in order to develop new varieties with desired characteristics. The development of new and improved crop varieties increases the resistance of plants to various stresses that may arise as a result of climate change. Such potential stresses include water and heat stress, water salinity, water stress and the introduction of new pests. Developed varieties that can withstand these will help ensure that agricultural production continues and even improves despite uncertainty about the future impacts of climate change. Nutrient-enhanced varieties can provide benefits to both animals and humans, reducing vulnerability to disease and improving overall health.	Azerbaijan, Mexico

#	Technology	Short description	Remarks
11.	Technologies for breeding hybrids with high adaptive potential to weather indicators.	Technologies aimed at improving varieties and hybrids with high potential for climate change adaptation include the following steps: • analysis (assessment) of the adaptive level of admitted varieties (hybrids) and identification of "weak points" in the studied genotypes; • replenishment of collections with original material that has blocks of genes necessary for their further inclusion in improvement (selection) programs; • testing and selection of new genotypes created naturally and artificially (refrigerators, phytotrons, etc.) • study of the level of conformity of bioeconomic and ecological genotypes, assessment of the potential of new varieties for seed propagation and implementation in real production conditions. For each crop (after analysis of biological systems), the "weak performance" of modern genotypes to change in existing and predicted meteorological parametres was determined. For winter crops (wheat, barley, rapeseed, etc.) - resistance to frost and winter, for spring crops - to drought and extremely high temperatures during critical stages of development of agricultural plants, resistance (tolerance) to new types of pests and diseases . Modification of improvement programs (aimed at the development of such traits in new genotypes) after their implementation will allow agriculture to reduce crop losses of these crops.	Moldova
12.	Application of 50 t/ha of manure with bedding to agricultural soils once every five years	The technology involves the return of biophilic elements contained in manure, urine and plant waste from cattle litter to the biological circuit. One ton of manure with bedding at a moisture content of 50-55% contains about 15-16 kg of nitrogen, phosphorus and potassium. This technology helps to maintain a stable content of organic matter in the soil. The nutrient content is increased and the soil structure is improved. Topsoil The topsoil becomes looser, more resistant to compaction, better supplied with water available to plants. This increases drought tolerance. Currently, there are no large farms, and the herd of cattle is concentrated in rural households. In order to use manure as a fertilizer, municipalities must organize the collection, storage, fermentation and storage of manure on special platforms. Technologies for processing and applying manure to the soil are given in specially developed recommendations. Really possible reserves of manure collection in the country do not exceed 2-3 million tons, which would be enough to fertilize only 200 thousand hectares of agricultural land per year, provided that this amount is real. The amount of manure that can be collected is 9 times less than necessary.	Moldova
13.	Aquaculture and fish farming	Aquaculture is the farming of aquatic organisms such as fish, crustaceans, molluscs and aquatic plants and may include stocking, feeding and protection from predators. Aquaculture involves the rearing of freshwater and marine populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish. Specific types of aquaculture include fish farming, shrimp farming, oyster farming, algaculture (e.g. seaweed farming) and ornamental fish farming. Fish farming is the most common form of aquaculture. It involves the commercial rearing of fish in aquariums, ponds, or ocean enclosures, usually for human consumption. Fish farmed fish species include salmon, tilapia and catfish.	Gambia
14.	Integrated Pest Management (IPM)	Integrated pest management (IPM) is sometimes referred to as ecological. Integrated pest management is a means of controlling pest numbers and keeping them below economic damaging thresholds through a variety of strategies used in a holistic approach while protecting plants, humans, animals and the environment from hazards. IPM aims to produce healthy crops by protecting plants from pests with environmentally friendly means that have minimal impact on agricultural ecosystems. WPI relies on various components, among which the use of chemical pesticides is the least important. The main alternative components are:	Lebanon

#	Technology	Short description	Remarks
		• Crop management: i) introduction of tolerant/resistant varieties and root crops to pests, ii) use of a diversified cropping pattern, including crop rotation, long crop rotations and agroforestry, iii) pruning and burning damaged parts to reduce pest numbers, • Soil management: i) improve soil fertility through green cover, including legumes in rotation, ii) increase soil organic matter through organic fertilizer application, iii) improve soil structure through reduced compaction through minimal tillage. • Pest management: i) release of helper insects ii) providing habitat and field boundary management for released insects, as well as attracting other predators such as birds and bats, iii) changing planting strategies to better control weeds, iv) the use of different methods for pest control (i.e. one pest per crop, multiple pests per crop, multiple crops per exploitation, and multiple exploitations within the same region).	
15.	Livestock disease management	Livestock diseases contribute to a range of problems in livestock production systems. These include damage to animal welfare, loss of productivity, uncertain food security, loss of income and negative impacts on human health. Livestock disease control can reduce disease by improving animal husbandry practices. These include: controlled breeding, control of entry to farms, and quarantine of sick animals. This is achieved through the development and improvement of antibiotics, vaccines and diagnostics, evaluation of ethnotherapeutic options, and vector control methods. Livestock disease management has two key components: - preventive measures (biosecurity) in susceptible herds. - control measures taken after the onset of infection. The likelihood of contracting this disease depends on the existing agricultural practices (prevention) as well as the level of its prevalence in the populations in the respective region. As the prevalence of a disease in a given area increases, the likelihood of infection increases.	Mongolia
16.	Cultivation of Common Vetch as a green manure as a change in crop rotation. green manure crops	The crop of common vetch (peas) (about 6 t/ha dry weight, containing 4% nitrogen) and root crops (about 4 t/ha dry weight, containing 2% nitrogen) accumulates about 10 tons of organic matter in the soil, which ensures the synthesis of about 2 .5 t / ha of humus containing about 200 kg of nitrogen. This amount of humus is enough to create a positive balance of carbon and nitrogen in the soil for 2 years. The arable layer will become structured, loose, will contribute to the creation of a favorable air-liquid and nutrient regime, and will also increase resistance to drought. This technology contributes to the environmental friendliness of agriculture, creating a positive balance of humus and carbon in the soil, returning about 200 kg of nitrogen to the soil, of which 50% is of symbiotic origin, and reduces the risk of yield reduction due to climate change.	Moldova
17.	Agricultural insurance as a climate change adaptation tool. Index based insurance	Based on the average data for 2010-2014, the gross harvest of vegetables, fruits and grapes was determined, then, through the assessment of insurance risks of these years, the minimum premium for 70% compensation was calculated and the total and per hectare amount of insurance premiums were determined. Taking into account the low level of solvency of farms and the international practice of agricultural insurance, the option of 50% participation of the population is preferable. Preference was given to the most valuable crops, the impact of the risks associated with which is more significant for farmers. The findings show that this insurance option is affordable for farmers and beneficial for insurance companies. Joint project on agricultural insurance, in particular cattle insurance, Farmers pay insurance premiums that vary depending on the type of risk. However, the success of this type of insurance is inconsistent and not always satisfactory. Benefits issued by insurance companies to farmers under "Index Insurance" are based on weather or other indices that greatly affect farm production and farmer income. These indices, obtained from weather stations or satellite imagery, are usually built using remote sensing and GIS techniques. Thus, index insurance is a type of insurance that focuses on only one climate risk factor, which is especially common in the region. Premiums paid by farmers are less expensive, while insurance company payments are more efficient.	Armenia, Moldova, Lebanon

#	Technology	Short description	Remarks
18.	Pasture management improvement	Degraded pastures have the potential to be restored through rotational grazing. This requires a package of investments in: (i) integrated pasture management (including capacity building); (ii) infrastructure rehabilitation and maintenance; (iii) pasture vegetation; and (iv) livestock breeding and health.	Prioritised as # 1 by FAO / EBRD project
19.	Improved manure management	Requires practices such as frequent removal of manure from livestock buildings, reduced storage times, dedicated storage infrastructure and adequate composting practices. Compost production is mainly practiced in the south of the Kyrgyz Republic among small farmers, but only a few farmers produce it for their own fields and for sale.	Prioritised as # 2 by FAO / EBRD project
20.	Drip irrigation	Provides water to each plant in small and frequent quantities, allowing for more efficient use of water if adequate water management systems are in place if adequate water management systems are in place. In the Kyrgyz Republic, the use of drip irrigation is steadily growing in all oblasts (except Talas oblast). Only highly profitable crops are financially viable for the application of drip irrigation technology in the country.	Prioritised as # 3 by FAO / EBRD project
21.	Improved greenhouses	The analysis considers existing greenhouses that operate six months of the year. Upgrading a greenhouse means investing in an energy-efficient heater and thermal enclosure. Promotion of improved greenhouses is possible in all regions of the Kyrgyz Republic, especially in the southern part of the country, where more than 80 percent of greenhouses operate.	Prioritised as # 4 by FAO / EBRD project
22.	Conservation agriculture (No till farming)	A farming system characterized by: (i) minimal mechanical disturbance of the soil (no-till); (ii) permanent organic soil cover; and (iii) crop rotation. Conservation agriculture can increase crop yields/productivity and reduce production costs such as fuel, labour costs, machinery maintenance costs, herbicides and pesticides in the long term. In the Kyrgyz Republic, only a few farmers use conservation agriculture through non-mouldboard technology (direct seeding) and crop rotation. They are mainly used on large farms in the north of the country (Chui region). Permanent organic soil cover is not applied as plant residues are used for grazing or removed from fields.	Prioritised as # 5 by FAO / EBRD project
23.	Biogas / Biofertilizers	In the Kyrgyz Republic, relatively small biogas plants (average 50 m3 reactors) have been commissioned that produce biogas and fermentable livestock manure at the farm level. The biogas is used for heating and cooking, while the fermented manure produced is used in the farmers' own fields as fertilizer.	Prioritised as # 6 by FAO / EBRD project
24.	Field Machinery	Eighty-seven percent of the current fleet is old (over 20 years old) and the country is experiencing a shortage of tractors and combines. Investing in new tractors and combines, with regular and proper maintenance, combined with driver training to improve machine control, will save on fuel consumption and maintenance costs, as well as food wastage.	Prioritised as # 7
25.	Feeding stations |/ sites.	The facilities are used for intensive livestock and finished livestock - a balanced and nutritious diet is provided to produce beef of consistent quality and quantity. In the Kyrgyz Republic, livestock management is largely based on pasture grazing, and old and inefficient methods of fattening (especially during the cold season) are common throughout the country. Only a few large farms (100-1,000 heads of cattle), operating almost all year round in the Chui region, effectively fatten cattle.	Prioritised as # 8 by FAO / EBRD project
26.	Biogas for heating and cooking	Biogas is a type of biofuel that is naturally produced from the decomposition of organic waste. In the Kyrgyz Republic, relatively small biogas plants (average 50 m3 reactors) have been commissioned that produce biogas and fermentable livestock manure at the farm level. Biogas is used for heating and cooking. There are no biogas plants generating electricity from biogas in the Kyrgyz Republic.	Prioritised as # 9 by FAO / EBRD project
27.	Steam boilers	This technology is targeted at energy efficient boilers (including economizer suite) that use natural gas to produce steam and require training to operate them correctly. In the agri-food industry, steam is used for a wide variety of purposes, of which the most important are heating, drying, and distillation.	Prioritised as # 10 by FAO / EBRD project
28.	Solar driven water pumps	Solar water pumps can be used as an alternative to mains powered water pumps in irrigated areas. Wind pumps (mechanical pumping of water without power generation) can be used in irrigated areas, replacing existing pumps powered by electricity.	Prioritised as # 11 by FAO / EBRD project
29.	Wind water pumps	Wind pumps are practically not used in the Kyrgyz Republic (only one wind pump is installed in the Issyk-Kul region) in accordance with the technically appropriate wind power.	Prioritised as # 12. by FAO / EBRD project

#	Technology	Short description	Remarks
30.	Sustainable Management and Conservation of Walnut Fruit Forest Genetic Resources	In the mountains of the Western Tien Shan (southern Kyrgyzstan) there are the largest in the world, in terms of area and diversity of trees and shrubs, walnut-fruit forests. Walnut, pistachio, almond, apple, pear, plum, hawthorn, grapes, sea buckthorn, currant, barberry and other fruit and forest species grow in the forests. In terms of the diversity of the species composition of fruit plants, the Western Tien Shan has much in common with other mountainous regions of Central Asia, which is considered the centre of origin and repository of genetic resources for a large number of currently cultivated fruit plants. Many ancient local varieties of crops such as walnut, apple, apricot, plum, grape, pomegranate, almond, grown by the population in mountainous areas, have a surprising resemblance to their wild relatives from mountain forests.	Proposed by the Kyrgyz Association of Land Users and Land Users
31.	Production facility for the equipment for the extruded feed for livestock	Creation of a workshop for the assembly and maintenance of equipment for the production of extruded feed for livestock: cattle (milk cows), sheep and goats, horses, etc. Kyrgyzstan is a mountainous agrarian republic. Agriculture in Kyrgyzstan is one of the leading sectors of the economy. In the total volume of the country's gross domestic product, the share of agriculture is a significant part of 24%. Animal husbandry is a traditional and one of the most important branches of agriculture in Kyrgyzstan, in which almost the entire rural population of the country is employed to one degree or another. The level of productivity of farm animals in Kyrgyzstan is low. The main factors of such low productivity of animals are the extensive form of the industry, the lack of good feeding and maintenance. Solution: Increasing the productivity of farm animals through complete feeding, i.e. fattening of animals with extruded granulated feed. Regardless of the type of feedlot (indoor, under a canopy, open), the production of extruded feed in the required quantities is possible for both small and large livestock, for this, you need equipment with a certain production capacity. For each type of animal and for each sex and age group, individual rations and feeding methods with full-ration extruded compound feed are compiled.	Proposed by the Department of Mechanization of the Ministry of Agriculture
32.	Agrochemical certification of land plots	30 years have passed since the last agrochemical examination of the fields, and in order for the Law “On the Protection of Soil Fertility of Agricultural Lands” to work in full measure, there is now a need for agrochemical examinations of soils, which correspond to the duties of land owners for the protection, rational use and increase of fertility agricultural lands. Without the availability of data from an agrochemical land survey, as well as without the availability of indicators of the state of fertility of agricultural land, documents and information on the calculation of the need for crops in nutrients, To implement the plan of Agrochemical certification of land shares of peasant (farm) farms, it is first necessary to modernize and re-equip existing soil-agrochemical stations in the cities of Bishkek and Osh region with modern instruments and equipment and, if possible, additionally open soil laboratories in the regions. Within 5-7 years, conduct agrochemical surveys of all arable lands, fallows and perennial plantations of the republic in the context of land shares, regardless of the form of ownership, with the issuance of agrochemical passports at the expense of the republican budget.	Proposed by the Republican Soils Agrochemical Station
33.	Land use maps digitalization	The use of digital technologies in agriculture will contribute to the formation of sound and consistent with modern trends in the development of the economy, the directions of state and / or municipal policy for managing real estate (including land resources) by more effective and objective methods. This is due to the fact that public authorities and local governments should use modern IT technologies in their activities, which will give farmers the opportunity to collect, process, and analyze large amounts of various data. In addition, agricultural producers will be able to ensure a sufficient level of information security, and state authorities and local governments optimize the process of making managerial decisions regarding the land and resource potential of the agro-industrial complex. All of the above confirms the relevance of this issue.	Proposed by the Land Resource
34.	Intensive horticulture	The main task facing the horticulture of Kyrgyzstan at the present stage of its development is to improve the quality of fruits, precocity and productivity of plantings while reducing costs per unit of output. For the development of domestic horticulture, first of all, it is necessary to intensify the transition of specialized horticultural farms to high-intensity types of gardens, which are distinguished by a rapid return on investment in their creation. The leading role in improving the economic efficiency of horticulture belongs to intensive technologies, which, based on the maximum mechanization of production processes, are designed to ensure the most complete realization of the high productivity potential of modern intensive gardens without reducing their environmental sustainability in specific natural and climatic conditions of their growth.	Proposed by the Crop Farming Development Department of the Ministry of Agriculture

#	Technology	Short description	Remarks
		Success in this business will be achieved mainly due to the ever wider mastering of progressive technologies for their creation and cultivation. The main methods for increasing the productivity of plantations and the quality of fruits in intensive orchards are pruning, irrigation system, mineral nutrition system, tillage, protection system, harvesting, storage, commodity processing. Ensuring the quality of fruits during production, harvesting, storage and bringing to the consumer is the basis for the competitiveness of products, their prices and the effectiveness of the final result.	
35.	Organic Agriculture	Organic agriculture is based on the concept of sustainable development, which is built into the existing ecosystem, does not disturb its harmonious functioning, preserves nature and provides the population with quality food. Organic farming is carried out on the basis of standards IFOAM (IFOAM), land monitoring, as well as control of MPC of harmful substances in products. Compliance with regulations and strict control occurs at all stages of the production process. Organic agriculture products are grown without the use of agrochemicals, pesticides, mineral fertilizers, genetically modified organisms, antibiotics, growth stimulants. These substances pose a danger to human health and threaten the environment. Organic food products are processed by biological, mechanical and physical methods in a way that maintains the quality of each ingredient. Organic products are protected from pests and diseases by good production practices that include proper cleaning and hygiene without the use of chemical treatments or irradiation. Such products are processed without the use of gases, synthetic waxes, chemical additives to improve taste or extend shelf life. Eco-friendly packaging has a minimal negative impact on the environment. In organic agricultural production, the provision of cultivated plants with organic nutrition elements, pest and weed control is coming to the fore, biological methods of plant protection using crop rotations, organic fertilizers (manure, composts, crop residues, green manure, etc.) and various processing methods are more actively used. soil.	Proposed by the Crop Farming Development Department of the Ministry of Agriculture
36.	Yield harvest storage technologies	Post-harvest practices have been there for decades, ranging from the traditional storage structures such granaries to modern ones such as silos. With changing climate and times, it is also important to change the storage structures to suit the current climatic conditions. After harvest, the keeping quality of any agricultural produce depends on the post-harvest technology undertaken. For grains, they should be well thrashed, if it is maize, it should be well shelled. The grains should then be dried to the required moisture content before being kept. After drying, put your grains in good storage bags, they should not be airtight, this will prevent rotting of the grains. Arrange your bags in your store in a good manner. You can either let the bags lie against each other horizontally, or let the bags in a vertical position. Ensure there is a wooden stand at the floor of the store, do not put bags on bare floor to prevent rotting, or even water entering the bags. Treat your grain with storage pesticides to prevent attack by rodents or postharvest pests such as weevils. With good storage methods, even if you do not get market for your grains, they can last longer until there is market. For perishable crops such as vegetables, the farmer can keep them in Refrigerators or coolants, even though not all farmers can afford these modern structures. With absences of these structures however, the farmer can for example keep his/her tomatoes in open air so as not to expose them to conditions that could lead to rotting.	Proposed by the Crop Farming Development Department of the Ministry of Agriculture

On the first meeting of SWG it was decided that the above list is too exhaustive and a Long List of Technology options to elaborate TFS for each should be compiled for further debate. After additional online consultations with the specialists and other stakeholders the Long List of Technology Options was debated and approved by the SWG. (See. Tab 3.9).

Table 3.9. The Final Long List of Technology Options for MCA analysis

#	Technology	Who proposed
1.	Drip irrigation	Department of Mechanization and Innovative Technologies of the Ministry of Agriculture
2.	Sprinkler irrigation	Department of Mechanization of the Ministry of Agriculture
3.	Production facility for the equipment for the extruded feed for livestock	Department of Mechanization of the Ministry of Agriculture
4.	Agroforestry	Kyrgyz Association of Land Users and Land Users
5.	Sustainable use and conservation of walnut fruit forest genetic resources	Kyrgyz Association of Land Users and Land Users
6.	Organic Farming	Crop Farming Development Department of the Ministry of Agriculture
7.	No-till soil preparation	Crop Farming Development Department of the Ministry of Agriculture
8.	Biogas for gas and fertilizers	LLC Fluid
9.	Sustainable pasture management in the face of climate change	National Pasture User Association
10.	Intensive orchards with drip-fertigation system	Crop Farming Development Department of the Ministry of Agriculture
11.	Solar water pumps	MNRETS
12.	Agrochemical certification of land plots	Republican Soils Agrochemical Station of the Ministry of Agriculture
13.	Digitization of land use maps	Kyrgyz Land Design and Inventory Institute Use of the Ministry of Agriculture

3.5 Criteria and process of technology prioritisation

3.5.1 Criteria and their weights for technology prioritization

Technologies were prioritised using Multi-Criteria Analysis (MCA) to assess their importance for adaptation to climate change impacts and their relevance in the national context. MCA facilitates the participation of stakeholders and hence allows normative judgments, while incorporating technical expertise in the adaptation technology assessment. Based on the assessment, adaptation technologies are prioritized to indicate which technologies should be implemented first. MCA is useful when comparing multiple options across a multiple set of criteria. A prioritization exercise could be done comparing multiple technologies to solve a concrete adaptation problem. MCA can also be used to prioritize technologies applied to solve different problems, which ideally should work towards the vulnerability reduction.

When assessing adaptation technologies using MCA, it usually involves combinations of some criteria which are quantified in monetary terms, and others for which monetary valuations do not exist. It also allows for a mix of quantitative and qualitative criteria, with the result that the quality, form and format of

information may even differ within the same assessment of technologies. Wherever it is possible to quantify costs and benefits in monetary terms, then this data should be included in the MCA.

Multi criteria analysis (MCA) provides a structured framework for comparing a number of adaptation technologies across multiple criteria. A major benefit of using MCA for prioritizing adaptation technologies is the ability to include the preferences of stakeholders involved in the process, emphasizing the importance of having appropriate representation of stakeholders during the prioritization process.[109]

In order to compare different technology options and to identify what makes one technology better or more appropriate than another and more worthy of implementation, the criteria used in evaluating each technology option were defined. The final selection of criteria depends on the national climate change adaptation context and priorities.

After consultations with national consultants team and project implementation group, as well as with SWG six different categories for criteria were identified including: the Cost of deployment and multiple benefits: Economic; Social; Environmental; Climatic and Institutional. These different categories include 15 criteria for estimation further potential to the technology deployment and diffusion as well as the general meaning of technology for sustainable development.

Category of Cost criteria include the following three"

- Capital investment is related to the needed finance resources to procure transport and install a technology;
- Operation and technical service costs are linked with the daily and regular expenditures emerging during a technology exploitation for energy, other consumables, if any and for periodical technical services.
- Staff training costs needed for operators of a technology to develop personal capacities with new knowledge and skills.

Category of Economic criteria include the next three criteria:

- Performance improvement compared to existing option, refers to increased productive capacity on a new technology compare with old technology, if any.
- Economic growth criterion shows the estimated contribution of a technology to economic growth multiplied market potential.
- Market potential reflects expected level of possible under certain assumptions application of a technology within the country.

Social criteria group includes the following criteria:

- Jobs criterion reflects number of jobs created after the possible dissemination of a technology in the country.
- Growth in livelihoods income shows the expected amount of additional income generated by direct beneficiaries with the deployment of a technology.
- Gender equality and social inclusion criterion displays the contribution of a technology to any improvement of women and vulnerable groups.

Environmental group of criteria includes two criteria:

- Pollution reduction reflects expected contribution of a technology to the reduction of any type of pollution: air, soil, water, sound, etc.

[109] Sara Trærup and Riyong Kim Bakkegaard. 2015. Determining technologies for climate change adaptation/ UNEP DTU Partnership.

- Biodiversity conservation show the estimated level to which new technology will disturb local biodiversity, including flora and fauna species, as well as local ecosystems.

Climatic criteria include two most relevant for adaptation criteria:

- Increased resilience of an agrifood system shows estimated extend to which a technology contributes to a agrifood production system if disseminated.
- Reduced vulnerability of farmers will show estimated number of farmers who could reduce vulnerability of a farm production.

The selection criteria, their measurement units and weight assigned to each criterion debated and agreed on by SWG is shown in tab. 3.11.

Table 3.10. Climate change adaptation technology assessment criteria, their units of measurement and weight.

Criterion	Name	Unit of measurement	Weight %
1.	Capital investments	US $	14
2.	Operating and technical service costs	US $	6
3.	Staff training costs	US $	2
4.	Performance compared to existing option	+ %	9
5.	Market potential	Very high, high, medium, low, very low	6
6.	Economic growth	%	8
7.	Jobs	Number	9
8.	Gender equality and social inclusion	Very high, high, medium, low, very low	4
9.	Growth in livelihood income	%	6
10.	Pollution reduction (atmosphere, water, soils)	Very high, high, medium, low, very low	4
11.	Biodiversity conservation	Very high, high, medium, low, very low	4
12.	Increasing the sustainability of the food security	Very high, high, medium, low, very low	10
13.	Reducing the vulnerability of the population	Number of persons	15
14.	Complexity of implementation	Very high, high, medium, low, very low	2
15.	Compliance with national strategies	Very high, high, medium, low, very low	1
		Total	100

The comparison, scoring, weighting and priority identification within MCA is done with the application of three matrix tools: Performance Matrix, Scoring Matrix and Decision Matrix. The first matrix is filled in with the actual data from the TFSs. The second one – with the scores and the third one with weighted scores, which serve the basis for decision making on the priority of technologies.

To allow the comparison of different criteria that are assessed using a variety of scales, it is important to arrive at one common scale of measurement, i.e. to normalize the values in the performance matrix. This will result in a scoring matrix, in which the scale is the same for all criteria: 0-100. For each criterion, the most preferred option will have a score of 100, while the least preferred will have the score of 0. The scores for the remaining options will reflect differences in the strength of preference. The values in the performance matrix can be normalized using formula (a) is preferred value is higher, and (b) if preferred value is lower:

(a)

$$Yi = \frac{Xi - Xmin}{X\,max - Xmin} * 100$$

(b)

$$Yi = \frac{Xmax - Xi}{X\,max - Xmin} * 100$$

Here: Yi – score option i ; Xi – performance of option i ; X max and X min - the highest and the lowest performance among all the options.

This calculations were repeated for each criterion of the preselected technologies assessment.

The scoring of the qualitative evaluation indicators was decided as follows: Very high – 100; High – 80; Medium – 60; Low – 40 and Very low – 20.

All the methodology, including selection criteria, their weight and scoring methods and matrixes were presented and agreed upon on the SWG session.

3.5.2 Process of technology prioritization

Technology Fact Sheets (TFSs) for pre-selected technologies were prepared by the adaptation team, as well as by the specialists of the sectoral institutions and shared with the SWG. These TFSs enabled stakeholder groups to proceed with the prioritization exercise.

The technologies were then scored on a scale of 0-100 by SWG. The experts were asked to give a score from 0-100 in TNA Table (0 means least preferable and 100 means best preferable option). The best and least options were identified first and issued in order from 100-0, then scores for other options were given in between these extreme values. Once all the options had been scored within the technology category, the criteria were weighted.

This is needed as scores applied to one criterion are independent of the others. Assessment of weights proposed by the national consultant teams for each criterion was revised and approved by SWG as it provided opportunity to determine relative importance of each criterion.

The MCA matrixes used to prioritise technology options are presented in the tab. 3.11, 3.12, 3.13.

Table 3.11 Performance Matrix for agriculture adaptation technology assessment

Technologies / Criteria	Costs			Benefits													
				Economic			Social			Environmental		Climate		Institutional	
	Capital investments, $/ha	Operating and technical service costs, $/ha	Staff training costs, $	Performance compared to existing option, +%	Market potential	Economic growth, %	Jobs	Gender equality and social inclusion	Growth in livelihood income, %	Pollution reduction (atmosphere, water, soils)	Biodiversity conservation	Increasing the sustainability of food security	Reducing vulnerabilit, people	Complexity of implementation	Compliance with national development priorities
Organic farming	270	62	18000	15	very high	20	16000	very high	30	very high	very high	medium	48000	medium	very high
No-tillage farming	477	125	20000	134	low	30	4000	very high	50	medium	medium	medium	120000	very high	very low
Drip irrigation	1300	300	22000	150	medium	50	945	low	100	medium	low	very high	40000	low	very high
Sprinkler irrigation	2500	100	16000	80	low	25	440	low	50	low	low	medium	48000	high	low
Sustainable pasture management	2,42	0,06	3000	20	very high	50	2150	low	50	high	high	very high	600000	low	very high
Biogas plants for gas and fertiliser, $	29647,1	588,2	0	20	medium	10	450	medium	10	low	medium	medium	3500	low	low
Equipment manufacturing for extruded fodder, $	95000	18000	10000	20	medium	25	120	low	30	very high	very low	medium	30000	high	low
Solar water pumps, $	1294,1	176,5	117,6	100	medium	10	200	low	50	high	medium	medium	6000	medium	low
Intensive gardens with drip-fertigation systems	6444	966	20000	80	high	25	320	high	150	high	high	high	60000	medium	high
Agroforestry	7000	700	10000	80	high	15	4000	high	120	high	very high	medium	120000	medium	low
Sustainable use and conservation of genetic resources	6800	680	10000	20	low	10	1500	medium	10	very high	very high	low	4500	high	medium
Agrochemical certification of agricultural lands	7,35	0,1	58823	0	high	0	12800	medium	0	high	medium	high	384000	very high	very high
Digitalization of land use maps	0,14	0,05	5000	0	medium	0	12800	very low	0	low	medium	medium	384000	very high	high

Table 3.12 Scoring Matrix for agriculture adaptation technology assessment

Scoring Matrix (For each criterion scores should vary from 0 to 100)															
Technologies / Criteria $Yi = \frac{Xi - Xmin}{X\,max - Xmin} * 100$ $Yi = \frac{Xmax - Xi}{X\,max - Xmin} * 100$	Costs			Benefits											
				Economic			Social			Environmental		Climate		Institutional	
	Capital investments, $/ha	Operating and technical service costs, $/ha	Staff training costs, $	Performance compared to existing option, +%	Market potential	Economic growth, %	Jobs	Gender equality and social inclusion	Growth in livelihood income, %	Pollution reduction (atmosphere, water, soils)	Biodiversity conservation	Increasing the sustainability of food security	Reducing vulnerabilit, people	Complexity of implementation	Compliance with national development priorities
Organic farming	96,14	93,59	73,13	10,00	100,00	40,00	100,00	100,00	20,00	100,00	100,00	60,00	7,30	60,00	100,00
No-tillage farming	93,19	87,06	69,55	89,33	60,00	60,00	23,47	20,00	33,33	60,00	60,00	60,00	19,40	20,00	20,00
Drip irrigation	81,43	68,95	65,96	100,00	60,00	100,00	3,99	40,00	66,67	60,00	40,00	100,00	5,96	80,00	100,00
Sprinkler irrigation	64,29	89,65	76,71	53,33	40,00	50,00	0,77	40,00	33,33	40,00	40,00	60,00	7,30	40,00	40,00
Sustainable pasture management	99,97	100,00	100,00	13,33	100,00	100,00	11,67	40,00	33,33	80,00	100,00	100,00	100,00	80,00	20,00
Biogas plants for gas and fertiliser, $	69,74	97,69	100,00	100,00	60,00	0,00	100,00	60,00	0,00	40,00	60,00	60,00	0,00	40,00	40,00
Equipment manufacturing for extruded fodder, $	0,00	0,00	0,00	100,00	60,00	100,00	0,00	40,00	50,00	20,00	20,00	60,00	100,00	80,00	40,00
Solar water pumps, $	100,00	100,00	98,82	0,00	60,00	0,00	24,24	40,00	100,00	80,00	40,00	60,00	9,43	60,00	40,00
Intensive gardens with drip-fertigation systems	7,94	0,00	69,55	53,33	80,00	50,00	0,00	80,00	100,00	80,00	80,00	80,00	9,32	60,00	80,00
Agroforestry	0,00	27,54	87,46	53,33	80,00	30,00	23,47	80,00	80,00	80,00	100,00	60,00	19,40	60,00	40,00
Sustainable use and conservation of genetic resources	2,86	29,61	87,46	13,33	40,00	20,00	7,53	60,00	6,67	100,00	100,00	40,00	0,00	40,00	60,00
Agrochemical certification of agricultural lands	99,90	99,99	0,00	0,00	80,00	0,00	79,59	20,00	0,00	80,00	60,00	80,00	63,73	20,00	100,00
Digitalization of land use maps	100,00	100,00	91,52	0,00	60,00	0,00	79,59	20,00	0,00	40,00	60,00	60,00	63,73	20,00	80,00
Criterion waights	14	6	2	9	6	8	9	4	6	4	4	10	15	2	1

Table 3.13. Decision Matrix: Weight Scores for agriculture adaptation technology assessment

Decision Matrix: Weighted Scores																	
Technologies / Criteria	Costs			Benefits												Total	Ranking
				Economic			Social			Environmental		Climate		Institutional			
	Capital investments, $/ha	Operating and technical service costs, $/ha	Staff training costs, $	Performance compared to existing option, +%	Market potential	Economic growth, %	Jobs	Gender equality and social inclusion	Growth in livelihood income, %	Pollution reduction (atmosphere, water, soils)	Biodiversity conservation	Increasing the sustainability of food security	Reducing vulnerabilit, people	Complexity of implementation	Compliance with national development priorities		
Organic farming	1346,03	561,52	146,26	90,00	600,00	320,00	900,00	400,00	120,00	400,00	400,00	600,00	109,57	120,00	100,00	6213,38	2
No-tillage farming	1304,63	522,39	139,09	804,00	360,00	480,00	211,22	80,00	200,00	240,00	240,00	600,00	290,93	40,00	20,00	5532,26	5
Drip irrigation	1140,02	413,69	131,93	900,00	360,00	800,00	35,87	160,00	400,00	240,00	160,00	1000,00	89,42	160,00	100,00	6090,93	3
Sprinkler irrigation	900,02	537,92	153,42	480,00	240,00	400,00	6,89	160,00	200,00	160,00	160,00	600,00	109,57	80,00	40,00	4227,82	12
Sustainable pasture management	1399,54	599,99	200,00	120,00	600,00	800,00	105,04	160,00	200,00	320,00	400,00	1000,00	1500,00	160,00	20,00	7584,58	1
Biogas plants for gas and fertiliser, $	976,40	586,14	200,00	900,00	360,00	0,00	900,00	240,00	0,00	160,00	240,00	600,00	0,00	80,00	40,00	5282,54	7
Equipment manufacturing for extruded fodder, $	0,00	0,00	0,00	900,00	360,00	800,00	0,00	160,00	300,00	80,00	80,00	600,00	1500,00	160,00	40,00	4980,00	8
Solar water pumps, $	1400,00	600,00	197,65	0,00	360,00	0,00	218,18	160,00	600,00	320,00	160,00	600,00	141,51	120,00	40,00	4917,34	9
Intensive gardens with drip-fertigation systems	111,20	0,00	139,09	480,00	480,00	400,00	0,00	320,00	600,00	320,00	320,00	800,00	139,80	120,00	80,00	4310,09	11
Agroforestry	0,00	165,23	174,92	480,00	480,00	240,00	211,22	320,00	480,00	320,00	400,00	600,00	290,93	120,00	40,00	4322,30	10
Sustainable use and conservation of genetic resources	40,00	177,65	174,92	120,00	240,00	160,00	67,73	240,00	40,00	400,00	400,00	400,00	0,00	80,00	60,00	2600,30	13
Agrochemical certification of agricultural lands	1398,56	599,97	0,00	0,00	480,00	0,00	716,33	80,00	0,00	320,00	240,00	800,00	955,92	40,00	100,00	5730,77	4
Digitalization of land use maps	1400,00	600,00	183,04	0,00	360,00	0,00	716,33	80,00	0,00	160,00	240,00	600,00	955,92	40,00	80,00	5415,29	6
Criterion waights	14	6	2	9	6	8	9	4	6	4	4	10	15	2	1		

3.6 Results of technology prioritisation

As the result of technology MCA assessment by the stakeholders of the SWG, the analysed technology options have been ranked in the following way:

Table 3.14. Technologies scores and ranking

Technologies	Scores	Rank
Sustainable pasture management	**7584,58**	**1**
Organic farming	**6213,38**	**2**
Drip irrigation	**6090,93**	**3**
Agrochemical certification of agricultural lands	5730,77	4
No-tillage farming	5525,17	5
Digitalization of land use maps	5415,25	6
Biogas plants for gas and fertiliser, $	5282,54	7
Equipment manufacturing for extruded fodder, $	4980,00	8
Solar water pumps, $	4917,34	9
Agroforestry	4322,30	10
Intensive gardens with drip - fertigation systems	4310,09	11
Sprinkler irrigation	4227,82	12
Sustainable use and conservation of genetic resources	2600,30	13

The first three were identified as prioritized ones and will be analysed further in order to identify barriers that will need to be overcome to make these marketable.

Priority 1 technology: Sustainable Pasture Management (SPM)

Adaptation needs: The process of pasture degradation aggravated by the intensified by increased temperatures and reduced precipitation, as well as more frequent floods and mudflows challenged both rural livelihoods of rural communities, and food security since the majority of livestock produce in this country is provided by small holding farmers.

How this measure contributes to adaptation: Sustainable pasture management, including a set of already developed techniques including grazing planning, monitoring by the community-based Pasture Committees, has already been acknowledged to be an effective adaptation measure that needs to be diffused in Kyrgyzstan. Among other adaptive measures it includes grassland reseeding, watering, and tree stripes planting for summer shade and additional herder income.

Background: Today, a large part of Kyrgyzstan's land area serves as pasture for its 1.7 million cattle and 6.3 million sheep and goats. Many pastures are subject to degradation caused by overgrazing and exacerbated by climate change. The estimates suggest that 94% of pastures (in total 69,971 km^2) have been degraded. This degradation is estimated at a significant cost of around $600 million, or 16 per cent of the country's Gross Domestic Product (GDP). Thus, few efforts to promote Sustainable Pasture Management approaches have been implemented to develop adequate capacities at community level.

Benefits:

Economic. More effective sustainable pasture management entails more effective grassland regeneration and increased productivity growth. It should significantly reduce degradation processes, thus sustaining herder s livelihoods, too.

Social: This technology will foster livestock breeding being the main occupation of the rural communities, thus providing for employment and income growth, as well as rural localities food security and nutrition.

Environmental: Being one of the ecosystem-based adaptation methods, SPM, besides reversing processes of land degradation, is a well-known measure to support biodiversity conservation including the wildlife of mountainous areas of Kyrgyzstan. Additionally, SPM will also contribute to mitigation of climate change providing for carbon sequestration and stock in grasslands soils.

Priority 2 technology: Organic Farming

Adaptation needs: Growing competition on the food markets and huge imports of gene-modified products from China, put improving local agriculture produce quality on the agenda. At the same time, poor access to and high prices of synthetic fertilisers force local farmers to switch to organic fertiliser options like composted manure. The initiative is supported by the Government and a strategy for organic agriculture development has been endorsed promoting clean healthy food production.

How this measure contributes to adaptation: Switching to organic farming will improve food security and nutrition. It will also increase the income of family farms.

Background: Organic agriculture is based on the concept of sustainable development, which is built into the existing ecosystem, does not disturb its harmonious functioning, preserves nature and provides the population with quality food. Organic agricultural products are grown without the use of agrochemicals, pesticides, mineral fertilizers, genetically modified organisms, antibiotics, and growth stimulants. These substances pose a danger to human health and threaten the environment. Organic food products are processed by biological, mechanical and physical methods in a way that maintains the quality of each ingredient. Organic products are protected from pests and diseases by good production practices that include proper cleaning and hygiene without the use of chemical treatments or irradiation.

Benefits:

Economic. More healthy agricultural produce has already been validated by the local and international consumers increasing farmers' incomes and Kyrgyzstan exports.

Social: Refusal from chemicals increase manual labour, thus providing agricultural jobs for rural residents. Growing urban demand and higher prices contribute to the farmers livelihood income increase and household wealth.

Environmental: Reduction of chemicals use will no doubt reduce significantly soils and water pollution, while promoting greatly direct and indirect N_2O emission from soils.

Priority 3 technology: Drip irrigation

Adaptation needs: Inefficient traditional gravity irrigation technology in the context of decreasing river runoff and changing precipitation regimes also within the context of degrading irrigation infrastructure urgently require radical shift to more water efficient technologies, drip irrigation being promoted in recent years, providing good examples.

How this measure contributes to adaptation: Using two-three times less water this technology can provide to adapt significantly to reduce precipitation and growing temperatures reducing farms vulnerabilities while strengthening farmers' adaptive capacities to produce crops.

Background: In the 1990s, with the help of drip irrigation, about 800 hectares of perennial fruit plantations were already irrigated. However, further promotion of drip irrigation systems in the Kyrgyz Republic stopped shortly after. It was only after 2008 that various international projects began to finance the

implementation and dissemination of water-saving technologies and drip technology irrigation in the Kyrgyz Republic. Today it is a popular option for perennials, fruit orchards and berries plantations. When furrow irrigation is applied, the irrigation rate for 1 hectare of the garden is on average 600 m^3 of water, whereas when irrigating 1 hectare of a garden using drip irrigation (if, the planting pattern is 5mx5m, the number of plantations per 1 ha is 400, each plantation is supplied 50 l of water) will require 20 m^3 of water, which is 30 times less than with furrow irrigation. The system also provides for the rational use of fertilisers for each plant.

Benefits:

Economic. Less water means less payment for irrigation water use, while increasing agricultural produce. Thus, increased national agricultural crop farming output.

Social: Application of drip irrigation has already provided for new jobs for designing, equipment sales, installation, and servicing of the drip systems. Upscaling of the technology will create additional new jobs in all the regions of the country. Increased income from more agricultural produce will contribute to rural households' wellbeing, also reducing rural poverty.

Environmental: Use of this technology will result in the reduction of water intake from natural objects, and the reduction of water loss. It will also lead to decreased water erosion of soils, reducing soil pollution with fertilizers by rationing it for each plant. There will be no threats to local biodiversity.

Upon the decisions of the SWG, five other adaptation technology options will remain 'in reserve' and the further analysis will be undertaken if a corresponding need arises. These include the following:

Reserve technology 4: Agrochemical certification of agricultural lands

Adaptation needs: As shown in the section on key vulnerabilities of agriculture soils, degradation is an ongoing process which is exacerbated by increased impacts of the climate factors: higher temperatures and intensive spring rains and floods. The organic matter decrease has resulted in low yields of the main crops wheat, barley, maize and other challenging food security of the country. Soil-fertility monitoring provides adequate informed crop farming management decision on the time and norm for farmland soils fertilising, thus assuring high crop yields and contributing to food security and safe nutrition.

How this measure contributes to adaptation: Provision of soil quality certificates to farmers will provide not only the data on availability and levels of the main macroelements, but also on humus contents. It will inform farmers of agri-technical measures to maintain and improve soil fertility, while assuring healthy crops and safe food. Additionally, this technology implementation contributes to the digital inventory of the arable and rain-fed land plots, which will contribute to the better planning of climate-resilient crop localization, as well as to Sustainable Land Management in the context of climate change.

Background: About 30 years have passed since the last agrochemical examination of the fields, and to implement the Law "On the Protection of Soil Fertility of Agricultural Lands", there is now a need for agrochemical examinations of soils, which is also one of the land owners' duties according to the Land Code. Without the availability of data from an agrochemical land survey and indicators of the soils fertility, it is not possible to calculate the crops' need for nutrients. To implement agrochemical certification of the smallholding farmers' land parcels, it is necessary to modernize existing soil-agrochemical stations in the cities of Bishkek and Osh region, providing modern hardware, tools and software, and to open additional soil laboratories in other regions. It is planned also to provide the legal norms for mandatory update of the

agrochemical certificate every five years, also as an obligatory supporting document for the agriculture land sales.

Benefits:

Economic. It will provide farmers with the precise information on the needed inputs and expenses, thus increasing efficiency of the business. Increased crop yields will contribute the sector's economic outputs and contribution to GDP in general. Optimized expenses on agricultural inputs will contribute to better farmers' livelihoods and wellbeing.

Social. New laboratories provide for new jobs and require increase in qualification of new staff. Current practice shows that the majority of the labs staff are women thus it will also contribute to gender equality in employment.

Environmental. Regulation of chemicals rational use will evidently reduce chemical pollution of soil and water. Indirectly, it can influence adequate measures to be taken to increase organic matter, thus, providing for soil carbon sequestration and stock.

Reserve technology 5: No-tillage farming

Adaptation needs: Soil erosion and reduced fertility caused among others by the traditional technologies of soil ploughing is one of the main risks and observed climate change impacts that need to be addressed by adaptation measures. Deployment of this new soil preparation technology is perceived to improve soil fertility while providing for increased crop yields.

How this measure contributes to adaptation: Unpredictable rainfall patterns and rising mean temperatures can affect soil moisture, damage crop yields and lead to crop failures. No-till methods reduce the risk of drought by reducing soil erosion, increasing moisture retention and minimizing soil compaction. These factors combine to increase resilience to climate change impacts such as drought and floods. In addition, the recycling of nutrients in the soil is improved, which helps to control crop pests and diseases.

Background: Erosion control tillage refers to a series of methods and techniques for rooting crops on the remnants of a previous crop that are intentionally left on the soil surface. Conservation tillage typically leaves approximately one-third of crop residue on the soil surface. This slows down the movement of water, which reduces soil erosion. Erosion control tillage is useful for a number of crops, such as cereals, vegetables, root crops, sugarcane, cassava, fruits and grapes. The most common erosion control tillage methods are no-tillage, ridge tillage and mulch tillage. No-tillage is a way of growing crops without mixing the soil. In this method, the remains of last year's crop are left unmixed and planted directly into the remains in the soil prepared for sowing. No-tillage requires special seeding equipment to sow seeds into unmixed crop residues and soil. No-till farming is fundamentally changing the composition of weeds.

Benefits:

Economic. It will reduce expenses on agricultural machinery engagement, thus contributing to better farmers' livelihoods and household wellbeing. Increased crops yields will contribute the sector economic outputs and contribution to GDP in general.

Social. It is generally perceived that no-till technology will contribute to the new consultancy and machinery service jobs.

Environmental. No-tillage reduces soil erosion to just 5.6 tons of soil per hectare (t/ha) per year. With conventional ploughing the rainfall runoff is typically around 138 mm per month. No-tillage practices reduce runoff to approximately 42 mm. Runoff is reduced because crop residues on the soil surface slow

down the movement of water, giving the water more time to be absorbed by the soil and stored for plant use or released more slowly over time, thus, also providing for soils carbon sequestration and stock.

Reserve technology 6: Digitalization of land use maps

Adaptation needs: The use of digital technologies in agriculture will contribute to the formation of sound and consistent with modern state and / or municipal policy for managing real estate (including land resources) by more effective and objective methods in the context of climate change. This is due to the fact that public authorities and local governments already use modern IT technologies in their activities, which gives farmers the opportunity to collect, process, and analyse large amounts of various data. In addition, agricultural producers are able to ensure a sufficient level of information security, and state authorities and local governments optimize the process of making managerial decisions regarding the land resources potential of the agro-industrial complex. All of the above confirms the relevance of this technology. Sustainable Land Management today is hardly possible without modern land governance tools, remote sensing, big data sets, digital maps are among those.

How this measure contributes to adaptation: More informed decisions on the land use policy and action in the context of climate change provide for improved response to the climate change impacts. Modern digital land-use maps produced with corresponding GIS technologies provide a wide set of visual management tools, as well as serving as the background layer for modelling the future climate change impacts on land resources. As a result of digitalization, it is possible to improve the relationship between individual economic entities and reduce transaction costs. This is due to the fact that the functioning of digital platforms will allow optimizing logistics, eliminating unnecessary intermediaries from the distribution chain, and delivering manufactured products to the end consumer faster. Automation of decision-making processes in terms of land management of economic entities, as well as the introduction of intelligent systems for managing the resource potential of agriculture, lead to an increase in the competitiveness of domestic agricultural producers both in the domestic and foreign markets. The use of digital products for agri-technical processes by farmers can reduce the cost of food in certain sub-sectors by up to 15%.

Background: The existing experience in the implementation of digital technologies in various industries and directions shows that the widespread introduction of IT technologies in the management of the land and resource potential of agriculture is possible only if there is access to a sufficient amount of reliable and objective data on all land-use objects and on all types of resources. The latter requires a full land inventory data and constant monitoring of the natural resource potential and the digital transformation of the old paper land-use maps. Therefore, it is of ultimate importance to digitalise land-use maps which serve the basis for existing land titles.

Benefits:
Economic. The digitalization of land management is aimed at obtaining various kinds of effects (production, social, financial, etc.) that can ensure more rational and efficient agricultural land use and, thus, achieve higher competitiveness for our economic entities. The purpose of creating digital land-use maps (agricultural land and lands) is to aggregate heterogeneous field information in a single file containing spatial reference and field boundary information. The high-precision basis obtained by analysing aerospace images allows you to correctly design routes for agricultural equipment and work in programs using GLONAS technologies.

Social. This technology can evidently increase social sustainability and multi-stakeholder collaboration. The creation of digital systems expands the opportunities for women to participate in agricultural production.

Environmental. The use of modern technologies in natural-resource management provides for multiple benefits in sustainable use and conservation of natural-resource and ecosystem sustainability.

Reserve technology 7: Biogas plants for gas and fertilizer

Adaptation needs: The aim to increase organic crop farming area as stated in the national development priorities will require considerable amounts of organic fertilisers. The Biogas Equipment on livestock manure producing gas for cooking and heating has been already tested in this country though not in a very hi-tech form. It has already provided evidence on the effective application of organic residues from the reactors as fertilizers.

How this measure contributes to adaptation: Production of the organic fertilisers in Biogas Units and its wide use on the farmers' fields will help to stop soil degradation and increase its fertility, and consequently crop yields.

Background: Biogas plant **i**s a hermetically sealed container in which anaerobic fermentation of the organic mass of waste (manure), food waste, sewage, etc. takes place at a certain temperature. with the production of biogas. The principle of operation of all biogas plants is the same: after collecting and preparing raw materials, which consists in bringing it to the desired moisture content in a special container, it is fed into the reactor, where conditions are created to optimize the processing of raw materials. After processing organic waste, we get two products - biofertilizer and biogas. Biofertilizer contains a significant amount of nutrients and can be applied directly to the soil or used as a feed additive that is safe for animals. The biogas produced can be used in all gas appliances.

Benefits:

Economic. A biogas plant with a reactor volume of 25 m^3 is capable of processing up to 1.2 tons of manure per day in a mesophilic mode and producing about 30 m^3 of biogas and a little less than 1 ton of liquid environmentally friendly biofertilizer per day, the application rate of which is from 5 to 7 tons per hectare. The resulting 30 m^3 of biogas is sufficient for heating 100 m^2 of living space, cooking and providing hot water to a family of 5-6 people. Larger power plants can be used to generate electricity. Increasing yields through the application of biofertilizers to the soil will help increase farmers' incomes

Social. The technology does not limit women's participation. On the contrary, it helps to increase the productivity of crop production, which is predominantly done by women.

Environmental. This is a complex technology, which is also among the technological mitigation options, reducing methane (CH_4) and nitrous oxide (N_2O) emissions from entering fermentation and manure management.

The SWG debated all these technological option assessment results and the following seven technology options were identified as the priority ones for the Kyrgyz Republic distributed for the three agriculture subsectors (see tab. 3.15).

Table 3.15. Prioritized technologies for the Agriculture Sector adaptation.

#	Technology
1	Sustainable pasture management
2	Organic farming
3	Drip irrigation

Chapter 4 Technology prioritisation for the Water Resources Sector

As with the agriculture sector, the prioritization of the climate change adaptation technologies for the Water Resources Sector was determined by the set of climate change impacts on the sectors as defined in NCs and NDC, as well as indicative adaptation measures listed there.

Thus, NDC defines the following climate change impacts on agriculture that should be addressed in the near future:

1) Changes in the water content of river basins.
2) Decrease in water supply for the population and economy.
3) Deterioration of the quality of surface and ground waters.

According to NATCOM 3 the key adaptation measures in the water resources sector are as follows:

- Improving the water resource management and the introduction of economic incentives for the water rational use;
- Rehabilitation of the existing infrastructure and the new water facility infrastructure construction;
- Preservation of the upper watershed of rivers - restoration and forest planting, compliance with water protection zones regimes and bands of water bodies;
- Giving the protected areas status to the key runoff formation zones;
- Restoration and maintenance of a monitoring system of climatic parametres;
- Awareness raising on the qualitative and quantitative state of water resources;
- Strengthening the international cooperation on adaptation of the trans boundary water basins;
- Awareness raising on the socio-economic impacts of climate change, including the problem of increasing water deficit.

4.1 Key climate change vulnerabilities in the Water Resources Sector

Within NATCOM 3 preparation process a modelling exercise to assess future impacts and vulnerabilities has been undertaken for each water source.

Glacial water loss

The glaciation modelling was performed separately for each of 6771 glaciers of the Kyrgyz Republic (with an area of 0.1 km^2 and more) with a summation of the results on the selected hydrological basins. 1437 glaciers with an area below 0.1 km^2, for which there are no baseline data (only their total number and total area is known), have not been measured. These small glaciers, almost impossible to be modelled due to a lack of source data, make up 17.51% of the glaciers total number with total area of 0.84% and estimated amount of 0.26%. Their contribution to the river flow is small and, therefore, not considered in the model.[110]

A mathematical model of glacial evolution under the warming climate, developed by PhD V.A. Kuzmichenok[111], helped assess the glacial runoff. It represents the value of the water volume received by the drain in addition to the difference between precipitation and evaporation. The calculations are

[110] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[111] Kuzmichenok V.A. Probabilistic Assessment of Possible Evolution of glaciers and Runoff of Kyrgyzstan under Projected Climate Changes. Materials of Glaciological Studies. Moscow, 2009, vol. 107, 10-24 pp.

performed for all 11 aforementioned hydrological basins. Summarized results of the modelling for the Republic are presented in tab. 4.1.

Table 4.1. Modelled averages of glacial water flow in % of total runoff under the climatic scenarios.[112]

Scenario	RCP 2.6			RCP 6.0			RCP 8.5		
Precipitation	**-5%**	**0**	**5%**	**-5%**	**0**	**5%**	**-5%**	**0**	**5%**
2010	4	3.5	2.9	5.4	4.9	4.4	6.7	6.3	5.8
2020	4.4	3.4	2.4	6.9	6.1	5.1	9.1	8.3	7.5
2030	4.7	3.4	1.9	7.9	6.8	5.7	10.2	9.3	8.4
2040	4.9	3.3	1.4	8.2	7.2	6	10	9.4	8.6
2050	5	3.2	1	8	7.1	6	9	8.6	8.1
2060	5	3.2	0.6	7.3	6.8	5.8	7.7	7.4	7.1
2070	5	3.1	0.4	6.6	6.1	5.5	6.1	6.1	6.1
2080	4.8	3	0.3	5.8	5.5	5	5.1	5	4.8
2090	4.7	2.9	0.2	4.9	4.8	4.5	4.6	4.2	4
2100	4.5	2.8	0.2	4.3	4.1	4.1	4	3.7	3.5

Surface runoff

The surface runoff modelling used the relief digital models and moisture conditions of the country land area (DMR and DMHum respectively) developed by V.A Kuzmichenok. Each of these digital models describes the territory by a set of relevant characteristics in the nodes of a regular (square) grid with a 500 m pitch on the ground. These nodes coincide with a rectangular coordinate grid of a direct equivalent conical projection, the best for the country. Therefore, each node "represents" equal territorial units, covering an area of 0.25 km^2, and the calculations do not require any additional account of geodetic latitude. The land area of the Republic is wholly covered by 770,418 units of these digital models.[113]

The relief digital model contains the following values for each node of the regular grid: height, angle of slope, expositions, orientation index and mean curvature of topographic surface macro slope. The surface orientation indicator refers to the cosine of the angle between the normal to the surface vector and the direction of the sun at noon on the summer solstice. The average surface curvature is understood as the arithmetic average of the reciprocals of the principal radii of curvature. It is obvious that the surface with a positive curvature tends to accumulation (in the broadest sense of the word), and negative - to drift.

The digital model of moisture conditions on the land area provides for each node the following values: average annual temperature, annual amount of precipitation, annual layer of volatility, annual layer evaporation, runoff and moisture.

The estimation of possible changes in the surface runoff on the whole hydrological basin of the country based on glacier fluid loss is shown in Fig. 4.1.

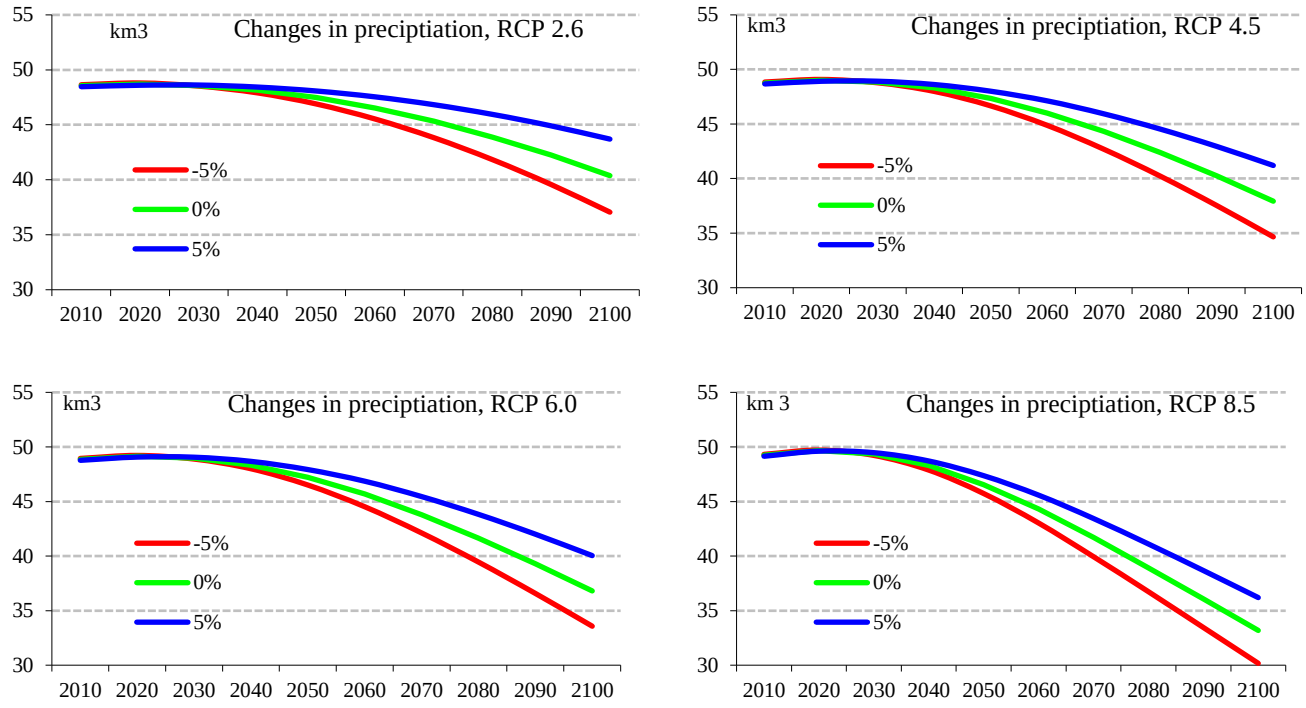
These data indicate a significant reduction in the flow under all possible scenarios and options for precipitation changes. However, the reduction range is very wide. For the worst-case climate change

[112] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[113] Ibid.

scenario (RCP 8.5 scenario and the annual precipitation reduction by 5%) the runoff may reduce by approximately 40%.[114]

Calculations of surface runoff for separate hydrological basins showed a little difference of the changes between the basins, determined by the specific conditions of the runoff formation zone.

Figure 4.1. Change in surface runoff in all basins under the climatic scenarios considering the glacial water flow [115]



As seen in Fig. 4.1 and Tab. 4.1, the surface runoff is mainly determined by the atmospheric temperature and precipitation, whereas the glacier's input to the total flow is less.

Runoff delivery

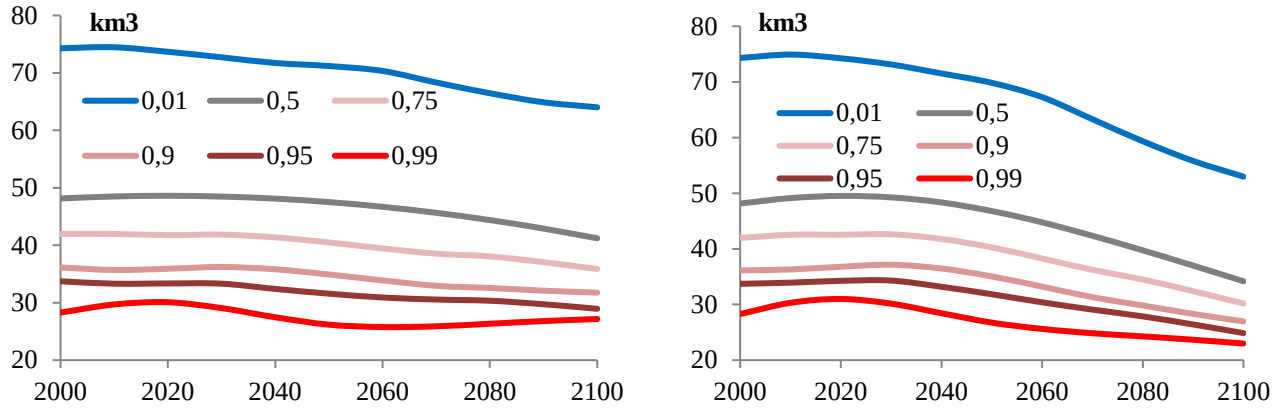
In addition to the surface runoff volume, its delivery was also modelled, which refers to a probability estimate of the minimum flows. The estimates used the statistical simulation method. The estimates of the probability of the climate factors (temperature and ground-level rainfall) distribution were obtained from the available observations. The statistical distribution of the climatic factors was assumed to be similar to the observed distribution, except for the mathematic expectation estimates. The estimates for the mathematic expectations for the climatic factors were used according to the climate scenarios. The modelling was performed separately to assess the glacial water loss and the runoff. Then the obtained results were combined to estimate the runoff accounting the glacial water loss. [116]

[114] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[115] Ibid.
[116] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

The flow provision is required to assess an adequacy of the existing water resources and to determine the water reservoir volume to ensure a continual water supply.

The estimation was made for all options from 0.01 to 0.99 for all water basins. Small values (e.g., 0.01) can be used to assess the floods. Fig. 4.2 shows the estimates for the whole country under two scenarios.

Figure 4.2. Estimation of the surface runoff in the country, including the glacial water loss, under two climatic scenarios, RCP 2.6 (left) and RCP 8.5 (right) [117]



As compared with the known assessments for other countries (e.g., [9]), the received provision ratio from 0.01 to 0.99 ranges about from 3 to 2.5, i.e. much lower.

It is probable that the ratio is relatively small due to a compensatory effect of the glaciers, levelling the extreme values of the simulated runoff. So, in the extremely hot and dry years, when the runoff from rainfall decreases due to lower precipitation and increased evaporation, the glacial water loss increases. The opposite picture is observed in the cool and wet years. The obtained runoff estimates are actually an assessment of the climatic risks for the water resources. [118]

Evolution of in-year distribution of surface runoff under climate change

In-year runoff distribution was determined based on the simulation method. The total runoff is divided into three components of the variables in the year of liquid precipitation, solid precipitation and glaciers ablation. The groundwater feed, with permissible error, is assumed to be constant throughout a year.

To ensure clarity and simplification of the decision, 4 typical hydrologic areas have been selected:

- Area A - the highest mountainous hydrological basin with a large area of glaciation (runoff from melting glaciers exceeds runoff from the seasonal snow cover melting). A proportion of the groundwater supply is about 2% of the maximum runoff rate (e.g., the basins of the Sarydzhaz and Big Naryn Rivers).
- Area B - alpine hydrological basin (the melting glaciers flow is approximately equal to the melting snow drain). A proportion of the groundwater supply is about 5% of the maximum flow rate (e.g., the Naryn River basin).

[117] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[118] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

- Area C - midland hydrological basin with fewer glaciers and maximum precipitation in June (mainly in the eastern part of Kyrgyzstan). The proportion of the groundwater supply is up to 10% of maximum flow rate.
- Area D - midland hydrological basin with fewer glaciers and maximum precipitation in May (mainly the western part of country). A proportion of the groundwater supply is up to 10% of the maximum flow rate.[119]

Climate change was considered for 5 possible change options from 1 (no change) to 5 (maximum change), which refers to the temperature in 2100 according to the RCP 8.5 scenario.

Simulation results for the highland areas showed a slight increase in the maximum discharge in the initial warming period, followed by a decrease in the maximum flow and shift to an earlier date by approximately 50 days (currently falling around the end of July).

For medium-altitude areas in the initial warming period, an increase in discharge does not take place. After the level stabilization, a steady decline in the maximum discharges is observed, which is less expressed as compared to the highlands. For C area a shift of the maximum runoff to the earlier terms makes up about 15 days, and for D area it is even lower.[120]

The Kyrgyz Republic, as a mountainous country, is particularly prone to numerous natural disasters. Of the 70 types of hazardous natural processes and phenomena that are widespread in the world, causing significant damage to the population, economic activity and infrastructure, more than 20 are manifested in the territory of the republic. Of all emergencies, about 70% are occupied by dangerous hydro-meteorological phenomena associated with climatic characteristics.

Natural processes are seasonal. For example, in the winter-spring period, avalanches prevail; mudflows and floods begin in spring; closer to summer, landslides become more active. The intra-annual course, in general, for emergency situations, is largely determined by the precipitation regime. Moreover, to a greater extent it is determined not by a change in the average values, which change relatively slowly, but by a change in the number of extreme values.

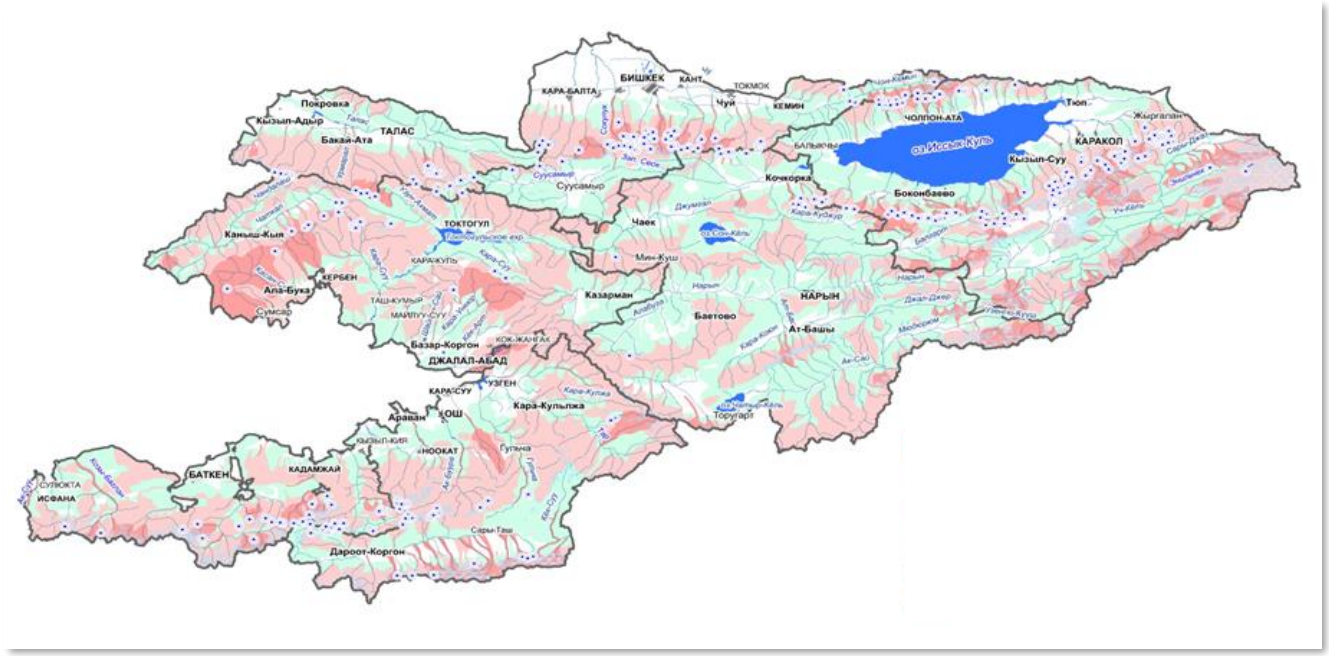
The greatest danger of impact on the economy and population of Kyrgyzstan is represented by dangerous hydrometeorological natural phenomena, out of which the most dangerous are mudflows and floods resulting from melting snow and heavy rains. They cause major economic damage (destruction of sections of roads and railways, bridges and protective dams, irrigation facilities, residential buildings, crops and domestic animals), sometimes people die in mudflows.

In the spring-summer period, mudflows and floods are observed throughout the territory of Kyrgyzstan, with the highest frequency in Osh, Jalal-Abad, Batken regions. There are 3,103 mudflow rivers in the Kyrgyz Republic. Of the total number of known cases of mudflows, about 80% are storm events. The frequency of such mudflows may be annual in some areas. Snowmelt, especially in combination with rain, also plays a significant role in the formation of mudflows. Their share is estimated at 15% of the total. The frequency of occurrence of such mudflows is estimated from 1 time in 3-5 years to 1 time in 6-10 years. The proportion of mudflows from the melting of glaciers and seasonal snow in the glacial area reaches about 13% of cases. Less than 1% falls on mudflows of a breakthrough type from lakes and intraglacial cavities. On the territory of Kyrgyzstan there are 2,000 high-mountain outburst lakes, of which 200

[119] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.
[120] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

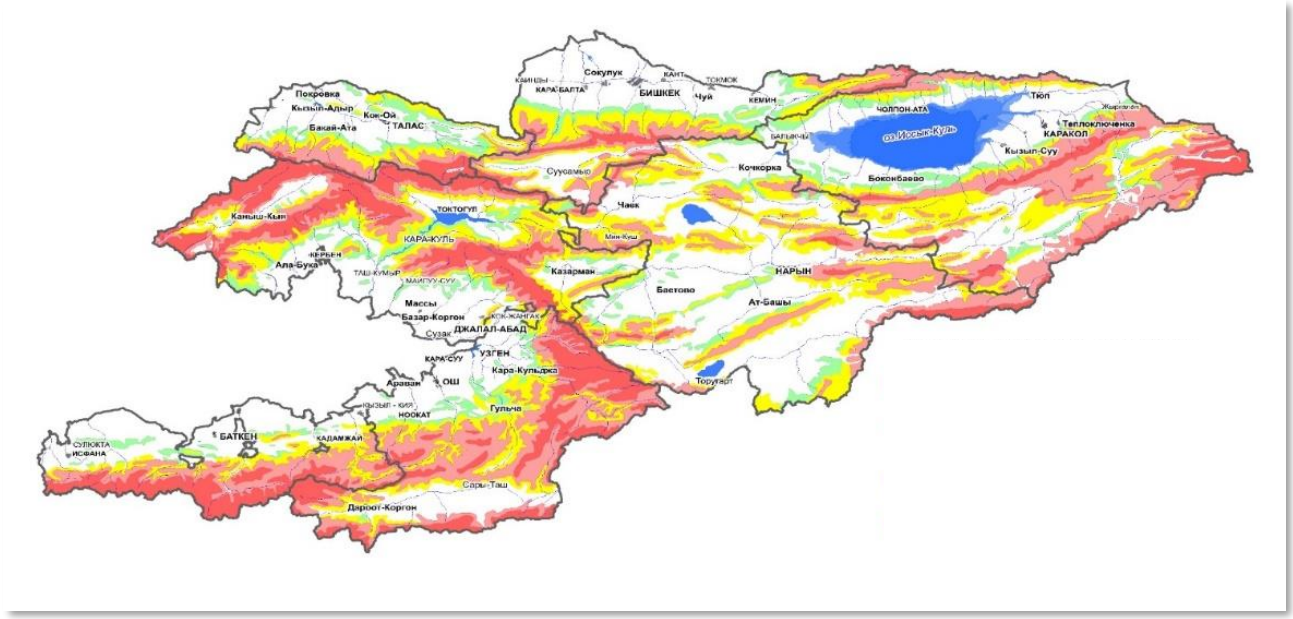
reservoirs have a high probability of outburst. The consequences associated with these phenomena cause damage not only to the population and industry of Kyrgyzstan, but also to neighboring countries (for example, in1998. the breakthrough of the high-mountain lake Kurban-Kul caused a mudflow on the Shakhimardan River, which flows through the Uzbek enclave and caused human casualties). More than 300 settlements are located on the territory of Kyrgyzstan in the zones of possible damage from lake outbursts. Cases of mudflows, which led to various damages, were recorded in 1153 settlements. On fig. a map of the zoning of the country's territory according to the degree of mudflow hazard is presented.

Figure 4.3. Zoning map of the territory of Kyrgyzstan according to the degree of flood and mudflow hazards.



High-mountain areas during the cold period are subject to the effects of snow avalanches. About 105 thousand km^2 are affected, which is 53% of the entire territory of the republic (fig. 4.4). Within 779 areas of avalanche formation, more than 30 thousand avalanche-prone zones have been identified. The avalanche period lasts from 3-4 months (Western Tien Shan) to 11-12 months (Central Tien Shan). Most often, avalanches in the Tien Shan hit roads in February and March (63% of the total recorded number of avalanches that caused damage to highways). January accounts for 16% of the total number of avalanches. In April, as a rule, 13% of the total number of avalanches are recorded. In December, about 4% of avalanches descend. In November and May, respectively, 1.5% and 2.5% of avalanches descend. The maximum amount of snow displaced by avalanches occurs in March (52.6%). Most of the avalanches descend from the northern and northwestern slopes. From 800 to 1500 avalanches of various sizes are recorded annually. Most avalanches cannot be examined due to the lack of development and inaccessibility of vast areas of mountainous territories.

Figure 4.4. Zoning map of the territory of the Kyrgyz Republic according to the degree of avalanche danger.



The surveyed number of avalanche-prone areas is about 10-15% of the total area of probable avalanches. During the observation period from 1949 to 2007, more than 75 thousand avalanches were registered on the territory of the Kyrgyz Republic, with a total volume of about 1.5 billion cubic metres.

Giant snow avalanches and firn landslides, the volume of which reaches a million or more cubic metres, are not uncommon for the mountainous regions of the republic. An avalanche with a volume of 6.4 million cubic metres was registered in the Padsha-Ata river basin, 4 million cubic metres in Uzun-Akmat, and 2.2 million cubic metres - in Enilchek, and 2.5 million cubic metres - in Chichkan (Kochkubulak), an avanlanche in Isfayram had the volume of 1.3 million cubic metres of snow and the one in Suusamyr - 1 million cubic metres.

Heavy precipitation (40-75 mm per day) in Chui, Osh, Jalal-Abad regions are observed once every 10 years (10 percent security). If they fall in winter, in addition to the formation of avalanche centres, they cause damage to residential and commercial buildings (destroy roofs), complicate the work of vehicles. If precipitation occurs in the warm season and falls in the form of heavy rains, then mudflow centres form, causing soil crust in the fields and lodging of crops.

The analysis of trends in key water related emergencies in the period 1990-2019 shows their stable growth. The highest growth rate was recorded for mudflows and floods (fig. 4.5).

Figure 4.5 General trends in major climate emergencies

4.2 Decision context

At the moment, the above-mentioned vulnerabilities are not duly addressed due to lack of the relevant sector-tailored adaptation policy. However, certain activities strengthening adaptive capacities and elaborating conducive enabling environment to promote green and climate resilient development are ongoing. Thus, the amendments are under discussion to reduce custom duties on import of resource-efficient and low-emission equipment, materials and vehicles, as well as tax exemption or reduction for economic entities transited to green production and consumption.

Kyrgyzstan also receives certain international support to increase climate change resilience, the long list of projects relevant for climate change adaptation of Kyrgyzstan is presented in Annex V to this Report.

Among those, two currently ongoing UNDP project deserve special attention being closely linked to TNA process and should be definitely taken into account in decision making on the water resources sector adaptation technology prioritisation.

The GCF funded UNDP implemented project entitled "Advancing development of a National Adaptation Plan (NAP) process for medium and long-term adaptation planning and implementation in the Kyrgyz Republic" supports the Government of Kyrgyzstan in establishing its National Adaptation Plan process and is consistent with the government's strategic vision for climate change adaptation. The project objective is to strengthen institutions and enhance vertical and horizontal coordination for climate change adaptation planning, facilitate mainstreaming of climate risks at sectoral and subnational levels, and identify a programme of priority climate change adaptation investments.

Evidently, the final NAP should include actions to promote the prioritized climate technologies to reduce vulnerabilities and foster resilience of the water resources sector, which will be described in TAP. Representatives of that project participated duly on the TNA project events contributing with information. Moreover, close partnership was established between two national experts' teams to facilitate information sharing.

Another UNDP Climate promise II, NDC Partnership is providing support currently to develop enhanced NDC Implementation Plan and Long-Term Strategy for Carbon Neutrality (LTS) until 2050. The first consultation with the experts engaged into that process showed high interest and willingness to be involved into TNA process, too. Thus, it was decided to coordinate TNA project also with NDC Implementation Plan and in terms of hydropower promotion, with LTS 2050 development.

The process of technology selection with TNA project in Kyrgyzstan was divided into the following stages:

1. Analysis of the climate change vulnerabilities assessments of the water resource sector conducted so far.
2. Analysis of the enabling frames, specific characteristics of the water resources sectors operations, also mapping stakeholders to determine the demand on technology.
3. Identification of priority subsectors vulnerable to climate change impacts to deploy climate adaptation technologies there.
4. Overview of past experience in technologies need analysis of EBRD and FAO.
5. Study of existing technologies in agriculture based on international and relevant national experience.
6. Selection and creation of the extended list of technologies by the national consultants, also gathering proposals from the sectors' stakeholders and compiling long list of adaptation technologies from open sources.
7. Detailed discussion of each technologies with a team of national experts and on the sessions of Sectoral Working Groups.
8. Elaboration of selection criteria for technology options prioritisation and their validation on the SWG session.
9. Formation of the short lists of technologies recommended for MCA exercise and preparation of Technology Fact Sheets.
10. Prioritisation of short listed technologies using MCA Matrixes Tool.
11. Discussion of the MCA result and corresponding recommendations on SWG and preparation of the TNA Reports.
12. Presentation of the selected technologies to the TNA Project National Steering Committee.

The national context of decision-making process on technology prioritization has some specific features:

- Domination of smallholding farmers in agriculture sector;
- Full dependency of agriculture on irrigation.
- Low technical capacities of majority of farmers and lack of information on modern water technologies
- Low investment capacities of the majority of farmers.
- Limited financial resources allocated to farmers by the Governmental Programme "Financing to Agriculture Phase 9" for low interest credits.
- Integrated Water Resource Management approach was used to develop five River Basin Plans.
- Water resources governed by the State Water Resources Service, which is managing water reservoirs and inter-farm channels network.
- On-farm irrigation systems are managed by the Associations of Water Users within Municipalities, which have rather weak technical capacities and knowledge on modern technologies in irrigation water management, monitoring and planning.
- The irrigation channels system conditions are poor and degrading, causing the considerable loss of irrigation water in some places from 24 to 70% during transportation, which is aggravated by the water evaporation during more frequent high temperatures summer periods and the transpiration of water during gravity field irrigation traditionally widely used by majority of farmers.
- Not all the settlements inhabitants have access to clean water and even less - to sewerage systems.
- Water supply, sanitation and waste water treatment systems belong to municipalities and mostly worn out.
- Local municipalities lack adequate financial resources to maintain and provide technical service neither to irrigation nor to water supply and sanitation systems.
- Melting glaciers increase uncertainty on the overall river runoff in future.

All above listed feature were duly taken into account by the members of SWG during decision making process on water technology prioritisation.

It should be noted that one of the major factors in decision making about the technologies assessment was determined by NATCOM 3 and NDC, which identified major climate change impacts on the Water Resources Sector, as well as indicative adaptation measures.

4.3 Overview of existing technologies in the Water Sector

Currently Kyrgyzstan has rather poor evidence data and underdeveloped enabling frames for the water resources sector agriculture adaptation to climate change impacts. Development of recommendations for the water sector adaptation to climate change is being underway within NAP development process and NDC proposed adaptation measures.

For the Water Resources Sector it is planned to introduce Integrated Water Resource Management approach as a main technology in water governance. For this, a solid scientific research about climate change impacts is needed. Numerous approaches to modelling of future scenarios for water resources in the context of climate change only increase uncertainty and do not well contribute to adaptation activities planning and climate resilient national water policy development.

Arid zone agriculture of Kyrgyzstan depends greatly on irrigation systems. There are 1023 thousand ha of irrigated land in the Kyrgyz Republic. There are 28.9 thousand km of irrigation canals, of which 5.7 thousand km are inter-farm and are managed by the Water Resources Service (WRS) under the Ministry

of Agriculture of the Kyrgyz Republic, 23.2 thousand km are on-farm irrigation canals, which are managed by Water Users Associations (WUA) of local communities and other economic entities for water supply on irrigated lands of the country. There are 274 irrigation systems and 93 accumulating irrigation facilities (reservoirs) in the republic. In total, there are also 219 pumping stations in the country, of which 111 electrified pumping stations are managed by WRS. [121]

Additionally, there are 5,705 km of collector-drainage network, of which 1,187.1 km are managed by WRS, and 460.7 km – by WUAs, and 4,057.2 km are managed by local municipalities. There are 240 thousand ha of lands with collector-drainage network in the republic, 87 thousand ha of irrigated lands are in unsatisfactory reclamation state. The vast majority of irrigation infrastructure in the republic has been in operation for 30, 40 and more years. This has resulted in more than 30% loss. [122]

Given the population growth in recent years, the need for construction of irrigation facilities and introduction of new irrigated land is the highest priority and urgent task to sustain food security and nutrition for the Kyrgyz Republic. The systems of water governance and its monitoring systems using mechanical rulers to observe and calculate water runoff are often provide arguable data causing conflicts among water users.

Under these conditions improvement of climate resilience of the irrigation infrastructure and the systems of water metering modernization is in the focus of the State Programme for Irrigation Development, which however, lack sufficient funding.

Access to safe drinking water is also on the adaptation agenda on Kyrgyzstan NDC in response to the corresponding climate change impact.

According to the National Statistical Committee of the Kyrgyz Republic, in 2018, the number of water supply networks in the Kyrgyz Republic was 973, with 84 in urban settlements and 889 in rural areas.

The rural population is particularly in need of drinking water supply and sanitation services. After the liquidation of collective and state farms in rural areas, rural drinking water supply systems were abandoned for more than 10 years, which subsequently led to intensive deterioration of their technical conditions and complete stoppage of drinking water supply systems in most villages of the republic, which in subsequent years had to be restored.

At the same time, the service life of many existing systems exceeds 30 years: in 262 villages the drinking water supply system was built before 1970, in 567 villages - before 1990.[123]

At the end of 2017, the volume of water supplied through water pipelines reached 320.75 million m^3, including over 187.74 million m^3 for the urban population and 133.01 million m^3 for the rural population. The use of water for household and drinking needs amounted to 157.0 million m^3. Losses related to leakage and unaccounted water consumption reached 67.3 million m^3.

According to the NSC, 29.1% of households obtain their water from centralised water supply systems, 55.4% outdoor water stand pipes, 6.6% from wells, 2.3% from springs and 6.6% from irrigation ditches.

This situation is exacerbated by the impacts of climate induced disasters damaging local water supply systems and increasing sediment in potable water reservoirs, shifts in precipitation regime and low water

[121] State Programme for the Kyrgyz Republic Irrigation Development for 2017-2028. Endorsed by Governmental Resolution # 440 as of 21 July 2017.
[122] Ibid.
[123] Programme of the Development of the Drinking Water Supply and Sanitation Systems in the Kyrgyz Republic until 2026. Endorsed by Resolution of the Government # 330 as of 12 June 2020.

levels in rivers and aquifers affect freshwater replenishment in rural potable water supply facilities, higher temperatures facilitating water bacteria growth.

4.4 Adaptation technology options for the Water Sector

The overviewing of existed relevant technologies and international best practices recommended to be applied for the adaptation of the water sector to climate change was carried out. Different sources of information on adaptation technologies: http://climatetechwiki.org/ and technology handbooks available at www.tech-action.org, under "Publications". For Adaptation, Technology guidebooks are available by vulnerable sector: Technology Guidebook for Water Sector, and Technology Guidebook for Agriculture sector. Factsheet examples, as well as links to additional materials are available at www.tech-action.org, under "Resources". (See Chapter 6. List of References).

In the result, a first Long List of Technology Options was compiled (tab. 4.2) and presented on the first session of the Sectoral Working Group including 28 options from the CTCN and UNEP-CCC. [124]

Table 4.2. First long list of climate technologies for the water sector.

#	Technology	Country	Scale of application	Short, medium/long term availability
1.	Construction of reservoirs for complex purposes and improving the efficiency of existing reservoirs	Azerbaijan [125]	Large-scale	long-term
2.	Use of water-saving technologies in the water consumption system		Large-scale	long-term
3. `	Improved water management		Large-scale	medium-term
4.	Reducing water leakage in water management facilities		medium-scale	short-term
5.	Use of waters of the hydrological cycle, including groundwater water		Large-scale	long-term
6.	Flow regulation		medium-scale	medium-term
7.	Implementation of engineering and protective measures on the watercourse channels of lakes and rivers against floods		medium-scale	medium-term
8.	Regeneration and reuse of water		Large-scale	long-term
9.	Flood warning technology		Large-scale	medium-term
10.	Riverbed cleaning		Large-scale	medium-term
11.	Extreme Events Prevention Technology		Large-scale	long-term
12.	Repair of water networks and facilities organization of supply and water discharge		Large-scale	medium-term

[124] CTCN site: https://www.ctc-n.org/collection/climatetechwiki?f%5B0%5D=taxonomy_term_page_objective_facets%3A14912&f%5B1%5D=taxonomy_term_page_sectors_facets%3A14957.. UNEP-CCC site: https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_fact_sheet

[125] Republic of Azerbaijan Ministry of Ecology and Natural Resources. 2012. Technology Needs Assessment Report. Adaptation. https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_report&fwp_tna_reports_region=azerbaijan

#	Technology	Country	Scale of application	Short, medium/long term availability
13.	Leak control, detection and repair leaks in drinking water pipeline networks	Kazakhstan [126]	Large-scale	short-term
14.	Collection of rain and melt water, construction of reservoirs and reservoirs		Large-scale	long-term
15.	Water accounting and metering for irrigation and watering		Large-scale	medium-term
16.	Reconstruction and renewal of hydraulic structures - State Customs Committee (reservoirs, dams and etc.), irrigation systems and networks		Large-scale	long-term
17.	Providing the rural population with drinking water of guaranteed quality. Construction of local water supply systems.	Moldova[127]	small scale	short term
18.	Drought risk assessment and mapping;	Ukraine[128]	large-scale	long-term
19.	Flood risk assessment and mapping		medium-scale	medium term
20.	Protection of source waters		small scale	short term
21.	Ecological restoration of rivers		large-scale	long-term
22.	Advanced wastewater treatment.		medium-scale	Medium term
23.	Well Tube Irrigation Control	Nepal[129]	small scale	short term
24.	Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters	Kyrgyzstan	large-scale	long-term
25.	Energy efficient pumps for pumping stations in the Kyrgyz Republic		medium-scale	long term
26.	Hydrotaran system for delivery and distribution of irrigation water		large-scale	long-term
27.	Subsurface irrigation on the background of closed drainage by sub-irrigation method		large-scale	long-term
28.	Artificial Glaciers for irrigation		small scale	short term
29.	Energy- and resource-saving drinking water supply systems form the surface water sources using local materials		medium-scale	long term
30.	New systems for wastewater treatment plants		medium-scale	long term
31.	Water meters to monitor water leaks in drinking water supply systems		large-scale	long-term

[126]Republic of Kazakhstan. 2011 Technology Needs Assessment for Adaptation to Climate Change. Adaptation https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_report&fwp_tna_reports_region=Kazakhstan

[127] Republic of Moldova. 2012 Technology Needs Assessment for Climate Change Adaptation. Report I. Technology Prioritisation. https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_report&fwp_tna_reports_region=moldova

[128]Ukraine. 2019. Technology Needs Assessment Report. Adaptation. https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_report&fwp_tna_reports_region=ukraine

[129] Government of Neal. Ministry of Forests and Environment. 2021.Technology Needs Assessment for Climate Change Adaptation. https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_report&fwp_tna_reports_region=nepal

This compiled list of technology options was circulated among the participants of the SWG and debated on the two sessions of the group. It was stressed that alignment to current strategic documents for the national and sectoral development should be the main criterion for the shortlisting of the technology option, as well as existing plans for the technical modernisation within the sector entities. Thus, the final long list of technology options as per sub-sectors was developed (see tab. 4.3.).

Table 4.3. The long list of climate technologies for the water sector.

#	Technology options	Sub-sector
1.	Energy efficient pumps for pumping stations in the Kyrgyz Republic".	Irrigation
2.	Subsurface irrigation on the background of closed drainage by sub-irrigation method	Irrigation
3.	Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters	Irrigation
4.	Hydrotaran (Hydraulic ram) system for delivery and distribution of irrigation water	Irrigation
5.	Artificial Glaciers	Irrigation
6.	Energy- and resource-saving drinking water supply systems form the surface water sources using local materials	Drinking water supply and sanitation
7.	New wastewater treatment plants	Drinking water supply and sanitation
8.	Water metering devices to monitor water leaks in drinking water supply systems	Drinking water supply and sanitation

4.5 Criteria and process of technology prioritisation

Technologies were prioritised using Multi-Criteria Analysis (MCA) to assess the importance of a technology for adaptation to climate change impacts and their relevance in the national context. MCA facilitates the participation of stakeholders and hence allows normative judgments, while incorporating technical expertise in the adaptation technology assessment. Based on the assessment, adaptation technologies are prioritized to indicate which technologies should be implemented first. MCA is useful when comparing multiple options across a multiple set of criteria. A prioritization exercise could be done comparing multiple technologies to solve a concrete adaptation problem. MCA can also be used to prioritize technologies applied to solve different problems, which ideally should work towards the vulnerability reduction.

When assessing adaptation technologies using MCA, it usually involves combinations of some criteria which are quantified in monetary terms, and others for which monetary valuations do not exist. It also allows for a mix of quantitative and qualitative criteria, with the result that the quality, form and format of information may even differ within the same assessment of technologies. Wherever it is possible to quantify costs and benefits in monetary terms, then this data should be included in the MCA.

Multi criteria analysis (MCA) provides a structured framework for comparing a number of adaptation technologies across multiple criteria. A major benefit of using MCA for prioritizing adaptation

technologies is the ability to include the preferences of stakeholders involved in the process, emphasizing the importance of having appropriate representation of stakeholders during the prioritization process.[130]

In order to compare different technology options and to identify what makes one technology better or more appropriate than another and more worthy of implementation, the criteria used in evaluating each technology option were defined. The final selection of criteria depends on the national climate change adaptation context and priorities.

After consultations with national consultants team and project implementation group, as well as with SWG six different categories for criteria were identified reflecting the Cost of deployment and multiple benefits: Economic; Social; Environmental; Climatic and Institutional. These different categories include 12 criteria for estimating further potential to the technology deployment and diffusion as well as the general meaning of technology for sustainable development.

The selection criteria, their measurement units and weight assigned to each criterion debated and agreed upon with SWG is shown in tab. 4.3.

Table 4.4. The climate technologies' options assessment selection criteria, their units of measurement and weight.

#	Criterion	Units of measurement	Weight, %
1.	Capital investment	US $	11
2.	Operating and maintenance costs	US $	5
3.	Staff training costs and certification costs	US $	5
4.	Improves farmers' income and ability to reinvest	Very high, high, medium, low, very low	10
5.	Stimulate private investments	Very high, high, medium, low, very low	8
6.	Potential for poverty reduction	Very high, high, medium, low, very low	6
7.	Gender equality and social inclusion	Very high, high, medium, low, very low	9
8.	Contribute to protection and sustainability of ecosystem services	Very high, high, medium, low, very low	12
9.	Increase resilience to climate change impacts	Very high, high, medium, low, very low	15
10.	Complexity to deploy and implement	Very high, high, medium, low, very low	8
11.	Replicability	Very high, high, medium, low, very low	6
12.	Alignment to national development priorities and policies	Very high, high, medium, low, very low	5
		Total	100

Technology Fact Sheets (TFSs) for pre-selected technology were prepared by the adaptation team, as well as by the specialist of the sectoral institutions and shared with the SWG. These TFSs enabled stakeholder groups to proceed with the prioritization exercise.

The comparison, scoring, weighing and priority identification within MCA have been done with the application of three matrix MCA tool: Performance Matrix, Scoring Matrix and Decision Matrix. The details of MCA were described in section 3.5.above.

[130] Sara Trærup and Riyong Kim Bakkegaard. 2015. Determining technologies for climate change adaptation/ UNEP DTU Partnership.

The technology prioritisation exercise for the Water Resources Sector was undertaken for the identified sub-sectors: Irrigation, Drinking Water. For this all the developed TFS were divided and analysed in two groups (see MCA Matrixes below).

Those MCA matrixes used to prioritise adaptation technology options for the irrigation subsector are presented in the tab. 4.5, 4.6, 4.7 below

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Table 4.5. Performance Matrix for the irrigation adaptation technology options assessment

Performance Matrix												
Technology / Criteria	Costs			Benefits								
				Economic		Social		Ecological	Climatic	Institutional		
	Capita investment, $/ha	Operating and maintainance, $	Staff training and certification, $	Improves farmers' income and ability to reinvest	Stimulates private investment	Potential for poverty reduction	Gender equity and social inclusion	Contribution to protection and sustainability of ecosystem services	Icreased resilience to climate change	Complexity to deploy, implement	Replicability	Alignmnet to national development priorities
Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters	79,38	7,94	350	medium	medium	low	low	very high	high	high	high	high
Energy efficient pumps for pumping stations in the Kyrgyz Republic".	22,4	2,24	350	low	medium	mtdium	low	low	high	high	medium	medium
Hydrotaran system for delivery and distribution of irrigation water	67	6,7	350	medium	medium	low	low	low	high	low	medium	medium
Subsurface irrigation on the background of closed drainage by subirrigation method	12	1,2	200	medium	low	low	low	medium	medium	low	high	medium
Artificial Glaciers	14,1	1,41	3000	medium	low	low	low	low	high	low	high	medium

Table 4.6. Scoring Matrix for the irrigation adaptation technology options assessment

Scoring Matrix (For each criterion scores should vary from 0 to 100)												
Technology / Criteria	Costs			Benefits								
$Yi = \frac{Xi - Xmin}{X\,max - Xmin} * 100$				Economic		Social		Ecological	Climatic	Institutional		
$Yi = \frac{Xmax - Xi}{X\,max - Xmin} * 100$	Capita investment, $/ha	Operating and maintainance, $	Staff training and certification, $	Improves farmers' income and ability to reinvest	Stimulates private investment	Potential for poverty reduction	Gender equity and social inclusion	Contribution to protection and sustainability of ecosystem services	Icreased resilience to climate change	Complexity to deploy, implement	Replicability	Alignmnet to national development priorities
Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters	0,00	0,00	94,64	60,00	60,00	40,00	40,00	100,00	80,00	80,00	80,00	80,00
Energy efficient pumps for pumping stations in the Kyrgyz Republic".	84,57	84,57	94,64	40,00	60,00	60,00	40,00	40,00	80,00	80,00	60,00	60,00
Hydrotaran system for delivery and distribution of irrigation water	18,37	18,37	94,64	60,00	60,00	40,00	40,00	40,00	80,00	40,00	60,00	60,00
Subsurface irrigation on the background of closed drainage by subirrigation method	100,00	100,00	100,00	60,00	40,00	40,00	40,00	60,00	60,00	40,00	80,00	60,00
Artificial Glaciers	96,88	96,88	0,00	60,00	40,00	40,00	40,00	40,00	80,00	40,00	80,00	60,00
Criteria weights	11	5	5	10	8	6	9	12	15	8	6	5

Table 4.7. Decision Matrix for the irrigation adaptation technology options assessment

Decision Matrix: Weighted Scores														
Technology / Criteria	Costs			Benefits									Total	Renking
				Economic		Social		Ecological	Climatic	Institutional				
	Capita investment, $/ha	Operating and maintainance, $	Staff training and certification, $	Improves farmers' income and ability to reinvest	Stimulates private investment	Potential for poverty reduction	Gender equity and social inclusion	Contribution to protection and sustainability of ecosystem services	Icreased resilience to climate change	Complexity to deploy, implement	Replicability	Alignmnet to national development priorities		
Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters	0,00	0,00	473,21	600,00	480,00	240,00	360,00	1200,00	1200,00	640,00	480,00	400,00	6073,21	3
Energy efficient pumps for pumping stations in the Kyrgyz Republic".	930,22	422,83	473,21	400,00	480,00	360,00	360,00	480,00	1200,00	640,00	360,00	300,00	6406,26	1
Hydrotaran system for delivery and distribution of irrigation water	202,11	91,87	473,21	600,00	480,00	240,00	360,00	480,00	1200,00	320,00	360,00	300,00	5107,19	5
Subsurface irrigation on the background of closed drainage by subirrigation method	1100,00	500,00	500,00	600,00	320,00	240,00	360,00	720,00	900,00	320,00	480,00	300,00	6340,00	2
Artificial Glaciers	1065,72	484,42	0,00	600,00	320,00	240,00	360,00	480,00	1200,00	320,00	480,00	300,00	5850,13	4
Criteria weights	11	5	5	10	8	6	9	12	15	8	6	5	100	

The assessment analysis of the adaptation technology options for the drinking water supply and sanitation subsector has been conducted as a separate exercise, corresponding matrixes presented in tab. 4.7, 4.8, and 4.9 below

Table 4.8. Performance Matrix for the drinking water supply and sanitation technology options

Performance Matrix												
Technology / Criteria	Costs			Benefits								
				Economic		Social		Ecologicsl	Climatis	Institutional		
	Capita investment, $	Operating and maintainance, $	Staff training and certification	Improves farmers' income and ability to reinvest	Stimulates private investment	Potential for poverty reduction	Gender equity and social inclusion	Contribution to protection and sustainability of ecosystem services	Icreased resilience to climate change	Complexity to deploy, implement	Replicability	Alignmnet to national development priorities
Energy- and resource-saving drinking water supply systems form the surface water sources using local materials	1,67	0,167	2200	low	medium	low	very low	high	medium	high	high	high
New wastewater treatment plants	417	41,7	2200	low	medium	low	very low	low	medium	high	mrdium	high
Water meters to monitor water leaks in drinking water supply systems	6	0,6	71	low	medium	low	very low	low	medium	medium	mrdium	high

Table 4.9. Scoring Matrix for the drinking water supply and sanitation technology options

Technology / Criteria $Yi = \frac{Xi - Xmin}{X\,max - Xmin} * 100$ $Yi = \frac{Xmax - Xi}{X\,max - Xmin} * 100$	Стоимость			Benefits								
				Economic		Social		Ecologicsl	Climatis	Institutional		
	Capita investment, $	Operating and maintainance, $	Staff training and certification	Improves farmers' income and ability to reinvest	Stimulates private investment	Potential for poverty reduction	Gender equity and social inclusion	Contribution to protection and sustainability of ecosystem services	Icreased resilience to climate change	Complexity to deploy, implement	Replicability	Alignmnet to national development priorities
Energy- and resource-saving drinking water supply systems form the surface water sources using local materials	100,00	100,00	0,00	40,00	60,00	40,00	20,00	80,00	60,00	80,00	80,00	80,00
New wastewater treatment plants	0,00	0,00	0,00	40,00	60,00	40,00	20,00	40,00	60,00	80,00	60,00	80,00
Water meters to monitor water leaks in drinking water supply systems	98,96	98,96	100,00	40,00	60,00	40,00	20,00	40,00	60,00	60,00	60,00	80,00
Criterion weight	11	5	5	10	8	6	9	12	15	8	6	5

Table 4.10. Decision Matrix for drinking water supply and sanitation technology options

Technology / Criteria	Стоимость			Выгоды									Total	Ranking
				Экономические		Социальные		Экологические	Климатические		Институциональные			
	Capita investment, $	Operating and maintainance, $	Staff training and certification	Improves farmers' income and ability to reinvest	Stimulates private investment	Potential for poverty reduction	Gender equity and social inclusion	Contribution to protection and sustainability of ecosystem services	Icreased resilience to climate change	Complexity to deploy, implement	Replicability	Alignmnet to national development priorities		
Energy- and resource-saving drinking water supply systems form the surface water sources using local materials	1100,00	500,00	0,00	400,00	480,00	240,00	180,00	960,00	900,00	640,00	480,00	400,00	6280,00	1
New wastewater treatment plants	0,00	0,00	0,00	400,00	480,00	240,00	180,00	480,00	900,00	640,00	360,00	400,00	4080,00	3
Water meters to monitor water leaks in drinking water supply systems	1088,53	494,79	500,00	400,00	480,00	240,00	180,00	480,00	900,00	480,00	360,00	400,00	6003,32	2
Criterion weight	11	5	5	10	8	6	9	12	15	8	6	5	100	

4.6 Results of technology prioritisation

As the result of technology MCA assessment by the stakeholders of the SWG, the analysed technology options for drinking water supply and sanitation were ranked in the following way:

The results of the MCA exercise for the irrigation subsector is presented in tab. 4.11 and 4.12.

Table 4.4. The results of the MCA analysis of the adaptation technologies for the irrigation subsector

#	Technologies	Score	Rank
1.	Energy efficient pumps for pumping stations in the Kyrgyz Republic".	6406,26	1
2.	Subsurface irrigation on the background of closed drainage by sub irrigation method	6340,00	2
3.	Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters	6073,21	3
4.	Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters	5850,13	4
5.	Energy efficient pumps for pumping stations in the Kyrgyz Republic".	5107,19	5

Table 4.5. The results of the MCA analysis of the adaptation technologies for the drinking water supply and sanitation subsector

#	Technologies	Score	Rank
1.	Energy- and resource-saving drinking water supply systems from the surface water sources using local materials	6671,59	1
2.	New wastewater treatment plants	5748,53	2
3.	Water meters to monitor water leaks in drinking water supply systems	4040,00	3

As per decision of the SWG, the first three technologies received maximum scores were identified as the priority ones.

Priority 1 technology: Energy- and resource-saving drinking water supply systems form the surface water sources using local materials

Adaptation needs: The introduction of this technology can be considered as a preventive measure against the existing risks of shortage of water resources for drinking needs in connection with the consequences of climate change like increased temperatures and reduced precipitations. According to the National Statistical Committee of the Kyrgyz Republic, in 2021, 6 % of population still do not have access to clean and safe water. Heat waves and high temperatures can aggravate sanitation situation, thus, increasing the growth of infectious diseases. Besides, losses related to leakage and unaccounted water consumption reached 67 million cubic meters.

How this measure contributes to adaptation: Low cost drinking water supply and sanitation systems can considerably improve access to safe drinking water. 715 priority villages were identified, in which the construction and rehabilitation of water supply systems is a priority. In addition, it is necessary to rehabilitate water supply systems in 448 villages.

Background: At present, the Kyrgyz Republic faces a very acute problem of providing high-quality drinking water to the population of cities and other settlements. In many villages and small towns, there is a shortage of drinking water of standard quality due to imperfect water treatment. And this is the main reason for the spread of intestinal infections, hepatitis and diseases of the gastrointestinal tract, the occurrence of pathologies and the increased impact of carcinogenic and mutagenic factors on the human

organism. The current crisis situation in the field of drinking water supply is due to the lack of measures to protect sources of drinking water supply, the unsatisfactory technical condition of water supply systems. It is important that for the purification of drinking water today all the materials are imported from abroad, such as quartz sand. Whereas local deposits in the Issyk-Kul, Jalal-Abad regions can fully satisfy the needs of the republic. Sodium hypochlorite can also be produced on the basis of local deposits of natural salt (village Tuz, Kochkor region, Nouruz, etc.).

Benefits:

Economic. This technology involves the use of local materials: quartz sand, natural salt, construction of micro-hydro power plants / solar panels. Will provide the amount of water for 60 thousand people. * 230 l/person per day. Due to the use of local materials, it is possible to reduce the cost of 1 m3 for water consumers. It will evidently revive economic construction activities in a lot of rural communes. Improving water supply systems, reducing the costs on medical treatment of people will help to increase the income of the population and increase the economic activity in the regions.

Social: The technology will create jobs related to construction and engineering, the supply of inert materials, the production of sodium hypochlorite, and the operation and maintenance of the drinking water treatment system. The number of employees for maintenance and operation for 1 facility is on average 21 people, for 24 = 496 people. The introduction of this Technology will help to preserve the health of the population, reduce the number of diseases transmitted through water, and provide comfortable living conditions.

Environmental: Improving the quality of groundwater from the harmful effects of substances polluting sources of drinking water supply. The use of renewable energy sources and energy efficient equipment (control systems, pumps, bactericidal installations, etc.) to provide the population with drinking water will reduce the anthropogenic load on the environment, while reducing GHG emissions from less energy consumed. Because the permissible limits of the negative impact on the environment are determined and the mechanisms for managing environmental safety are formed.

Priority 2 technology: Energy efficient pumps for pumping stations in the Kyrgyz Republic

Adaptation needs: The introduction of this technology will help reduce the shortage of water resources resulting from interruptions caused by the operation of old energy-consuming equipment of pumping stations. In connection with the forecasts for the reduction of river flow, this technology will contribute to the reduction of water scarcity indirectly, since electricity consumption will be reduced, also to reducing the pressure on water resources, as the main generation of electricity is carried out by hydropower plants.

How this measure contributes to adaptation: Timely irrigation water delivery to the dry land fields will increase resilience of the agricultural production in hat areas, while also sustaining farmers livelihoods and food supply to the local and national markets.

Background: The main consumer of water in the country is irrigated agriculture, more than 90% of available water resources are spent for irrigation needs. In order to grow crops in dry lands, pumping stations were built more than half a century ago; 115 units (365 units) that provide irrigation water for 57.0 thousand hectares (6% of the total irrigation area). Re-equipment of pumping stations, and especially in recent years, has become a necessary task, because the lifetime of equipment has already expired almost 4-5 times, it is morally and physically are outdated,. Despite the fact that in recent years, re-equipment has started, it is far from being enough, and covered only 20-30% of what is needed. In addition, re-equipment is carried out within the framework of already operating equipment, for example, pumps - 3.5 kW, while 1.5 kW units are needed.

Benefits:
Economic. It is required to replace all 365 pumping units at 115 pumping stations, as well as purchase additional ones for each pumping station. Thus this technology has rather good market potential. Improvement of irrigation water supply services, and irrigation services fee and reduce the burden on the republican budget, increase in salaries for pumping station workers. Significantly, approximately two times reduction of the electricity consumption of electricity (at the rate of 1.08 soms per 1 kWh) will lead to economy of about 244.0 million soms per year.

Social: The introduction of this Technology will reduce the heavy manual labour, the staffing of pumping station workers, which will increase the wages of the remaining workers. If implemented, this technology can improve irrigation services for about 89,700 people across the country

Environmental: Electric energy consumption by pumping stations will be reduced by about half, which will help reduce GHG emissions by half.

Priority 3 technology: Subsurface irrigation on the background of closed drainage by sub irrigation method

Adaptation needs: Up to 10.0 km^3 of water per year is used for irrigation, of which up to 3.5 km3 is lost during transportation, 1.5-1.9 km3 - in the on –farm and intra-farm network.[131] The method of subsoil irrigation using underground pipelines is a version of drip irrigation.

How this measure contributes to adaptation: The Technology under consideration contributes to rational water use and in connection with the forecasts for the reduction of runoff, as a result of Global climate change, this technology will help reduce the shortage of water resources. This technology, due to its peculiarity, when irrigation is carried out along underground molehill drains, (i.e. open air flood irrigation is excluded, which under hot temperature contributes to evaporation from irrigation arrays) prevents considerably water evaporation.

Background: Sub-irrigation is economically much more efficient than surface irrigation and most fully meets the requirements of agricultural crops, because. optimal conditions are created for the growth and development of plants, higher water use ratio, simplicity of design during construction and operation, irrigator productivity increases by 30-50%, high yields are provided regardless of weather conditions, nutrients and microelements are preserved in the soil, etc.

Benefits:

Economic. The introduction of this technology will improve the quality of services for the supply of irrigation water, increase the volume of income from irrigation services fees for the rural Associations of the Water Users, thus sustaining them financially. The introduction of this Technology will increase the yield of agricultural crops, which contributes to an increase in incomes of the population.
Social: It will reduce the heavy manual labour of lifting the gates of water intakes will help maintain the health of service personnel, farmers and evidently will help to maintain the health of service personnel, including women - farmers. New jobs will be required to maintain collector-drainage and subsoil irrigation systems. It will free up time for other activities: alternative ways of generating income: housekeeping, gardening, vegetable growing, women's leisure time.

Environmental: It will prevent erosion of canals formed during unregulated supply of irrigation water to the distribution network, reduce the shortage of water resources, irrigation water will be supplied in

[131] C. Valentini. 2015. Modern irrigation technologies and the possibility of their application in Kyrgyzstan. National dialogue on water policy in Kyrgyzstan in the field of Integrated Water Resources Management.

accordance with irrigation regimes, which will preserve the fertile soil layer. It will also allow to reduce the processes of gully formation, erosion on irrigated lands, prevent the washout of the humus layer of the soil, the formation and flow of solid runoff into rivers, reservoirs, drains.

The remaining two options, which were also considered as quite actual and feasible for adaptation will be included into the pipeline and the further analysis of these will be done, if a corresponding need arises.

Reserve technology 1: Automated systems for metering and distribution of irrigation water, including control and metering points with the installation of vandal-proof water meters

Adaptation needs: The irrigation sector is facing a serious challenge to provide irrigation water to thousands of small holdings farms. One of the factors contributing to the guaranteed, stable, transparent supply of irrigation water is the automation and installation of instrumentation at the points of irrigation water supply to inter-farm / state and on-farm channels and systems. Timely provision of water for irrigation in a sufficient amount is the most challenging task today, which is aggravated by the rainless periods and cause social conflicts.

How this measure contributes to adaptation: The installation of instrumentation and automation of the process of supplying irrigation water will reduce the amount of water taken for irrigation and losses during transportation. The technology under consideration contributes to rational water use, and especially in areas with a tight water balance at the present time. And in connection with the forecasts for the reduction of runoff, this technology will help optimise use and reduce impacts of the shrinking water resources.

Background: At present there are about 430 thousand peasant farms and subsidiary peasant farms in Kyrgyzstan. The average farm size is usually 1-3 hectares. At the same time, this includes the arable land they rent from the National Fund for the Redistribution of Agricultural Land. In fact, in the southern regions it is 0.6 - 1.1 hectares, in the northern regions - from 1 to 5 hectares.

Benefits:

Economic. The introduction of this technology will improve the quality of services for the supply of irrigation water, increase the volume of income for Associations of Water Users.

Implementation of this Technology will allow eliminating corruption schemes for paying for irrigation services, increase the amount of income to the republican budget, which, in turn, will allow funds to be directed to repair works and increase the salary of water sector employees.

Social: It is also expected, it will free up time for other activities: alternative ways of generating income: housekeeping, gardening, vegetable growing, and leisure time.

Environmental: It will prevent erosive erosion of canals formed during unregulated supply of irrigation water to the distribution network, remove the threat of destruction of hydraulic structures that occurs in this case, and reduce the shortage of water resources, irrigation water will be supplied in accordance with irrigation regimes, which will preserve the fertile soil layer. It will also reduce the processes of gully formation, erosion on irrigated lands, reduce the washout of the humus layer of the soil and the flow of solid runoff into rivers, reservoirs, drains

Reserve technology 2: New wastewater treatment plants

Adaptation needs:

How this measure contributes to adaptation: The implementation of this technology will contribute to the formation of secondary / additional water resources - return water of standard quality, which can be used, which will help reduce the shortage of water resources. Due to the use of new treatment systems, the

volume of normatively treated wastewater, which can be further used, will increase, depending on the capacity of treatment facilities, using the example of a city with a population of 60 thousand people it is about 77.5 million m^3

Background: In the Kyrgyz Republic, only 29.1% of the population has access to sanitation systems. For cities, this figure is 61.1%, and in the regions it does not exceed 10%. Urban wastewater is one of the main sources of water pollution, and the lower the concentration of treated inflow, the greater the pollutant load on wastewater after treatment. Today the volume of treated wastewater in the republic is 129.1 million m^3 per year.

Benefits:

Economic. According to the main strategies t is necessary to build and rehabilitate treatment facilities in 25 cities: Bishkek, Osh, Jalal-Abad, Toktogul, Mailuu-Suu, Kerben, Tash-Komur, Kara-Balta, Kant, Tokmok, Kemin, Batken, Kyzyl-Kiya, Isfana, Aidarken, Kadamjai, Kara-Suu, Uzgen, Nookat, Balykchy, Karakol, Cholpon-Ata, Talas, Naryn, Kok-Yangak.

Social: Improved sanitary conditions in all those cities will benefit about 2 million people. Improving the health of the population living near wastewater treatment plants, since Sanitary Protection Zones will be provided in order not to exceed sanitary norms. The use of recycled/returned treated wastewater for irrigation will help reduce diseases transmitted through irrigated agricultural products by irrigation with raw sewage. There will be a decrease in colds caused by the fact that toilets are located outside and far from the school building, etc. as per gender data enterprises of this type employ 16.6% of women[132]from the total number of employees. With the commissioning of new wastewater treatment facilities, new jobs for women will appear at one enterprise - 4 units, for 25 - 100 people. Women will spend less time caring for children, as colds will decrease due to the improvement of homes, schools, and other warm toilets and sewerage systems. There will be more time for studying, obtaining the necessary modern skills for income generation, professions, etc.

Environmental: This technology will lead to a reduction in the chemical impact of wastewater on soil and water. The implementation of this technology will contribute to the formation of secondary / additional water resources of return water of standard quality, which can be reused for various needs: irrigation, car washing, etc. This will relieve the pressure on the quantity and quality of water resources and natural landscapes, and will lead to an improvement in the ecological state environment. Moreover, GHG emissions from the "Waste" sector of the Kyrgyz Republic have increased significantly in recent years (more than 600 Gg CO2-eq.), incl. the wastewater treatment and discharge category. Therefore, wastewater treatment will reduce the formation of methane and reduce emissions of CH_4.[133].

The SWG debated all above technological options' assessment results and the following three technology options were identified as the priority ones for the Kyrgyz Republic distributed as per two water subsectors (see tab. 4.13).

Table 4.6. Prioritized technologies for the Water Sector adaptation.

#	Technology
Drinking Water Supply and Sanitation	

[132]http://www.stat.kg/media/publication archive/b057b115-c40b-4180-ae16-28ec7e459117.pdf
[133]Third National Communication of the Kyrgyz Republic under the UN Framework Convention on Climate Change, Bishkek, 2016

#	Technology
1	Energy- and resource-saving drinking water supply systems form the surface water sources using local materials
Irrigation	
2	Energy efficient pumps for pumping stations in the Kyrgyz Republic".
3	Subsurface irrigation on the background of closed drainage by sub irrigation method

Chapter 5 Summary and Conclusions

Kyrgyzstan is a mountainous landlocked country, which is already experiencing the rise in temperature and shifts and uncertainty in precipitations regimes as well as various weather extremes and climate induced disasters. All those will no doubt affect agriculture production and livelihoods, as well as water resources ecosystems service provision.

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

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

Under the first stage conducting a TNA in Kyrgyzstan, the technologies have been assessed for agriculture and water sectors adaptation to climate change. For this, a wide process of the key stakeholders' engagement was organised and two Sectoral Working Groups (SWG) were established involving representatives of the government, academia, private sector, farmers and civil society organizations. The working sessions of SWG were conducted to assure quality of the TNA first stage outputs and their alignment to the national development priorities and climate policies (NDC and NATCOMs).

The following technological priorities have been identified within the TNA process (tab. 5.1).

Table 5.1. TNA priorities identified for Agriculture and Water Sectors

Agriculture		Water	
Livestock breeding	*Crop Farming*	*Drinking Water supply and Sanitation*	*Irrigation*
1. Sustainable pasture management	2. Organic farming	1. Energy- and resource-saving drinking water supply systems form the surface water sources using local materials	2. Energy efficient pumps for pumping stations in the Kyrgyz Republic".
	3. Drip irrigation		3. Subsurface irrigation on the background of closed drainage by sub irrigation method

The implementation of these technologies would require strengthening the policy framework through the development of supporting strategies, laws, regulations, other documents to speed up the deployment of these technologies. For this, a stocktaking exercise to analyse existing gaps and barriers to improve enabling frames will be undertaken. Arising recommendations for improvements to deploy and diffuse prioritised adaptation technologies in Agriculture and Water sectors will be accumulated then into the

Technological Action Plan (TAP). To mobilise financial resources to start its implementation GCF format Concept notes will be additionally developed based on TAP.

Kyrgyzstan has committed to implement policies and measures aimed at climate resilient development. Activities related to adaptation in the context of climate change are already being implemented in the framework of national and state programs, national and regional programs and plans.

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Annex I: Technology Factsheets for selected technologies

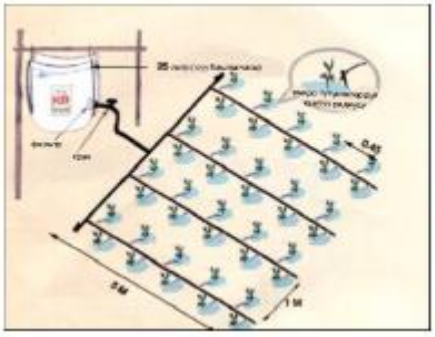
TFS for the Agriculture Sector

Technology Fact Sheet # 1

Sector	**Agriculture**
Subsector	**Livestock Breeding**
Technology name	**Biogas and fertilizers**
Introduction	**Biogas plant** is a hermetically sealed container in which anaerobic fermentation of the organic mass of waste (manure), food waste, sewage, etc. takes place at a certain temperature. with the production of biogas. The principle of operation of all biogas plants is the same: after collecting and preparing raw materials, which consists in bringing it to the desired moisture content in a special container, it is fed into the reactor, where conditions are created to optimize the processing of raw materials. After processing organic waste, we get two products - biofertilizer and biogas Biofertilizer contains a significant amount of nutrients and can be applied directly to the soil or used as a feed additive that is safe for animals. Produced biogas is used in all gas appliances.
Climate benefits	
Adaptation	The use of biofertilizers in rural areas contributes to: - improvement of soil structure, increase of its fertility and biological activity; - increase in productivity (2-3-fold increase in productivity); - acceleration of crop ripening (2 weeks earlier compared to control samples); - increasing the resistance of plants to adverse effects and diseases; - increase in animal weight (when used as a feed additive for animals). All above mentioned sustain local food security while increasing income and resilience of rural households.
Mitigation	The processing of organic waste in biogas stations serves to achieve environmental and sanitary safety and reduce the poverty level of the rural population. Substitution of fossil fuels combustion to get the same amount of energy for cooking and heating reduce GHG emissions
Specifications	
Performance:	**Biogas plant with a reactor volume of 25 m^3** is capable of processing up to 1.2 tons of manure per day in a mesophilic mode and producing about 30 m^3 of biogas and a little less than 1 ton of liquid environmentally friendly biofertilizers per day, the application rate of which is from 5 to 7 tons per hectare. The resulting 30 m^3 of biogas is sufficient for heating 100 m^2 of living space, cooking and providing hot water to a family of 5-6 people. Larger power plants can be used to generate electricity.
Resource efficiency:	100% cost savings to support the technological mode of the station. Fully automated biogas plant control system that saves energy costs.
Life time:	20-25 years old
National context	
Market potential:	The ubiquity of this technology
Advantages:	Products grown using biofertilizers are environmentally friendly. Payback is 2-3 years.
Flaws:	Complete set of containers
Necessary institutional requirements	Does not require the creation of additional organizations
Alignment with national priorities	Corresponds to national priorities for ensuring food security and improving the nutrition of the population. Restoration of degraded lands. Yield increase.
Expert opinion	
Price	

Capital expenditures:	2520000 som
Operation and maintenance:	50000 som per year
Other:	10000 lump sum to train operators
Contribution to development, additional benefits	
Increase in income	Increasing yields through the application of bio-fertilizers to the soil will help increase farmers' incomes.
Workplaces	An increase in productivity will help increase employment.
The economic growth	Increasing crop and livestock production will contribute to the economic growth of rural communities.
Number of beneficiaries:	1-50 households, depends on the capacity of the biogas plant
Health	Improving nutrition through the cultivation of quality agricultural products will contribute to the health of rural communities.
Education	Gaining knowledge about this technology broadens one's horizons. And the preparation of appropriate communication materials helps to increase the level of self-education of each interested farmer.
Gender equality and social inclusion	Technology does not limit women's participation. On the contrary, it helps to increase the productivity of crop production, which is predominantly done by women.
Environmental benefits	**Processing of organic waste in biogas stations serves to achieve environmental and sanitary safety**
Implementation options	• Accessible on the national market • Available engineering consultation
Barriers to implementation	• Low awareness and few technical expertise • Lack of funds for investment • Insufficient technical knowledge and skills

Technology Fact Sheet # 2

Sector	**Agriculture**
Subsector	**Crop Farming**
Technology name	**Drip irrigation systems (DIS)**
Introduction	Drip irrigation is a method of moistening the soil in the root layer of plants by continuous portioned (drip) water supply with a special dropper. The DIS consists of a reservoir (tank), a filter, a faucet, a main, distribution and irrigation pipeline and a dropper (Fig. below). Irrigation water with the help of special droppers (micro tubes) is supplied without loss to each plant. In the 1980s, a number of projects were implemented in the Republic to introduce drip irrigation technologies on experimental plots with an area of more than 10 hectares in Batken region (vineyards), Issyk-Kul region (apple and apricot orchards), Chui region (vegetables), etc. In 1990 In the 1990s, with the help of drip irrigation, about 800 hectares of perennial fruit plantations were already irrigated. However, soon, further promotion of drip irrigation systems in the Kyrgyz Republic stopped. And only after 2008, various international projects began to finance the implementation and dissemination of water-saving technologies and drip technology irrigation in the Kyrgyz Republic.  

	The drip irrigation system can be used in the following conditions: • in areas of irrigation water deficit; • on sloping, uneven and foothill lands; • on highly permeable soils (stony, sandy, gravelly, etc.); • those lands where other methods of irrigation (irrigation along furrows and strips, sprinkling, etc.) are not acceptable and inefficient. The drip irrigation system can be applied to apricot, apple, peach, sweet cherry, vineyard, tomato, pepper, cucumber, strawberry, watermelon, melons and other highly profitable crops, as well as in greenhouses for vegetables.
Climate benefits	
Adaptation	• Strengthening food security of the Kyrgyz Republic. • Increasing the climate resilience of farm livelihoods.
Mitigation	• Increasing carbon sequestration in perennial plantations
Specifications	
Performance:	Irrigation rate for cotton is 6-10 thousand m^3/ha, grain crops up to 2.5 thousand, alfalfa 2-12 thousand m^3/ha of water. The irrigation norm is divided into irrigation norms. Usually, with gravity irrigation, irrigation rates (m^3/ha) are 600-1200, with sprinkling - 300-800, with water-charging irrigation - 1000-2000. 1) When furrow irrigation, the irrigation rate for irrigating 1 hectare of the garden area is on average 600 m^3 of water, and when irrigating 1 hectare of the garden using drip irrigation (if, the planting pattern is 5mx5m, the number of plantations per 1 ha is 400, each plantation is supplied 50 l of water) will require 20 m3 of water, which is 30 times less than with furrow irrigation. On average, the irrigation rate for each plantation of horticultural crops is from 10 to 60 litres, depending on age, and the number of irrigations averages up to 10-15 times in dry years and 6-7 times in wet years. 2) Irrigation rate when irrigating 1 hectare of tomato by furrow method is 800-1000 m3, and with drip irrigation (planting pattern 0.6m x 0.4m, number of plants per 1 ha - 41666 pcs. average water rate per plant - 2 litres) the irrigation rate is 83 m3 of water, which is 12 times less than with furrow irrigation. Irrigation rate - from 1 to 10 litres of water per plant, depending on the phase of tomato development, weather and soil type.
Resource efficiency:	Saving water by 30 times for the orchard and 12 times for growing tomatoes and 55% for cotton. Saving irrigation water for a vineyard by 2.2 times, for an apple orchard by 2.4-3.5 times, for an apricot orchard by 3-4 times; Increase in productivity, compared with surface methods of irrigating the vineyard by 2.7 times, apples by 1.5-1.7 times, apricots by 3-3.5 times; The estimated payback period for capital investments in the construction of the DIS is from 2.6 to 5 years. The use of water in drip irrigation is more efficient than any other irrigation method, as evidenced by the following reasons: • higher crop yields, i.e. specific water consumption per unit of production is low; • less than during sprinkling or flooding, moisture loss due to evaporation, tk. 60% less local area of the moistened area; • wind does not affect the distribution of moisture or evaporation; • slow absorption of water into the soil and its distribution from a point source - droppers, prevents the discharge of irrigation water beyond the contour even in difficult (slope, uneven terrain, etc.) topographic conditions; • the sensitivity of the drip irrigation system to the pressure drop in the irrigation pipeline is much less than with sprinkler irrigation; • irrigation can be done all 24 hours a day, regardless of external conditions such as wind, rain and evaporation; • the amount of weeds is much less than with other irrigation methods; • there is no need for planning work on the soil;

	• it becomes possible to simultaneously supply with irrigation water, mineral nutrition (fertilizing irrigation) and pesticides to combat pests and diseases; • the possibility of manifestation of irrigation soil erosion is excluded; • early maturation of many agricultural crops, tk. with drip irrigation, the soil temperature is higher and more fertile than with sprinkling or flooding, and is maintained at the level of the biological optimum.
Life time:	10 years
National context	
Market potential:	When equipping all perennial plantations
Advantages:	• 4-10 times water saving compared to furrow irrigation; • 1.5-2 times increase in crop yield compared to irrigation • along the furrows; • good development of annual shoots, acceleration of crop maturation by 10-20 days; • washout of the fertile soil layer, salinization and waterlogging of the soil is not allowed; • large areas can be irrigated with low water consumption; • land planning is not required, requiring high costs; • the possibility of applying fertilizer together with irrigation water; • the likelihood of the spread of diseases and pests is reduced due to the fact that the plants, when watered, remain dry; • insecticides and fungicides are not washed off the leaves, as is the case with sprinkling; • a relatively small amount of weeds in the irrigated field, due to the limited contour of soil surface moistening, which reduces the total evaporation by the field, which positively affects the water balance of the aeration zone; • drip irrigation prevents the spread of diseases and weeds that could be transferred through open channels and directly on the irrigated field itself with other irrigation methods - flooding or furrow irrigation; • drip irrigation prevents the occurrence of anaerobic conditions inside the soil for a longer period of time, thus eliminating the possibility of various soil diseases.
Flaws:	1. high cost of the system compared to other irrigation methods; 2. the system requires clean irrigation water, as the dropper hole is small (0.2-2 mm) and can become clogged.
Necessary institutional requirements	It is necessary to create a network of consulting and service points.
Alignment with national priorities	State Programme for the Development of Irrigation for 2017-2028
Expert opinion	• the average irrigation rate in the Kyrgyz Republic for furrow irrigation is about 8000 m^3/ha; e) • Based on the generalization of previous experience in Kyrgyzstan and other countries of Central Asia, in the case of replacing furrow irrigation with drip irrigation technology, it is possible to increase crop yields by at least 1.5-2 times, while at the same time reducing specific water consumption by at least 2 times, i.e. e. reducing the irrigation rate to an average level of about 4000 m^3/ha; • the value of the tariff rate for services for the supply of irrigation water is 0.03 som/m^3, that is, 200 times lower than the average world prices for water.
Capital expenditures:	For irrigation of vegetables, melons, berries, etc. – 1.5-2.0 thousand USD/ha or 90-120 thousand som/ha; For irrigation of gardens with row spacing from 3.5 to 5 m - 1.3-1.5 thousand USD/ha or 80-90 thousand som/ha.
Operation and maintenance:	For example, if the unit cost of a set of equipment with a guaranteed service life of 10 years (depreciation rate of 10%) is estimated at 2,000 USD/ha, the cost of design is about 300 USD/ha, the cost of installation is 600 USD/ha, the cost of training is 100 USD/ha,

	then the total amount of investment in DIS will be 3,000 USD/ha, and the annual unit cost of depreciation of fixed assets (initial investment) will be 300 USD/ha.
Other:	Warranty periods of operation of stationary DIS equipment from various suppliers usually range from 5 to 15 years; in the case of choosing high-quality equipment, it is appropriate to take the estimated life of the system as 10 years, while the estimated depreciation rate for irrigation equipment will be 10% / year;
Contribution to development, additional benefits	
Increase in income	Profitability will increase by 150-200%.
Workplaces	80 for rural advisory service and 120 for DIS service points.
The economic growth	Contribution to the growth of local agricultural production by 50%.
Number of beneficiaries:	Farmers who are engaged in agriculture in the highlands and dry land. Also the development of lands that are not cultivated.
Health	More favourable and sound environment.
Education	The very education of farmers. Implementation of the technology description in textbooks for universities and professional lyceums.
Gender equality and social inclusion	Women can increase the household budget for children's education and diversify the family's diet.
Environmental benefits	Reduction of water intake from natural objects. Reduction of water losses. Decreased water erosion of soils. Reducing soil pollution with fertilizers by rationing for each plant. There are no threats to biodiversity.
Implementation options	Applicable in all regions of the country.
Barriers to implementation	1. Investment required 2. Need to import equipment 3. Requires hands-on training on demonstration plots 4. There is a need to raise awareness of the possibilities of the technology. 5. It is necessary to create a network of consulting and service points.

Technology Fact Sheet # 3

Sector	**Agriculture**
Subsector	**Land Management**
Technology name	**Agrochemical surveys of soils and certification of fields**
Introduction	To protect the soil from depletion and increase fertility, it is necessary to introduce an agrochemical passport for the land shares of peasant (farm) farms. Until 1988, on all arable lands of former collective farms and state farms, agrochemical surveys of fields were carried out at intervals of 3-5 years, agrochemical maps were issued and, according to laboratory data, science-based doses of mineral and organic fertilizers were applied, and the agrochemical services of the republic issued recommendations for the preservation and improvement of soil fertility . According to the Law of the Kyrgyz Republic dated August 10, 2012 No. 165 "On the protection of soil fertility of agricultural land", land users, owners are required to take measures to restore soil fertility, its chemical and biological properties in order to prevent depletion, drying up and compaction of the soil. 30 years have passed since the last agrochemical examination of the fields, and in order for the Law “On the Protection of Soil Fertility of Agricultural Lands” to work in full measure, there is now a need for agrochemical examinations of soils, which correspond to the duties of landowners for the protection, rational use and increase of fertility agricultural lands. Without the availability of data from an agrochemical land survey, as well as without the availability of indicators of the state of fertility of agricultural land, documents and information on the calculation of the need for crops in nutrients, To implement the plan of Agrochemical certification of land shares of peasant (farm) farms, it is first necessary to modernize and re-equip existing soil-agrochemical stations in the cities of Bishkek and Osh region with modern instruments and equipment and, if possible, additionally open soil laboratories in the regions.

	Within 5-7 years, conduct agrochemical surveys of all arable lands, fallows and perennial plantations of the republic in the context of land shares, regardless of the form of ownership, with the issuance of agrochemical passports at the expense of the republican budget. In the future, to legally oblige landowners with an interval of five years for irrigated and seven years for rainfed lands, at their own expense, to conduct an agrochemical survey and update the data of agrochemical passports of land shares, as well as this document should be an integral part of the purchase and sale of land.
Climate benefits	
Adaptation	Soils fertility monitoring provides adequate crop farming management decision on the need and norm of a farmland fertilising, thus, assuring high crop yields and, consequently food security and safe nutrition. Co-benefits of this technology implementation is the digital inventory of the land plots, which will contribute to better planning of the climate resilient crop localization, as well as to the Sustainable Land Management development.
Mitigation	Sound soils serve for GHG removals and stock.
Specifications	
Performance:	Soil fertility of farmers' land plots will increase and/or remain
Resource efficiency:	Costs for agricultural technology and soil fertilization will be more efficient.
Life time:	Unclear question.
National context	
Market potential:	The Kyrgyz Republic is an agrarian country, about 65-70% of the population lives in rural areas, and there are more than 400 thousand land users in the Republic and everyone wants to receive the planned harvest of agricultural crops. In agriculture, everything is important, conditioned seeds, compliance with agricultural technology, etc., but first of all, work must begin with an agrochemical analysis of the soil. Market potential: 400 thousand land plots: 5 years = 80 thousand analyses per year.
Advantages:	Agrochemical analyses of soils for the land user to obtain a planned and high-quality harvest of agricultural crops will allow the use of reasonable doses of organic and mineral fertilizers without harming nature. Secondly, constantly monitor soil fertility. According to the Law "On the protection of soil fertility of agricultural land" (10.08.2012, No. 165), the land user is obliged to take measures to preserve and improve land fertility.
Disadvantaged	• Gaps in Land legislation. • Lack of needed technical regulations • To conduct agrochemical surveys of more than 400 thousand land plots, it will take about 5-6 years and financial resources to open soil laboratories in the regions.
Necessary institutional requirements	The Ministry of Agriculture to develop and approve the Rules for conducting an agrochemical survey of soils and certification of fields
Alignment with national priorities	According to Article 101 of the Land Code of the Kyrgyz Republic dated June 2, 1999 No. 45, authorized bodies must maintain the State Land Cadastre of the Kyrgyz Republic. Article 101. State land cadastre 1. The state land cadastre is an integral part of the unified system of state cadastres and is a systematic collection of information and documents on the natural, economic characteristics and legal regime of lands in the Kyrgyz Republic, their categories, which in the form of cadastral maps and plans includes graphic information about the location , size, boundaries of land plots, textual description of the composition of land, quantity, quality of land and their assessment. The state land cadastre includes cadastral surveys, during which soil, geobotanical, ameliorative, agrochemical and other special surveys and surveys are carried out.
Expert opinion	It is necessary to approve at the legislative level the Rules for conducting an agrochemical survey of soils and certification of fields in the Kyrgyz Republic. At the same time, conduct agrochemical surveys for irrigated arable land every 5 years, rainfed arable land for 7 years, seed farms and test plots for 3 years.

	The first round of agrochemical surveys with the issuance of an agrochemical passport for land shares should be carried out at the expense of the state and donor organizations, then the land user must be carried out at his own expense. Conducting agrochemical surveys of soils will have a positive impact on the environment by maintaining and increasing soil fertility.
Price	
Capital expenditures:	1) 400 thousand land plots x 2000 som = 800 million som for conducting agrochemical surveys and issuing an agrochemical passport of the land share (field). 2) Open soil laboratories in Issyk-Kul, Naryn, Batken regions: 3 laboratories x 4 million som = 12 million som. Total about 812 million som. Financial resources in the amount of 812 million som are required.
Operation and maintenance:	Operation and maintenance of soil laboratories at the own expense of the laboratories.
Other:	
Contribution to development, additional benefits	
Increase in income	Due to the agrochemical analysis of soils and the use of reasonable doses of organo-mineral fertilizers by land users, crop yields will increase sharply, incomes of land users will increase, but most importantly, the potential of the land will be preserved.
Workplaces	The opening of soil laboratories in the regions, as well as mass agrochemical soil surveys, will require the involvement and training of relevant specialists (about 40-60 units * 3-4 specialists)
The economic growth	Agrochemical surveys and the use of scientifically based doses of organo-mineral fertilizers will allow land users to receive a planned and high-quality crop crop, which will allow them to receive additional income, and this is economic growth.
Number of beneficiaries:	More than 400 thousand land users.
Health	Agrochemical surveys and the use of scientifically based doses of organo-mineral fertilizers will allow land users to receive a quality crop of crops, which in turn will positively affect the health of the population of the republic.
Education	The culture of agriculture of land users will increase.
Gender equality and social inclusion	Agrochemical soil surveys will not address gender equality issues. However, indirectly improve food security and nutrition/
Environmental benefits	Preservation and improvement of soil fertility, fulfilment of the tasks of the food programme of the republic. Better Land Use Matrix.
Implementation options	Big investments required
Barriers to implementation	• Agrochemical surveys with the issuance of an agrochemical passport of land shares are not fixed at the legislative level. • Not enough specialists to conduct full-fledged survey covering the whole country.

Technology Fact Sheet # 4

Sector	**Agriculture**
Subsector	**Crop Farming**
Technology name	**Organic Agriculture**
Introduction	Organic agriculture is based on the concept of sustainable development, which is built into the existing ecosystem, does not disturb its harmonious functioning, preserves nature and provides the population with quality food. Organic farming is carried out on the basis of standards IFOAM (IFOAM), land monitoring, as well as control of MPC of harmful substances in products. Compliance with regulations and strict control occurs at all stages of the production process. Organic agriculture products are grown without the use of agrochemicals, pesticides, mineral fertilizers, genetically modified organisms, antibiotics, growth stimulants. These substances pose a danger to human health and threaten the environment. Organic food products are processed by biological, mechanical and physical methods in a way that maintains the quality of each ingredient. Organic products are protected from pests and diseases by good production practices that include proper cleaning and hygiene without the use of chemical treatments or irradiation.

	Such products are processed without the use of gases, synthetic waxes, chemical additives to improve taste or extend shelf life. Eco-friendly packaging has a minimal negative impact on the environment. organic(ecological, biological) agriculture - a method of farming, within which there is a conscious minimization of the use of synthetic fertilizers, pesticides, plant growth regulators, feed additives. In organic agricultural production, the provision of cultivated plants with organic nutrition elements, pest and weed control is coming to the fore, biological methods of plant protection using crop rotations, organic fertilizers (manure, composts, crop residues, green manure, etc.) and various processing methods are more actively used. soil.
Climate benefits	
Adaptation	Switching to organic farming will improve food security and nutrition. It will also increase the income of family farms
Mitigation	Reducing the use of mineral fertilizers will reduce direct and indirect emissions of nitrous oxide from soils.
Specifications	
Performance:	Increase in production by 15%
Resource efficiency:	Soil conservation.
Life time:	long term
National context	
Market potential:	When conducting organic agricultural production, own resources are used, established national traditions of agricultural production are applied, soil fertility is increased, biodiversity is preserved, and most importantly, the environment is not polluted. In recent years, the demand for organic food has been constantly growing in the world. The Kyrgyz Republic is a country in which the natural biodiversity and ecological state are not violated and are preserved almost in their original form, and therefore the republic has all the conditions for the production of environmentally friendly organic food. It is well known that land resources in the Kyrgyz Republic are limited. This leads to the production of insignificant volumes of agricultural products, including organic ones, as a result of which it is uncompetitive on the world market.
Advantages:	The Republic has all the conditions and opportunities to enter the market of near and far abroad with organic agricultural products that have special taste qualities, which have no analogues on the world market. Currently, the republic has the first experience of organic agricultural production is gaining momentum. Organic farms are represented by three large agricultural cooperatives, 12 organic aimags, uniting 23 villages. There are 2 certified farms. The number of economic entities producing organic products has reached 1,700. These farms grow organic products on 7,000 hectares of organic land. There are 32 thousand hectares for growing organic products.[134] The main organic products in the republic are cotton, chickpeas, beans, apricots, medicinal herbs, prunes, nuts, and potatoes. According to IFOAM (International Federation of Organic Agriculture Movements), the number of economic entities producing organic products in Kyrgyzstan has reached 1035.[135] A project on the development of organic agriculture is being implemented in the Kyrgyz Republic with the support of KOICA and FAO. Advantages: - Refusal of hazardous chemicals; - saving money on expensive synthetic fertilizers; - guaranteed quality and product certification; - improved taste and nutritional value of products; - environmental Protection;

[134] https://www.akchabar.kg/ru/news/v-kyrgyzstane-ploshad-vyrashivaniya-organicheskoj-produkcii-dostigla-32-tysyach-ga/
[135] www.tazabek.kg/news:1540677?f=cp

	- utilization and composting of organic waste for fertilizing fields; - improvement of soil quality.
Disadvantages:	The development of organic agricultural production may be hindered by the following factors: - lack of a regulatory framework, system of inspection, certification and accreditation, database, marketing and monitoring. - insufficient presence or absence of organic seed and planting materials in the republic; - selective (not permanent) use by economic entities of organic production of biological plant protection products and organic fertilizers; - non-transparent implementation of certification systems; - uncontrolled import into the territory of the republic of seeds produced with the use of genetically modified organisms (GMOs) and synthetic substances, the use of which is contrary to organic methods of agricultural production; - lack of knowledge and practical skills of economic entities of agriculture in the cultivation of organic products. - insufficient attractiveness of long-term investments for domestic banking capital, foreign investors, as well as the lack of financial support from donor organizations; - high cost of certificates issued by international organizations to bring organic products to foreign markets; - lack of own capital of business entities starting organic agricultural production; - lack of marketing and financial management skills. - difficulty in promoting rotational crops
Necessary institutional requirements	It is necessary to develop and implement by-laws on production and certification standards. You need to create a certificate service. However, certification requires a base, a laboratory, which is not available in the republic famous for its organic products.
Alignment with national priorities	1. Law of the Kyrgyz Republic "On organic agricultural production in the Kyrgyz Republic" dated May 18, 2019 No. 65 2. Concept for the development of organic agricultural production in the Kyrgyz Republic for 2017-2022. PPKR dated August 2, 2017 No. 459
Expert opinion	A large-scale implementation is necessary, and at the expense of providing unproductive lands for use to everyone.
Price	
Capital expenditures:	The current conversion and maintenance rates are 270 and 180 EUR/ha[136] The total cost of creating an organic peasant farm will amount to USD 8,666,623. At the same time, the annual expenses of the enterprise will amount to USD 1,984,591. And the revenue for the year will be from USD 4,873,827. Thus, this project is effective and the payback period will be just over 30 months.[137]
Operation and maintenance:	Included above
Other:	Certification of one type of product costs USD 18,000 for one agricultural enterprise
Contribution to development, additional benefits	
Increase in income	Increasing of a farm revenue by 30%-50% compared to traditional
Workplaces	16 thousand people
The economic growth	Agricultural production output will increase 30%.
Number of beneficiaries:	60 thousand people
Health	Quality products contribute to better health. Development of children and lactating women.
Education	Increasing knowledge of the benefits of organic SH will facilitate the development of curricula for schools.

[136] https://rosorganic.ru/news/cap-256-millionov-evro-na-organiche.html

[137] peasant farm in the Kostanay region will amount to 507,767,040 roubles (USD 8,666,623). At the same time, the annual expenses of the enterprise will amount to 116,274,800 roubles (USD 1,984,591). And the revenue for the year will be from 285,551,680 roubles ($4,873,827).https://dspace.susu.ru/xmlui/bitstream/handle/0001.74/15914/2017_411_filatovaa.pdf?sequence=1

Gender equality and social inclusion	The main pillar of organic communities, of course, are women. Of the 18 leaders of the organic aimag (Rural Districts), 12 are women. Of the 1,052 farmers certified under the Guaranteed Participation System (PGS), more than 60% are women. Production enterprises in organic aimags are mostly run by women.[138]
Environmental benefits	Reduced soil pollution. Less emissions of GHG. Conservation of biodiversity.
Implementation options	There are about 500 thousand hectares of low-productive agricultural lands in Kyrgyzstan.
Barriers to implementation	Lack of investment funds, personnel and laboratories and regulatory framework.

Technology Fact Sheet # 5

Sector	**Agriculture**
Subsector	**Agriculture and forestry**
Technology name	**Agroforestry**
Introduction (general information)	Agroforestry is a management systemof the land use, in which trees or shrubs are grown around or among crops or pastures. This diversification of the farming system initiates agro-ecological continuity, as in natural ecosystems, and thus sets off a chain of events that increase the functionality and resilience of the farming system. Trees also produce a wide range of useful and sought-after fruit/nut products, medicines, wood products, etc. This is a deliberate combination of agriculture and forestry has many benefits, such as a significant increase in the yield of staple food crops, increased income for farmers through income generation, increased biodiversity, improved soil structure and health, reduced erosion and carbon sequestration.
Climate benefits	
Adaptation	The proposed agroforestry system and climate-smart farming practices will support ecosystem development, ensure the financial sustainability of local governments and climate change resilience, contribute to food security and improve the nutrition of the local population.
Mitigation	Reducing greenhouse gas emissions by 16.63%, where forests and gardens account for 2.24%; Combating deforestation and land degradation is a means to reduce the adverse effects of climate change, as well as to improve coordination and build capacity for livelihood development and resilience.
Specifications	
Performance:	The agroforestry method will help to get multiple crops from one piece of land and improve household nutrition. The intensification of agriculture will give high yields from one plot. Walnut plantations will begin to bear fruit in 5-7 years (considering that modern varieties produce fruits much earlier than forest ones) and so on for 100-120 years. This is an alternative source of income for mining activities, which can be a good source of income for many years to come. The seedlings will become full-fledged trees 10 years after planting and will fully participate in sequestration. The leaves of these trees will fertilize the soil and serve as compost. The leaves of the trees will serve as green manure, and also as feed for farm animals.
Resource efficiency:	The need to introduce an agroforestry system will provide the local population with a wide range of economic, socio-cultural and environmental benefits. Agroforestry will ensure the resistance of agricultural lands to erosion, landslides, floods, winds and droughts, increase soil fertility, water-holding capacity, improve the agrophysical and agrochemical properties of the soil, and contribute to the restoration of unproductive agricultural lands
Life time:	For many years
National context	
Market potential:	Aims at building the capacity of local residents so that the needs of the residents coincide with the offers of the market, and the asymmetry of information and practices is eliminated.

[138] https://www.thethirdpole.net/ru/553/78541/

Advantages:	Agroforestry contributes to soil improvement, protection from erosion, leaching of nitrates and flooding, and has benefits for the conservation and enhancement of biodiversity. Will help territorial development, all stakeholders (local authorities, communities) is an additional guarantee of sustainability.
Disadvantages:	• Improving the regulatory legal framework; • Lack of developed markets; • Lack of information on agroforestry; • Lack of high-yielding seedlings in the local market; • Lack of scientific research; • Lack and lack of knowledge in the agroforestry system; • Lack of planning and financial literacy; • Lack of fertile soils; • Transition from extensive farming to intensive farming.
Necessary institutional requirements	In Kyrgyzstan, a system of integrated agriculture and forestry is traditionally practiced in various forms of agroforestry, especially in the southern regions of the republic, the positive experience of which needs to be extended to other regions and regions of Kyrgyzstan. In this regard, it is necessary to create an appropriate mechanism for the introduction of agroforestry throughout the country in coordination and cooperation with all relevant stakeholders, as well as in synergy with sectoral strategies and programs. Policy support is required for effective agroforestry research, including the development and dissemination of agroforestry systems for different agroecological areas, as well as technical support for the transformation of agroforestry into a results-based industry to ensure the well-being of the population, farmers and forest users.
Alignment with national priorities	Forest Code of the Kyrgyz Republic dated July 8, 1999 No. 66; Decree of the President of the Kyrgyz Republic "On measures to develop the agro-industrial complex of the Kyrgyz Republic" dated February 8, 2021 No. 25; Concept for the development of the forest industry of the Kyrgyz Republic for the period up to 2040; The Cabinet of Ministers of the Kyrgyz Republic has directed national priorities to improve the welfare of citizens by creating an environment for the socio-economic development of the region, implementing anti-crisis measures and laying the foundations for successfully achieving long-term development goals in the face of climate change.
Expert opinion	To improve the management of state lands, it is necessary to use a mechanism based on the principle of a reasonable balance of the economic return of lands for the well-being of society and the exclusion of their degradation. At the same time, the most important tool for improving efficiency will be the introduction of innovative and modern technologies in the practice of managing and monitoring the country's land. To achieve the goal of improving the efficiency of management of degraded land resources, namely agricultural and forestry lands in Kyrgyzstan, it is necessary to introduce agroforestry as a system of efficient land use.
Price	
Capital expenditures:	Costs for creating 1 hectare of intensive garden: - 238 pieces of seedlings at a price of USD 5 – USD 1300 - garden fencing - USD 1000 - fertilizers - USD 300 - agrotechnical work to prepare the land - USD 100 - installation of a drip irrigation system - USD 3600 - expenses associated with seasonal work - USD 300 Total: USD 6800-7000
Operation and maintenance:	Drip irrigation is required, the creation of artificial mini-glaciers, especially in hard-to-reach places.
Other:	
Contribution to development, additional benefits	

Increase in income	The agroforestry approach will help to have multiple crops from a single piece of land and will improve the well-being of households through multiple crops. The intensification of agriculture will give high yields from one plot.
Workplaces	The introduction of agroforestry will help create additional jobs (from 100 in one rural area) and stop the migration of the younger generation for over 20 years.
The economic growth	Increasing the contribution of agriculture to the growth of the income of the budget of the republic, from the introduction of the agroforestry system by 2030 by 10 times. Reducing the poverty level of the rural population by 25%.
Number of beneficiaries:	Scaling all regions and attracting farmers especially in remote areas.
Health	The agroforestry system and climate-smart farming practices will support the development of ecosystems, provide resilience to climate change, contribute to food security and improve the nutrition of the local population, and improve the living standards of rural areas.
Education	Introduction of the agroforestry system into the curricula of universities and other professional educational institutions; Development of special programs for the development, expansion and promotion of agroforestry systems at local levels; Training, professional development and technical services to all who wish to introduce agroforestry at the regional level.
Gender equality and social inclusion	The involvement of women will make it possible to obtain additional financial resources for the well-being of the family and participation in the social life of the village.
Environmental benefits	Climatic factors such as high temperatures and heavy rains undermine agricultural production by intensifying the process of aridity. This vicious circle is fueled by climate change. Also, climate change contributes to the development of adaptation and mitigation measures aimed at more efficient use of natural resources and improvement of management practices in other areas of human life. Thus, the agroforestry system, whose development becomes more promising as a result of shifting climatic zones or changes in precipitation, is a solution to climate change and can serve as a hedge against a potential threat like land degradation.
Implementation options	Optimization of the management system for the introduction of agroforestry in the regions (functional analysis); Development of an agroforestry system for the whole country and for further development; Conducting an information campaign on the development of the agroforestry system Application of innovative approaches and new technologies in development. The agroforestry system has innovative approaches and new technologies that can be scaled up across the country, such as drip irrigation on rainfed or hard-to-reach lands;
Barriers to implementation	Lack of funds Enabling frames gaps

Technology Fact Sheet # 6

Sector	**Agriculture**
Subsector	**Agriculture and Forestry**
Technology name	**Sustainable Use Conservation of Walnut Fruit Forests' Genetic Resources**
Introduction (general information)	In the mountains of the Western Tien Shan (southern Kyrgyzstan) there are the largest in the world, in terms of area and diversity of trees and shrubs, walnut-fruit forests. Walnut, pistachio, almond, apple, pear, plum, hawthorn, grapes, sea buckthorn, currant, barberry and other fruit and forest species grow in the forests. In terms of the diversity of the species composition of fruit plants, the Western Tien Shan has much in common with other mountainous regions of Central Asia, which is considered the centre of origin and repository of genetic resources for a large number of currently cultivated fruit plants. Many ancient local varieties of crops such as walnut, apple, apricot, plum, grape, pomegranate, almond, grown by the population in mountainous areas, have a surprising resemblance to their wild relatives from mountain forests.
Climate benefits	

Adaptation	Walnut and fruit forests are concentrated in three forest regions of the republic from an altitude of 1100 to 2100-2300 m above sea level. They perform a huge soil-protective, water-protective and water-regulating role, they are the centre of origin of cultivated plants, a repository of biodiversity and the genetic fund of flora and fauna characteristic of this biogeocenosis. The total area of walnut forests is 631 thousand hectares. The age structure of walnut forests: young stands make up about 10%, middle-aged stands make up one third, and the rest of the area (almost 60%) is mature and overmature stands aged 100-120 years or more. Walnut has long been cultivated around the world and varieties have been developed, but the huge genetic diversity of this breed is still far from being used. And the pantry of these genetic resources is a unique, vast population of walnuts - the walnut-fruit forests of the Western Tien Shan. On the southwestern foothills of the Ferghana Range, on an area of 36.01 thousand hectares, wild pistachio grows. It is the only nut breed able to successfully grow and bear fruit in exceptionally dry conditions where other breeds cannot grow. The most valuable pistachios are nuts that have high taste and nutritional qualities, which have received worldwide recognition. The nut kernel contains up to 70% fat, up to 20% proteins, carbohydrates and biologically active substances. Other parts of the tree have been used since ancient times in the manufacture of varnishes, paints and tanning agents, in woodworking, and for medicinal purposes. Due to the powerful root system, the pistachio is of great soil and water conservation importance. In essence, preserving biodiversity on its territory, Kyrgyzstan performs the functions of one of the planetary bio reserves, and while maintaining a stable area of functioning of genetically healthy material of flora and fauna, it performs the functions of a regional bio-nursery.
Mitigation	The unique genetic diversity is under the threat of extinction, due to the almost complete absence of natural seed renewal, unauthorized economic activity of the population, livestock grazing, lack of protective and reforestation measures. Under these conditions, the preservation of the diversity existing in the forests of Kyrgyzstan is of paramount importance for the evolution and development of forests, providing all user groups, including breeders and researchers, with genetic material.
Specifications	
Performance:	Walnut plantations bring up to 20-30 kg/ha
Resource efficiency:	Healthy forest ecosystems contribute to the solution of food security and food security (which is becoming extremely important in the face of growing epidemiological risks), ensures the high quality and energy value of the products obtained as a guarantee of good human health and the preservation of the gene pool of the people.
Life time:	Long years
National context	
Market potential:	The organization of organic production of agricultural products is an additional source of income for farmers, it is also a contribution to the fight against poverty of the population and is an important tool for sustainable management of the agricultural and forestry sectors, it is the contribution of these sectors of the economy to the socio-economic development of the country. Walnut plantations and wild berries, fruits have nutritional value, and can bring economic benefits to the welfare of the local. Production of organic products (it is possible to produce “organics” of the reference range of the “premium” class). The organic direction not only does not destroy nature, but also actively contributes to the conservation and restoration of the habitat, ensures the sustainable renewal of its resource base (unlike other forms of economic activity). Already, about 50% of agricultural products produced are objectively organic (meets the basic requirements), but do not have certification. The turnover of organic products is about USD 90 billion and it is expected to increase by 10-15% annually, and by 2024 it may reach USD 324 billion.

Advantages:	It will make a significant contribution to strengthening the food and environmental security of the republic, which has such advantages as: improving the climate, eroded and depleted lands, the appearance of moisture and a humid microclimate, improving biological diversity, improving the ecology and habitat for people.
Flaws:	Degradation of forests, reduction of forest cover, loss of the forest gene pool, etc., threaten the complete and irretrievable loss of vegetation and soil cover and the formation of a lifeless desert on previously productive lands. Many plants are valuable as a source of cash receipts for the population and the state from the sale of products: berries, fruits, nuts, mushrooms, medicinal raw materials. The disappearance of these plant species or some of them will have negative consequences for the economy of local communities and the republic as a whole. Of particular value are medicinal plants, of which more than 200 species have been identified. In Kyrgyzstan, more than 60 types of medicines are produced from plants of the domestic flora. Some of the medicinal plants that grow only on the territory of Kyrgyzstan (54 species), is under threat of extinction. Irrational and uncontrolled use of the country's natural resources in the future can cause irreparable damage to ecosystems, which will reduce incomes and increase poverty of the population, further worsening the economic situation. Due to the high sensitivity of the Tien Shan mountain ecocommunities to anthropogenic impact, there is a need for particularly careful control of nature management. The practical solution of many problems in the protection of mountain ecosystems is directly or indirectly related to the protection of the unique vegetation of the mountains. The recovery rate of walnut forests is only 5%, indicating that there is not enough reforestation. The local population is mainly engaged in the collection and sale of walnuts and is not interested in reproducing walnut trees in the forests, as there are no incentives for this. The development of new directions for economic activity will reduce the burden on walnut trees and reduce environmental risks.
Necessary institutional requirements	Increasing the productivity and sustainability of forestry □ applying methods that ensure sustainable productivity increases and address climate change and environmental degradation; Development of forestry for the sustainable management of natural resources and the expansion of income-generating opportunities among the rural population
Alignment with national priorities	Forest Code of the Kyrgyz Republic dated July 8, 1999 No. 66; Decree of the President of the Kyrgyz Republic "On measures to develop the agro-industrial complex of the Kyrgyz Republic" dated February 8, 2021 No. 25; Concept for the development of the forest industry of the Kyrgyz Republic for the period up to 2040;
Expert opinion	Developing national capacity to successfully implement large-scale and sustainable measures to restore forests and other wooded lands, and improve technical knowledge to prevent degradation, improve ecosystem functions, provide shade, conserve soils, store CO_2, and regulate water flows. Develop and approve a state programme for the restoration and expansion of areas of walnut-fruit forests, provide annually in the budget of the republic funds to increase areas for walnut-fruit forests, form an investment centre to attract international projects.
Price	
Capital expenditures:	Costs for creating 1 hectare of intensive garden: - 238 pieces of seedlings at a price of USD5 - USD1300 - garden fencing - USD 1000 - fertilizers - USD 300 - agrotechnical work to prepare the land - USD 100 - installation of a drip irrigation system - USD 3600 - expenses associated with seasonal work - USD 300 Total: USD6800-7000
Operation and maintenance:	
Other:	
Contribution to development, additional benefits	

Increase in income	Growing multiple crops from a single piece of land will improve the well-being of households through multiple crops. The intensification of agriculture will give high yields from one plot. Increasing demand for wild forest products. Almost all parts of the walnut tree are for sale. The trunk and branches are used in the furniture industry. Leaves, roots, peel, shells of nuts are raw materials for the chemical and pharmaceutical industries. Constant profits can be made for decades. Long shelf life of the product, no special storage conditions and simple transportation conditions.
Workplaces	Creation of additional jobs (from 100 in one rural area), suspension of migration of the young generation over 20 years
The economic growth	For the effective implementation of sustainable management and conservation of genetic resources Walnut-fruit forests a budget and programs are needed that will be provided annually by republican, regional and local authorities. -Increasing the contribution of agriculture to the growth of income of the republic's budget. - Reducing the poverty level of the rural population by 25%. increasing the productivity of forests; - Increasing the economic efficiency of forestry - Increasing the value of forest land; - Reducing the cost of compensation for victims of mudflows, landslides and other natural disasters associated with insufficient protective forest plantations.
Number of beneficiaries:	Scaling all regions and attracting farmers especially in remote areas.
Health	Climate-smart farming practices will support the development of ecosystems, provide resilience to climate change, contribute to food security and improve the nutrition of the local population, and improve the living standards of rural areas.
Education	Develop and approve a state programme for the restoration and expansion of walnut fruit forests.
Gender equality and social inclusion	Will not address gender equality issues
Environmental benefits	Ecological benefits from reducing the volume of environmental protection measures aimed at reducing water and wind erosion of soils, preserving biodiversity of flora and fauna, and reducing net carbon dioxide emissions. Social is the creation of recreational areas that improve the health of the local population, changing the attitude of the population to the preservation of positive experience in the conservation and expansion of forestland, improving the management of the forest fund in the regions.
Implementation options	The need for institutional reform that will ensure the sustainable development, management and use of agriculture and forestry sectors. Institutional reform should be aimed at the efficient use of land resources, trade in manufactured products, ensuring the well-being and food security of the population.
Barriers to implementation	Expected barriers and risks are the lack of financial means to implement the desired measures.

Technology Fact Sheet # 7

Sector	**Agriculture**
Subsector	**Land Management**
Technology name	**Digitization of land use maps**
Introduction (short description)	The most important factor in the development of the economy of the agrarian and / or agro-industrial region is the effective use of the resource potential of organizations of the agro-industrial complex. When considering the composition of the resource potential in agriculture, special attention is paid to land resources, since the effectiveness and efficiency of the functioning of not only this industry, but also the country's economy as a whole depends on their availability and condition. Land resources in agricultural production act simultaneously as an object and a means of production. As a means of production, land is non-renewable,

	non-replaceable, spatially limited, therefore, with rational land use, land resources can not only maintain their quality characteristics, but also improve them. Agricultural land in our country is used insufficiently efficiently and irrationally, which leads to negative consequences (decrease in soil fertility, susceptibility to erosion, pollution, waterlogging, etc.). All this can have a negative impact on the food and economic security of our country. The use of digital technologies in agriculture will contribute to the formation of sound and consistent with modern trends in the development of the economy, the directions of state and / or municipal policy for managing real estate (including land resources) by more effective and objective methods. This is due to the fact that public authorities and local governments should use modern IT technologies in their activities, which will give farmers the opportunity to collect, process, and analyze large amounts of various data. In addition, agricultural producers will be able to ensure a sufficient level of information security, and state authorities and local governments optimize the process of making managerial decisions regarding the land and resource potential of the agro-industrial complex. All of the above confirms the relevance of this issue. The existing experience in the implementation of digital technologies in various industries and directions shows that the widespread introduction of IT technologies in the management of the land and resource potential of agriculture is possible only if there is access to a sufficient amount of reliable and objective data on all land use objects and on all types of resources. The latter requires a full inventory and constant monitoring of the natural resource potential of the industry and the digital transformation of the system of state information support for land use. Therefore, the basis of the Digital Agriculture project is certainly digital basic data on land use and land cover. Digital technologies are present in all spheres of human life, which is associated with new requirements for production technologies, information systems, computer technology, etc., therefore, it is also necessary to develop integrated digital solutions in land use. The most significant technologies that make it possible to switch to digital management of the land-resource potential of land use are "remote sensing of the earth (ERS) using satellite systems for the formation of electronic maps of fields and the use of UAVs with multispectral cameras for remote monitoring of the state of the environment, soil, ecological situation, crop growth, vegetation index determination, early diagnosis of plant diseases, irrigation management, etc. Despite all the measures taken to rationalize land use, a number of problems related to the process of land management remain unresolved. First of all, this is due to the fact that human activity in the production of agricultural products can cause irreparable damage to the land: littering, reduced soil fertility, degradation, etc. Under these conditions, the role of municipal land control is increasing, whose specialists also cannot obtain positive results without the use of digital technologies.
Climate benefits	
Adaptation	The digital transformation of the mechanism for managing land and resource potential should affect the processes of making managerial decisions in the field of land use at all levels of government and management, as well as management and rely on innovative production technologies, as well as the use of information about the current state and prospects for the development of the management object (land resources). As a result of digitalization, it is possible to improve the relationship between individual economic entities and reduce transaction costs. This is due to the fact that the functioning of digital platforms will allow optimizing logistics, eliminating unnecessary intermediaries from the distribution chain, and delivering manufactured products to the end consumer faster. Automation of decision-making processes in terms of land management of economic entities, as well as the introduction of intelligent systems for managing the resource potential of agriculture, lead to an increase in the competitiveness of domestic agricultural producers both in the domestic and foreign markets. The use of digital products for agrotechnical processes by domestic farmers can reduce the cost of food in certain sub-sectors by up to 15%.
Mitigation	The mitigation benefit is also clear, as sustainable land management promotes carbon sequestration in the soil.
Specifications	

Performance:	The digitalization of land management is aimed at obtaining various kinds of effects (production, social, financial, etc.) that can ensure more rational and efficient agricultural land use and, thus, achieve higher competitiveness for domestic economic entities.
Resource efficiency:	The purpose of creating digital land use maps (agricultural land and lands) is to aggregate heterogeneous field information in a single file containing spatial reference and field boundary information. The high-precision basis obtained by analyzing aerospace images allows you to correctly design routes for agricultural equipment and work in programs using GLONAS technologies. Tasks for which electronic maps of agricultural lands and lands can be used: • introduction of precision farming technologies or No-Till; • creation of a fertility passport; • environmental monitoring; • creation of cartograms of soil properties; • yield analysis, creation of thematic maps; • execution of land management and cadastral works; • territorial planning; • construction of roads, highways and interchanges;
Lifespan:	long term
National context	
Market potential:	Approximately 430 rural districts throughout the country/
Advantages:	Without the development and implementation of innovative digital technologies in the agricultural industry, it is impossible to increase the effectiveness and efficiency of the use of the land and resource potential of the industry in modern conditions. At the same time, inefficient land use in agriculture will not ensure the sustainability of the functioning of both individual economic entities and the industry as a whole, which will inevitably affect the economic security of the regions and the country. The digital transformation of the mechanism of land management in agriculture is based on the introduction of innovative processes for the production of agricultural products and the use of up-to-date information on the state and prospects of the natural resource potential of the industry.
Disadvantages:	An integrated approach to solving the problem is required. Simply creating a digital land use database (digital maps) does not solve the whole problem.
Necessary institutional requirements	Despite the existing problems of digitalization of agricultural land management (insufficient provision of rural areas access to the Internet, lack of financial resources to update the material and technical base and improve the skills of staff), which impede the introduction of digital innovations, local and regional authorities, as well as the farmers themselves, should ensure the formation of conditions for the transfer of information, the exchange of documents, implementation of training of specialists of the necessary qualifications and specialties in a remote format using IT technologies.
Alignment with national priorities	It is in line with the National Development Strategy 2018-2040 and the National Development Programme until 2026.
Expert opinion	In our country, the use of digital technologies in managing the land and resource potential of agriculture is associated with the need to increase production volumes and increase productivity and quality of labor in the industry. It is necessary to take into account the fact that the digitalization of the management of the land resource potential of land use should include not only the automation of the management process itself, but also the improvement of technological processes, for example, the introduction of a “precision farming” system, remote monitoring of fields, etc.
Costs	
Capital expenditures:	Experience from other countries and rapid assessments indicate that a total of USD 15 million will be required from various sources, both internal and external.
Operation and maintenance:	Capacity Building for Land Services and Local Governments Resilient to the Impacts of Climate Change – USD 5,000,000
Another:	

Other benefits	
Income increase	Help reduce poverty. Increase in income at a moderate pace
Workplaces	At an average rate
The economic growth	Increasing social sustainability and multi-stakeholder collaboration Agricultural production at an average pace.
Number of beneficiaries:	Significant
Health	Improving food security and nutrition
Education	It is necessary to create a centre of competence under the Land Resources Service under the Ministry of Agriculture.
Gender equality and social inclusion	The creation of digital systems expands the opportunities for women to participate in agricultural production.
Environmental benefits	• Increase in biomass and vegetation • Biodiversity restored, including plant species • Permanent water sources (open and underground) • Increasing soil fertility • Reducing greenhouse gas emissions • Disaster Risk Reduction • Guaranteed environmental sustainability and ecosystem functions and services
Implementation Options	Countrywide. There are some best practices as well as developed management tools, including software, Digital Mapping Guide, etc.
Barriers to Implementation	- Lack of funding - Lack of managerial knowledge and skills. - Outdated equipment.

Technology Fact Sheet # 8

Sector	Agriculture
Subsector	Animal Husbandry
Technology name	Production facility for the equipment for the extruded feed for livestock/
Introduction (Short description)	Creation of a workshop for the assembly and maintenance of equipment for the production of extruded feed for livestock: cattle (milk cows), sheep and goats, horses, etc. Kyrgyzstan is a mountainous agrarian republic. Agriculture in Kyrgyzstan is one of the leading sectors of the economy. In the total volume of the country's gross domestic product, the share of agriculture is a significant part of 24%. Animal husbandry is a traditional and one of the most important branches of agriculture in Kyrgyzstan, in which almost the entire rural population of the country is employed to one degree or another. The level of productivity of farm animals in Kyrgyzstan is low. The main factors of such low productivity of animals are the extensive form of the industry, the lack of good feeding and maintenance. Solution: Increasing the productivity of farm animals through complete feeding, i.e. fattening of animals with extruded granulated feed. Regardless of the type of feedlot (indoor, under a canopy, open), the production of extruded feed in the required quantities is possible for both small and large livestock, for this, you need equipment with a certain production capacity. For each type of animal and for each sex and age group, individual rations and feeding methods with full-ration extruded compound feed are compiled. The use of extruded feed allows you to get high milk yields up to 15 thousand. kg per year, an increase in the average daily weight gain - up to 20%, the safety of young animals increases up to 95%. Extruders make it possible to obtain a new generation of feed from both grain and grain mixtures and straw. Benefits of implementation: 1. High digestibility (up to 90-95%, i.e. only 5-10% goes into manure) - allows you to introduce more than 30-40% less than the usual portion into the animal's diet (that is, less feed is required).

	2. Sterility - this quality is especially valuable when fattening in the early stages of development. 3. Excellent absorption properties when feeding, neutralize various intestinal infections and irritations. 4. Special taste qualities are a stimulant for animals to use when mixing feeds of lower consumer quality. 5. High weight gain reduces the time of keeping animals for fattening. 6. Extruded feed allows you to store it from 4 to 6 months without changing the original properties. 7. Use dry food without steaming. The organization of a workshop for the assembly and maintenance of equipment for the production of extruded feed for cattle / small cattle will help reduce the price of both the equipment itself and its maintenance in the future, because local materials will be partly used, and the issue of equipment leasing will be worked out.
Climate benefits	
Adaptation	Better feed improves livestock productivity by up to 20%, which improves the climate resilience of agri-food systems and improves food security and nutrition.
Mitigation	Higher feed quality reduces GHG emissions under the enteric fermentation category.
Specifications	
Performance:	Assembly and delivery of 1 set of equipment per month (equipment capacity from 15 kg/hour to 500 kg/hour)
Resource efficiency:	Savings on components up to 20%
Life time:	At least 15 years
National context	
Market potential:	High
Advantages:	Digestibility of extruded feed up to 95%, increase in animal productivity up to 20%, saving on feed up to 30% After the creation of the workshop, the possibility will be worked out for the sale of equipment on lease
Disadvantages:	Relatively high price. Lack of equipment in the domestic market. Lack of qualified personnel.
Necessary institutional requirements	Not
Alignment with national priorities	National Development Strategy for 2018-2040 National Development Programme until 2026
Expert opinion	Has a high market potential for ambassador approbation. Especially when promoting the approach of cluster development of agriculture.
Costs	
Capital expenditures:	Organization of a workshop for the assembly and maintenance of equipment for the production of extruded feed - USD 95,000
Operation and maintenance:	Operation - up to 1,500 USD per month
Other:	Conducting training seminars, preparation and reproduction of brochures and manuals - USD 10,000
Contribution to development, additional benefits	
Increase in income	When using equipment for the production of extruded feed, it will save up to 30-40% on feed, increase daily gain up to 20%, it becomes possible to sell excess feed
Workplaces	Until 6
The economic growth	Animal fattening farmers will be able to recoup the equipment within no more than 12-15 months, which will lead to a further increase in economic opportunities.
Number of beneficiaries:	Direct - at least 20 Indirect - at least 1500
Health	The use of good feed guarantees the health of animals, which in turn will have a beneficial effect on human health.
Education	It is possible to conduct training to work with the equipment both on site and at our base. It is possible to conduct training seminars on the dissemination of technology. There is an

	agreement with KNAU on holding practical seminars on the topic of fattening and feeding animals
Gender equality and social inclusion	It is possible to partially attract women and people with disabilities to work
Environmental benefits	Reducing waste and emissions from animals, soil pollution.
Implementation options	Possible implementation within 3-6 months
Barriers to implementation	Lack of investment, lack of knowledge and personnel, lack of a market for quality equipment and benefits for obtaining equipment.

Technology Fact Sheet # 9

Sector	**Agriculture**
Subsector	**Crop Farming**
Technology name	**Intensive gardens with drip-fertigation system**
Introduction	Fruits and berries are extremely strong chemical regulators of the digestion process, which is due not so much to their energy value as to their influence on the biochemical processes of digestion and metabolism. Due to the content in fruits and berries of such valuable and easily digestible substances as sugars, vitamins, organic acids, minerals, fresh fruits are vital human food throughout life. A high level of fresh fruit consumption increases human performance and resistance to various diseases. Fruits and berries contain mainly sugar, the amount of which in the fruits of a number of species reaches 20-23%. Nuts contain a lot of fat (65-77%), proteins (15-22% or more) and carbohydrates (2-7%). Fruits, berries and nuts contain acids, mineral and aromatic substances, as well as vitamins C, A1, B1, B2, B6, P and PP, etc. Fruit products have a number of properties that are of great importance in clinical nutrition. All fruits and berries contain a large amount of water. Sometimes up to 80-90% of their total mass. But this is an unusually useful "water", since it contains all the same substances that are related to the regulators of human life (sugars, acids, mineral salts, soluble vitamins, etc.). This water favourably affects the water-salt metabolism. which relate to the regulators of human life (sugars, acids, mineral salts, soluble vitamins, etc.). This water favourably affects the water-salt metabolism. which relate to the regulators of human life (sugars, acids, mineral salts, soluble vitamins, etc.). This water favourably affects the water-salt metabolism. Fruits, nuts and berries are subjected to various processing. They make jam, compotes, dried fruits, marshmallows, jelly, marmalades, jams, syrups, juices, wines. This makes it possible to supply the population with fruit growing products throughout the year. Consuming a variety of fresh fruits and berries throughout the year is necessary to ensure the health of the population. The scientifically substantiated annual rate of consumption of fruits and berries for a person is 90-100 kg. The main task facing the horticulture of Kyrgyzstan at the present stage of its development is to improve the quality of fruits, precocity and productivity of plantings while reducing costs per unit of output. For the development of domestic horticulture, first of all, it is necessary to intensify the transition of specialized horticultural farms to high-intensity types of gardens, which are distinguished by a rapid return on investment in their creation. The leading role in improving the economic efficiency of horticulture belongs to intensive technologies, which, based on the maximum mechanization of production processes, are designed to ensure the most complete realization of the high productivity potential of modern intensive gardens without reducing their environmental sustainability in specific natural and climatic conditions of their growth. Success in this business will be achieved mainly due to the ever wider mastering of progressive technologies for their creation and cultivation. The main methods for increasing the productivity of plantations and the quality of fruits in intensive orchards are pruning, irrigation system, mineral nutrition system, tillage, protection system, harvesting, storage, commodity processing. Ensuring the quality of fruits during production, harvesting, storage and bringing to the consumer is the basis for the competitiveness of products, their prices and the effectiveness of the final result. Due to the high cost of fruits, an essential element of the technology is: a drip irrigation system, fertigation, the availability of a modern fruit storage facility, trade logistics, and work with retail chains.

Climate benefits	
Adaptation	• Strengthening food security of the Kyrgyz Republic. • Improving the quality of nutrition and public health. • Increasing the climate resilience of farm livelihoods.
Mitigation	• Increasing carbon sequestration in perennial plantations
Specifications	
Performance:	Increasing the productivity of fruit crops with intensive plantation cultivation technologies is achieved by regulating the main factors of the production process. In the process of development and fruiting of the apple tree, a large and sometimes decisive role belongs to the water supply of plants, especially in areas of insufficient water supply. Water is necessary for the processes of photosynthesis, serves as a transport for nutrients absorbed by the roots, is necessary to maintain the cell plasma in a state of swelling, and for active metabolism in the cell.
Resource efficiency:	• Increasing the yield up to - 35-40 t / ha. • Increasing the yield of marketable fruits - up to 90%. • High survival rate of seedlings after planting. • Acceleration of entry into commercial fruiting - for the 2nd year. • Reducing the payback period of an intensive garden - up to 3-4 years.
Life time:	8-10 years old
National context	
Market potential:	High market potential
Advantages:	The planting density and yield of an intensive orchard is significantly different from a traditional one. In the first one, from 800 to 2.5 thousand trees are placed on one hectare, and in the second - 350-450. Accordingly, the yield in traditional orchards is much less: 12 t/ha versus up to 60 t/ha in intensive ones. However, intensive orchards, unlike traditional ones, which bear fruit for 30 years, are effective only for 8-10, maximum 12 years, after which their productivity drops sharply, and producers must do a complete renewal of plantings. The main advantages of drip irrigation in intensive gardens: • Yield increase • Increasing the yield of marketable fruits • High survival rate of seedlings after planting. • Acceleration of entry into commercial fruiting - for the 2nd year. • Increasing frost resistance and winter hardiness of trees due to a balanced nutrition system. • Increasing the degree of control of the garden - laying fruit buds, the strength of vegetative growth, solving the problem of the frequency of fruiting. • Reducing the payback period of an intensive garden. The benefits of fertigation are as follows: • Fertilizer accuracy • Fertilizer uniformity • Reducing fertilizer doses • Efficiency of using expensive fertilizers • Apply fertilizer only as needed • Limiting leaching of fertilizers from the soil
Flaws:	- High cost of equipment and high-quality planting material - Fruiting period 8-0 years with the necessary full reclamation - Lack of knowledge on the proper operation of drip-fertigation systems.
Necessary institutional requirements	It is necessary to have service companies conducting maintenance of DIS and consulting services for fertigation.
Alignment with national priorities	Corresponds to: 1) National Development Strategy 2018-2040 2) National Development Programme until 2026

Expert opinion	It is known that the intensity of growth processes, photosynthesis and distribution of assimilates decrease in a plant under prolonged exposure to water deficiency, and the productivity of the entire plant decreases. Water is the main component of fruit plants. Fruits contain 90-92% water, leaves, shoots, branches - from 56 to 75%, roots - 65-68%. To ensure the vital activity of an apple tree during the growing season on an area of 1 ha, up to 200-300 m3 of water is needed. For the formation of an apple harvest of 45 t/ha, 900 mm of precipitation is needed. The use of drip irrigation systems significantly increases the degree of garden controllability, reduces dependence on stress factors, and allows you to maximize the potential of variety-rootstock combinations. When installing drip irrigation systems simultaneously with planting, the survival rate of seedlings increases, the garden enters fruiting in the 1-2nd year. At the time of full fruiting, the garden enters the 3-5th year. With the help of a drip irrigation system, it is possible not only to maintain soil moisture at an optimal level, but also to artificially lower it during certain phenophases as an agricultural technique. A decrease in soil moisture in the garden during flowering helps to increase the percentage of productive ovaries. A more intense water regime during the differentiation of fruit buds also, according to some researchers, contributes to an increase in the number of generative buds. The principle of drip irrigation and fertigation is to supply the required amount of water and nutrients in the phenophases of plant development directly to the root zone, which ensures optimal water-air and nutrient regimes of the soil, reduces water and fertilizer consumption, reduces plant disease and the possibility of spreading diseases. The combination of these simple factors is extremely effective. When using drip irrigation with an automatic control system, an accurate dosed intake of all fertilizers in the solution is carried out, control of the amount of solution per unit of irrigation area. The use of fertigation requires compliance with certain requirements for the use of fertilizers. For fertigation, only completely soluble fertilizers are used, free from sodium and other harmful impurities.
Price	
Capital expenditures:	6 444 USD/ha
Operation and maintenance:	966 USD/ha
Other:	
Other benefits	
Increase in income	Increasing income by 4 times in contrast to the traditional garden up to 60 t/ha
Workplaces	10000
The economic growth	Contributes to the growth of agricultural output by 50%
Number of beneficiaries:	50000
Health	Healthy Nutrients Promote Health and Reduce Disease
Education	It is fashionable to develop and use training modules on intensive gardening with DSE in vocational lyceums and universities
Gender equality and social inclusion	Promotes the involvement of women in agricultural production. Increasing incomes will also contribute to a better standard of living and women's participation in public work.
Environmental benefits	Increase horticultural output by 50%
Implementation options	There are about 500 thousand unproductive agricultural lands that can be used for intensive gardening
Barriers to implementation	• Lack of investment funds • Lack of proper equipment • Lack of technical knowledge on the use of drip-fertigation systems.

Technology Fact Sheet # 10

Sector	**Agriculture**
Subsector	**Crop Farming**
Technology name	**No-tillage farming**

Introduction (Short description)	Ploughing is the agricultural preparation of the soil by mechanical mixing, draft animal mixing, or human muscle agitation, such as ploughing, digging, turning over, shovelling, hoeing and raking. Small scale farming tends to use smaller scale methods using hand tools and in some cases draft animals, while medium scale farming and large scale farming tend to use larger scale methods such as tractors. The overall goal of ploughing is to increase crop yields while conserving resources (soil and water) and protecting the environment. Erosion control tillage refers to a series of methods and techniques for rooting crops on the remnants of a previous crop that are intentionally left on the soil surface. Conservation tillage typically leaves approximately one-third of crop residue on the soil surface. This slows down the movement of water, which reduces soil erosion. Erosion control tillage is useful for a number of crops, such as cereals, vegetables, root crops, sugarcane, cassava, fruits and grapes. Erosion control tillage is a popular technology in many advanced countries. The most common erosion control tillage methods are no-tillage, ridge tillage and mulch tillage. No-tillage is a way of growing crops without mixing the soil. In this method, the remains of last year's crop are left unmixed and planted directly into the remains in the soil prepared for sowing. No-tillage requires special seeding equipment to sow seeds into unmixed crop residues and soil. No-till farming is fundamentally changing the composition of weeds. Relatively fast-growing weeds may no longer be a problem due to stronger competition, but over time trees and shrubs may begin to grow. Cover crops – "green manure" – can be used to control weeds in a no-tillage system. Cover crops are usually legumes, usually rich in nitrogen, often increasing soil fertility. In ridge tillage, the soil is left unmixed from harvest to planting, and the crop is planted in raised ridges. When planting, the top of the ridge is usually removed. Planting is carried out with drags, disc coulters, plough knives and row cleaners. Remains are left on the surface between the ridges. Weeds are controlled by cover crops, herbicides and/or cultivation. Ridges are restored during inter-row cultivation. Mulch tillage practices involve mixing the soil between harvesting one crop and planting the next, but after planting the seeds, about a third of the soil is left covered with residue. Mulching tillage methods use chisel cultivators, shovelers, and field cultivators.
Climate benefits	
Adaptation	Unpredictable rainfall patterns and rising mean temperatures can affect soil moisture, harming crop yields and leading to crop failures. Anti-erosion ploughing methods soils reduce the risk of drought by reducing soil erosion, increasing moisture retention and minimizing soil compaction. These factors combine to increase resilience to climate change impacts such as drought and floods. In addition, improving the recycling of nutrients in the soil helps control crop pests and diseases.
Mitigation	Keeps carbon stock in the soil
Specifications	
Productivity:	Increase in production in farms by 10%.
Resource efficiency:	No-till tillage requires less equipment than conventional tillage. However, for farmers who have already invested heavily in conventional tillage equipment, this can be a burden. In addition, although no-tillage requires less machinery, it does require some specialized equipment that must be purchased. However, new machinery can be acquired gradually over time, or specially designed planters can be hired to plant crops. In general, there appear to be no significant financial barriers to the introduction of no-till technology. No-tillage reduces soil erosion to just 5.6 tons of soil per hectare (t/ha) per year. With conventional ploughing, rainfall is typically around 138 mm per month. No-tillage practices reduce runoff to approximately 42 mm. Runoff is reduced because crop residues on the soil surface slow down the movement of water, giving the water more time to be absorbed by the soil and stored for plant use or released more slowly over time.
Life time:	Long term
National context	
Market potential:	The area of arable land in 2022 was 1,287 thousand hectares.

Advantages:	Erosion control ploughing benefits agriculture by minimizing erosion, increasing soil fertility and increasing crop yields. Ploughing loosens and ventilates the soil, which promotes deeper root penetration. It is believed that ploughing helps the growth of microorganisms present in the soil and the uniform mixing of crop residues, organic matter and nutrients in the soil. In addition, soil erosion control systems benefit farmers by reducing fuel consumption and soil compaction. By reducing the number of trips to the field, farmers significantly save fuel and labour. In addition, after the introduction of this system, labour costs for land preparation and weed control are reduced. This, in turn, increases the time available for additional on-farm work and off-farm activities to diversify livelihoods. In addition, after the implementation of the system, the need for herbicides and fertilizers is reduced. For example, in Paraguay, the total economic benefit from the introduction of no-tillage practices on small farms, typically less than 20 ha, was approximately USD 941 million.
	save fuel and labour. In addition, after the introduction of this system,
	• Cost reduction due to:
	• Reduced processing time
	• Increase in the area cultivated by one worker
	• Simplification of agricultural implements (multifunctional equipment)
	• Preservation of the carbon stock
	• Preservation of crop residues on the soil surface, which:
	  • reduces the risk of soil crusting (mulching effect)
	  • reduces the risk of soil erosion in sloped areas
	• A more homogeneous, constant, soil profile conducive to better formation of the root system is preserved.
	• Tillage: Saves time in the spring by preventing the soil from drying out between plowing and seedbed preparation.

Flaws:	Erosion control tillage may require the use of herbicides in case of heavy weed growth, especially in the transitional phase, until a new balance of weed populations is established. Erosion control practices can also lead to soil compaction over time; however, compaction can be prevented by using chisel cultivators or subsoilers. Setting up the system will require an initial investment of time and money, as well as the purchase of equipment and herbicides. Elevated levels of surface residues can lead to higher plant diseases and pests if not properly managed. There is a close relationship between this technology and the corresponding soil characteristics. It has negative consequences for soils with a high content of clay and compacted soils. • High purchase price and significant maintenance costs for special equipment • A significant amount of crop residues when growing corn for grain, the need to produce very fractional (or in two stages) their grinding. • Lower rate of drying of the soil profile in spring (thermal inertness of the soil). • The concentration of organic matter in the first centimetres of the soil layer, to the detriment of deep horizons. • More sophisticated technique: Risk of compaction of unploughed areas if clay content is below 15%. • Risk of soil compaction if not dry enough.
Necessary institutional requirements	Farmers can purchase equipment with the support of national, regional and local equipment supplier organizations. In Kyrgyzstan, the Agricultural Financing Programme provides loans to small businesses for the development of small farms. However, entrepreneurial support is needed to expand the equipment supply base and provide spare parts for all agricultural equipment. The nature of the programme can be expanded to improve access to other inputs such as cover crop seeds, herbicides and fertilizers. In addition, private and public sector equipment suppliers play a role in meeting the demand of different types of farmers for adapted tools and equipment.

Alignment with national priorities	Corresponds to the National Development Strategy 2018-2040. and the National Development Programme until 2026.
Expert opinion	To implement erosion control tillage, farmers must undergo extensive training. Preparations include studying crop rotation, analyzing soil conditions, monitoring soil temperature and moisture, adjusting nutrient and weed management practices, and selecting appropriate equipment. Studies conducted to date have shown that the main barrier to the spread of no-till technology tillage is the lack of knowledge in the field of weed control in relation to a particular place. Therefore, the main data required for the application of no-tillage technologies are information about common weeds, herbicides (including detailed information about their chemical and toxicological characteristics) and methods of their application.
Price	
Capital expenditures:	The cost of erosion control equipment depends on whether the land is being ploughed by motorized traction, draft animals or humans. In the case of larger manufacturers, the main cost item will be the cost of machinery and fuel. However, increased use of herbicides may reduce these savings, especially in the early stages of technology adoption. On relatively small farms, the reduction in labour costs can be significant. Studies have shown that erosion control methods reduce labour costs by approximately 50% compared to traditional systems. Special financial incentives and subsidies may be required to help farmers adopt this practice.
Operation and maintenance:	Costs per hectare for conventional tillage, including all equipment and materials costs, averaged 545.38 USD and 477 USD for no-till. On a net profit per ha of 150 USD with conventional tillage and a net profit of 18 USD per ha with no tillage and cover crops.
Other:	Costs for training farmers and developing information materials.
Contribution to development, additional benefits	
Increase in income	Net profit per 1 hectare is almost 50% higher than the net profit of producers using traditional tillage methods
Workplaces	When switching to zero tillage 30% of arable land (400 thousand ha) 4000
The economic growth	10% agricultural production.
Number of beneficiaries:	20000
Health	Not
Education	Training modules for Challenge and professional lyceums
Gender equality and social inclusion	There is an opportunity to involve women in agricultural production
Environmental benefits	Reduced soil degradation. Sequestration of carbon in soils, conservation of soil fertility and soil biodiversity
Implementation options	The uptake of this technology can be greatly facilitated by the exchange of information through farmers' associations, the publication of information products containing sufficient practical information on the implementation of technologies, and studies demonstrating positive economic returns.
Barriers to implementation	One of the main barriers to uptake of this technology is the lack of locally applicable knowledge and/or the low level of research and development in the field of erosion control technology. Also, when equipment and other inputs, such as herbicides, are not produced and available locally, costs can rise substantially, which can be a barrier to the adoption of this technology. Environmental barriers to the adoption of no-tillage systems include low rainfall and low biomass production, a short growing season, and soils at risk of waterlogging. Limiting socio-economic factors include: high demand for crop residues as feed for livestock, Perhaps the main barriers are cultural barriers. Growers do not feel comfortable using this new technology because it goes against the way they farmed in the past. In addition to the financial benefits associated with no-tillage, there are a number of anti-erosion benefits.

Technology Fact Sheet # 11

Sector	**Agriculture**
Subsector	**Crop Farming**
Technology name	**Solar water pumps for irrigation**
Introduction	Kyrgyzstan has rainfed lands that need to be irrigated using new technologies such as the use of solar pumps to irrigate highlands and rainfed lands. With this technology it will be possible to increase agricultural production.
Climate benefits	
Adaptation	Strengthening food security of the Kyrgyz Republic. Increasing the climate resilience of farm livelihoods.
Mitigation	Increasing carbon sequestration
Specifications	
Performance:	Solar panels, pump hoses for watering up to 20 hectares of land Irrigation rates (for a young garden, for example) - 1 ha - water m3, Number of irrigations per season - total water m3 Pump with a power of 0.9 W, water m 3 per hour. Total work per year - hours 350W photovoltaic panels
Resource efficiency:	Energy saving With a conventional pump - the need for pumping water m 3 - 0.8 kWh, Savings - – 15 kW
Life time:	10 years
National context	
Market potential:	The produced products of such lands will be very valuable, since agricultural crops and soils have never been cultivated there without any diseases and pests. There will be very high yields and, accordingly, profits for farmers. Batteries and pumps with spare parts are available for sale.
Advantages:	1. Cheap operation. 2. Irrigation outside of on-farm irrigation networks
Flaws:	1. Requires knowledge of installation and maintenance 2. Require capital investment 3. Unable to repair photovoltaic panels 4. Problems of disposal of electronic waste.
Necessary institutional requirements	Maintenance training should be provided to those who will operate the equipment.
Alignment with national priorities	Fully aligned with national priorities (Specify documents)
Expert opinion	
Price	
Capital expenditures:	Solar panels = 60,000 som Pump = 30,000 som Hoses = 20,000 som
Operation and maintenance:	15 000 som
Other:	10 000 som
Contribution to development, additional benefits	
Increase in income	Profitability will increase by 50 percent. There will be no electricity costs. With this system, the harvest will increase by 50 percent, and the income of farmers will increase accordingly.
Workplaces	From 2 to 5 people will be provided with work
The economic growth	Farmer economic growth expected to reach 90 percent
Number of beneficiaries:	Farmers who are engaged in agriculture in the highlands and dry land. Also the development of lands that are not cultivated.
Health	Increased green cover. Gas exchange and soil cover to conserve soil fertility.
Education	
Gender equality and social inclusion	Women can increase the household budget. Diversify your diet.

Environmental benefits	Covering the soil with greenery. Increased carbon sequestration. Preservation of soil fertility.
Implementation options	To all regions of the country.
Barriers to implementation	6. Investment required 7. Need to import equipment 8. Requires hands-on training on demonstration plots 9. Need to raise awareness of the possibilities of the technology

Technology Fact Sheet # 12

Sector	**Agriculture**
Subsector	**Crop production**
Technology name	**Application of water saving technologies, such as sprinkler irrigation**
Introduction (Short description)	Systems of pressurized irrigation, sprinkler or drip, can improve water efficiency and contribute substantially to improved food production. Sprinkler irrigation is a type of pressurized irrigation that consists of applying water to the soil surface using mechanical and hydraulic devices that simulate natural rainfall. These devices replenish the water consumed by crops or provide water required for softening the soil to make it workable for agricultural activities. The goal of irrigation is to supply each plant with just the right amount of water it needs. Sprinkler irrigation is a type of pressurized irrigation that consists of applying water to the soil surface using mechanical and hydraulic devices that simulate natural rainfall. These devices replenish the water consumed by crops or provide water required for softening the soil to make it workable for agricultural activities. The goal of irrigation is to supply each plant with just the right amount of water it needs. Sprinkler irrigation is a method by which water is distributed from overhead by high-pressure sprinklers, sprays or guns mounted on risers or moving platforms. A sprinkler irrigation system typically consists of: i) A pump unit which takes water from the source and provides pressure for delivery into the pipe system. The pump must be set to supply water at an adequate pressure so that the water is applied at a rate and volume adequate to the crop and soil types ii) Main pipes and secondary pipes which deliver water from the pump to the laterals. In some cases these pipelines are permanently installed on the soil surface or buried below ground. In other cases they are temporary, and can be moved from field to field. The main pipe materials used include asbestos cement, plastic or aluminium alloy iii) The laterals deliver water from the pipes to the sprinklers. They can be permanent but more often they are portable and made of aluminium alloy or plastic so that they can be moved easily iv) Sprinklers, the water-emitting devices which convert the water jet into droplets. The distribution of sprinklers should be arranged so as to wet the soil surface in the plot as evenly as possible. A wide range of sprinkler systems is available for small and large-scale application. Set systems operate with sprinklers in a fixed position. These sprinklers can be moved to water different areas of the field, either by hand or with machinery. Hand-move systems are more labour intensive and may be more suited where labor is available and cheap. On the other hand, mechanically operated systems require a greater capital investment in equipment. Mobile systems minimize labour inputs by operating with motorized laterals or sprinklers, which irrigate and move continuously at the same time.
Climate benefits	
Adaptation	Sprinkler irrigation technology can support farmers to adapt to climate change by making more efficient use of their water supply. This is particularly appropriate where there is (or is expected to be) limited or irregular water supply for agricultural use. The sprinkler technology uses less water than irrigation by gravity, and provides a more even application of water to the cultivated plot. - Irrigation is an essential tool for getting guaranteed yields in conditions increasingly dry climate of Kyrgyzstan 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 - In these conditions, to reduce consumption of energy and water for irrigation is a major challenge to adapt to climate change.
Mitigation	
Specifications	
Productivity:	15 ha
Resource efficiency:	40 % less water than for gravity irrigation
Life time:	20 years
National context	
Market potential:	Such technology will be applied at agricultural lands with irrigation water scarcity, as well as areas with potential risks of droughts and high temperatures.
Advantages:	One of the main advantages of the sprinkler irrigation technology is more efficient use of water for irrigation in agriculture. Sprinkler systems eliminate water conveyance channels, thereby reducing water loss. Water is also distributed more evenly across crops helping to avoid wastage. The sprinkler irrigation system has also been shown to increase crop yields and is suited for most row, field and tree crops that are grown closely together, such as cereals, pulses, wheat, sugarcane, groundnut, cotton, vegetables, fruits, flowers, spices and condiments and for cultivating paddy crop. Sprinkler irrigation technology is well adapted to a range of topographies and is suitable for all types of soil, except heavy clay. Sprinkler systems can be installed as either permanent or mobile fixtures. Sprinklers provide a more even application of water to agricultural land, promoting steady crop growth. Likewise, soluble fertilizers can be channelled through the system for easy and even application. The risk of soil erosion can be reduced because the sprinkler system limits soil disturbance, which can occur when using irrigation by gravity. In addition, sprinkler irrigation can provide additional protection for plants against freezing at low temperatures. Secondary benefits from improved crop productivity include income generation, employment opportunities and food security.
Disadvantages:	The main disadvantages associated with sprinkler systems are related to climatic conditions, water resources and cost. Even moderate winds can seriously reduce the effectiveness of sprinkler systems by altering the distribution pattern of the water droplets. Likewise, when operating under high temperatures, water can evaporate at a fast rate reducing the effectiveness of the irrigation. Although sprinkler irrigation can help farmers use water resources more efficiently, this technology relies on a clean source of water and, therefore, may not be suited to areas where rainfall is becoming less predictable. Implementation costs are higher than that of gravity-fed irrigation systems and large labour force is needed to move pipes and sprinklers in a non-permanent system. In some places such labour may not be available or may be costly. Mechanized sprinkler irrigation systems have a relatively high energy demand.
Necessary institutional requirements	A whole range of institutional conditions must be understood before sprinkler irrigation technology selection can be made. These include land tenure issues, water rights, and financial incentives by government and taxation. Large-scale irrigation schemes will usually form part of national policy and could be harnessed to support national employment initiatives. Where the sprinkler irrigation type is not available nationally, foreign imports or government-supported stimulation of national manufacture will be required alongside investment in training for design, installation and maintenance. Coordination with public or private authorities in charge of water management will be crucial and could be facilitated through the establishment of a committee of farmers users of sprinkler system, i.e. Sprinkle

	Irrigation systems will be more effective for the big crop fields of agriculture cooperatives established by the farmers.
Alignment with national priorities	Aligned to the National Development Strategy for 2018-2040 and The National Development Programme until 2026.
Expert opinion	When planning to install a sprinkler irrigation system, information should be obtained regarding the following key factors: • The crop or crops to be cultivated and their water requirements throughout the growing season • The shape and size of the field. This will determine the range of suitable technologies, investment and labour requirements • Topography, in particular the location and elevation of the water source relative to the field, land slopes and uniformity • The source of irrigation water can be surface water, groundwater or non-conventional water (such as desalinated water and treated wastewater) . Water must be available in • sufficient quantity from a locally accessible source. A clean supply of water free of sediment is required to avoid blockage in sprinkler nozzles and crop spoilage • Available labour force. Where skilled labourers are not available on location, local farmers will require training to install, maintain and repair the various components of the sprinkler system • The soil profile. Sprinkler irrigation technology is best suited to oils with high infiltration rates so that ponding and surface runoff can be avoided. • Energy requirements of different systems, including the manufacturing, transportation and installation of the various systems. The location of the water source will also affect the need for energy for pumping • Social aspects such as local preferences, capacity to maintain the system, implications for labour requirements and how these may affect different members of the community • An understanding of existing health risks is crucial to avoid schemes that may promote water borne diseases/ • An environmental impact assessment should be conducted to fully understand potential impacts of drainage and diverting water resources, amongst others.
Costs	
Capital expenditures:	The cost of a drip irrigation system ranges from USD 1000 to USD 3500 per hectare depending on the specific type of technology, automatic devices, and materials used as well as the amount of labour required. As most cultivated lands are suitable for the application of sprinkler irrigation (approximately 1.6 million ha of cultivated lands), huge investment will be needed (up to USD 4 billion). Financing for equipment may be available from financial institutions via leasing operations or direct credit. The cost of a sprinkler system for an average size farm is about USD 50,000.
Operation and maintenance:	Operational & maintenance costs over 10 years Operational cost for technology will be around 50-100 USD per hectare per year Maintenance of the system mainly relates to regular cleaning of the component parts. Seals on pipes and sprinkler nozzles should be checked to avoid water seepage. During periods when the equipment is not being used, it is recommended to store component parts in a cool, dark place.
Other:	Additional costs will be needed to provide necessary capacity building activities for local farmers.
Contribution to development, additional benefits	
Increase in income	• Contributes to food security priority by increasing productivity • Leads to increase in income of rural population • Reduces migration to urban areas from rural communities
Workplaces	6-11 per systems
The economic growth	• Contributes to diversification of economic activities priority of the country • Leads to improvement of economic condition of rural population • Leads to efficient use of resources such as land, water and fertilizers

Number of beneficiaries:	• Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets
Health	More agricultural produce will contribute duly to the food security and sound nutrition.
Education	Sprinkle irrigation systems as a part of curriculum should be integrated into the hydro engineers' education in the Kyrgyz Agrarian University. Installed systems could serve as a practical site for students training.
Gender equality and social inclusion	Could facilitate more women's engagement into agricultural production. Higher income could provide better opportunities for women to participate in social life of a commune.
Environmental benefits	• Reduces use of irrigation water • Reduces amount of applied fertilizers to agricultural lands • Increases land fertility
Implementation options	National wide
Barriers to implementation	- High costs - Lack of relevant knowledge and skills

Technology Fact Sheet # 13

Sector	**Agriculture**
Subsector	**Animal Husbandry**
Technology name	**Sustainable Pasture Management under climate change**
Introduction (Short description)	For many centuries, nomadic pastoralists used pasture areas in the Tien Shan and Pamir mountains. In the process of political and economic transformation after the collapse of the Soviet Union in 1991, state farms have been dismantled, land and livestock privatized, and specialized employees such as technicians have suddenly become independent farmers. Today, large farms and herds no longer exist, having been replaced by a multitude of small household enterprises. Each household's socioeconomic situation is unique, and so are household livelihood strategies. Activities focusing on sustainable development and sustainable pasture management must therefore take account of this new socioeconomic situation. However, overgrazing and unsustainable land management are contributing to the degradation of Kyrgyzstan's pasturelands. This degradation has come at a significant cost of around $600 million, or 16 per cent of the country's Gross Domestic Product (GDP), Thus, several projects promoting Sustainable Pasture Management approaches have been implemented since 2008 to develop adequate capacities. A large part of Kyrgyzstan's land area serves as pasture for its 1.7 million cattle and 6.3 million sheep and goats. Many pastures are subject to degradation caused by overgrazing and exacerbated by climate change. Statistics on pasture conditions at country level are outdated. IFAD (2021) technical note summarizes the results of the comparison of the average pasture conditions of 2000–2004 and 2016–2020 using remote sensing imagery. The results (Table below) show that large areas of pasture were degraded moderately or severely between the start of the century and 2016–20. This study estimates that 94% of pastures (in total 69,971 km2) have been degraded at least during one season

Degradation level	Winter		Spring		Summer		Autumn	
	ha	%	ha	%	ha	%	ha	%
Severely degraded	420,270	82.3	974,410	33.5	2,529,140	43.2	865,463	29.4
Moderately degraded	60,374	11.8	1,583,127	54.3	2,924,358	50.0	1,816,875	61.7
No variation	28,828	5.6	352,074	12.1	394,405	6.7	260,937	8.9
Enhancement	1,349	0.3	3,241	0.1	4,368	0.1	2,571	0.1
Total	510,821	100	2,912,852	100	5,852,271	100	2,945,846	100

	Sustainable Pasture Management (SPM) is a climate change adaptation technology in the animal husbandry sector. SPM helps sustain healthy soils and restore degraded pastures which bring many benefits including ensuring sustainable animal husbandry, alleviating rural poverty and building resilience to major environmental challenges.Pasture degradation has already taken place to various degrees and the objective of SPM should be restore degraded land while preventingfurther degradation and ensuring continued ecosystem health and function. Pasture degradation and desertification are among the most serious environmental problems. In the countryside, pasture degradation is widespread and occurs in all ecosystems at different intensities. Pasture is one of the main source of livestock food and rural livelihood (66% of population) in Kyrgyzstan. Well managed pasture helps to protect the environment and natural resources and also continues to sustain ecological functions and services. Pasture degradation in the country is indicated in several ways: decreased biomass production, soil fertility decline, and desertification, fewer and more unpalatable plant species. In addition, physical damage by human activities has increased extensively. Overgrazing, off-road driving, mining, global warming, low precipitation and lack of land management skills are causing more and more problems for the rangelands in Kyrgyzstan. Thus it is becoming increasingly difficult to provide the necessary amount of fodder for the livestock that are the main source ofincome for more than one third of the population. The systems of pasture managements include several categories of pasture depending on the seasonal use.
Climate benefits	
Adaptation	The technology would help to increase resilience of livestock, which isvulnerable to climate change.
Mitigation	Mitigation benefit is also evident since SPM also contribute to soil GHG sequestration. Better feeding of livestock also reduce GHG emission from enteric fermentation.
Technical characteristics	
Productivity:	Comprehensive sustainable pasture management (SPM) will conservenatural resources and thereby increase livestock productivity. All of these directly increase the nation's resilience to withstanding the negative impacts of climate change and the benefits of SPM will be widespread with producers as well as consumers.
Resource efficiency:	SPM will restore ecosystem services of pastoral ecosystems.
Life time:	Long Term
National context	
Market potential:	About 430 rural districts all over the country/
Advantages:	SPM is expected to increase biomass and vegetation of pastures; restore biological diversity including plant species. SPM well applied will sustain water sources (open and ground), as well as increase soil fertility. It can also reduce risks of natural disasters. It is generally accepted that SPM will sustain rural livelihoods of local communities.
Disadvantages:	Requires social cohesion and agreement within the commune. In some places, SPM has a certain conflict potential to be well treated in advance.
Necessary institutional requirements	Capacity building for community based and operational Pasture Committees as well as to Local Self Government will be needed to better consider climate forecasts as well as to integrate climate change vulnerabilities mitigation measures into local development strategies and natural resources management.
Alignment with national priorities	Aligned to the National Development Strategy for 2018-2040? And National Development Programme until 2026.
Expert opinion	UNDP, IFAD, GIZ and other international development partners implemented several project in promotion of SPM. However, they manage to set the scene for the diffusion of the SPM to all 453 rural communities of the country
Costs	
Capital expenditures:	Experience of other countries and rapid assessment shows that in total USD 21.8 million would be required from different sources both internal and external.
Operation and maintenance:	Capacity building of Pasture Users Associations and Local Self-Governments in SPM resilient to climate change impacts – USD 550,000.
Other:	

Other benefits	
Increase in income	Contribute to poverty reduction. Increase incomes at a medium rate
Workplaces	At a medium rate
The economic growth	Improved social sustainability and cooperation of differentstakeholders Agriculture output at a medium rate.
Number of beneficiaries:	Considerable
Health	Improved food security and nutrition
Education	Sustain traditional lifestyle of herders. Training module of SPA should be included into the curricular of the Kyrgyz National Agrarian University and vocational schools
Gender equality and social inclusion	SPM promotes considerable opportunities for women to participate in agriculture production. There are cases of establishing kindergarten on summer pastures.
Environmental benefits	• Increased biomass and vegetation • Restored biological diversity including plant species • Sustained water sources (open and ground) • Increased soil fertility • Reduced greenhouse gas emissions • Reduced risks of natural disasters • Ensured ecological sustainability and ecosystem functions andservices
Implementation options	All over the country. Some good practices available as well as developed management tools, including Electronic-Pasture Committee Software, Community Grazing Plan Guidelines. NDVIA tool was tested by IFAD to develop modern Pastures Maps.
Barriers to implementation	-Lack of modern pasture management planning and monitoring tools - Lack of Management knowledge and skills.

TFS for the Water Resources Sector

Technology Fact Sheet # 1

Sector	Water resources
Subsector	Drinking Water Supply and Sanitation
Technology name	**Energy and resource-saving drinking water supply systems from surface sources using local materials**
Introduction (Short description)	At present, the Kyrgyz Republic faces a very acute problem of providing high-quality drinking water to the population of cities and other settlements. In many villages and small towns, there is a shortage of drinking water of standard quality due to imperfect water treatment. What is the main reason for the spread of intestinal infections, hepatitis and diseases of the gastrointestinal tract, the occurrence of pathologies and the increased impact of carcinogenic and mutagenic factors on the human body. The current crisis situation in the field of drinking water supply is due to the lack of measures to protect sources of drinking water supply, the unsatisfactory technical condition of water supply systems. It is important that for the purification of drinking water in the present. materials imported from abroad are used, such as quartz sand. Whereas local deposits in the Issyk-Kul, Jalal-Abad regions can fully satisfy the needs of the republic. Sodium hypochlorite can also be produced on the basis of local deposits of natural salt (village Tuz, Kochkor region, Nouruz, etc.). In some cases, an integrated approach can be applied: - construction of a micro-hydro power plant to provide electricity for the production cycle of purification and supply of drinking water less than 1 MW - construction of a facility for lifting water with a hydrolic ram type pump (practically used since Soviet times in the Vodokanal control centre in Bishkek)
Climate benefits:	

Adaptation	The introduction of this technology can be considered as a preventive measure against the existing risks of shortage of water resources for drinking needs in connection with the consequences of climate change.
Mitigation	This Technology is aimed at saving water resources, electrical energy and reducing the import of materials imported from abroad. What ensures the prevention of an increase in greenhouse gas emissions into the atmosphere.
Specifications	
Productivity / scope of work:	Implementation of this Technology requires: - a detailed reconnaissance survey of the intended construction site for a water treatment plant and drinking water disinfection facilities; - conducting surveys: topographic, geodetic, geological, hydrogeological, hydrological, environmental impact assessment, study and analysis of natural water quality; - development of the project, passing the examination by the State Agency for Construction of the Kyrgyz Republic; - holding public hearings - construction of a new drinking water treatment system, including: - construction of clean water tanks, this is: -settling tanks are flow structures where water moves slowly, approximately at a speed of 1 cm / s, that is, in a laminar mode; - quick filters. First, the water is treated with chemical reagents, after which there is an effective deposition on the filter media; - water disinfection facilities. - laying of pipelines; - purchase of equipment for water disinfection; - acquisition of special equipment; - acquisition of infrastructure equipment; - commissioning works; - commissioning, transfer to the balance of the Mayor's Office of cities and ayil okmotu. In some cases, a decision may be made to build a micro hydroelectric power station to generate electricity, as well as to use the Gidrotaran pump
Resource efficiency:	
Life time:	25-30 years old
National context	
Market potential:	It is necessary to introduce this Technology for the preparation and production of drinking water of standard quality from surface sources using local materials in most of the aiyl aimaks and small towns of the Kyrgyz Republic. As of January 1, 2018, 715 priority villages were identified, in which the construction and rehabilitation of water supply systems is a priority. In addition, it is necessary to rehabilitate water supply systems in 448 villages.
Advantages:	This Technology involves the use of local materials: quartz sand, natural salt, construction of micro-hydro power plants / solar panels. Will provide the amount of water for 60 thousand people. * 230 l/person per day. Due to the use of local materials, it is possible to reduce the cost of 1 m3 for water consumers.
Flaws:	The need for additional research on the choice of construction site for treatment facilities, deposits of necessary materials, type of water treatment,
Necessary institutional requirements	Existing institutional structures: Aiyl okmotu, ARIS, Department of Construction and Engineering Infrastructure under Gosstroy KR. It is necessary to develop new building codes for drinking water supply systems in large settlements and to establish cost-effective tariffs for the supply of drinking water.
Alignment with national priorities	National Strategy for Sustainable Development - 2040 Programme for the development of drinking water supply and sanitation until 2026. Development Programme of the Kyrgyz Republic until 2026 Implemented projects through ARIS with the help of external donors.
Expert opinion	Proposed by WG members and approved at the WG meeting
Price	

Capital expenditures:	The cost of implementing this Water Treatment Technology for one settlement can be estimated at 10.0 million US dollars, with a population of up to 60.0 thousand people.
Operation and maintenance:	Costs are required for monitoring, organizing a sanitary protection zone, operating, and training personnel.
Other:	
Contribution to development, additional benefits	
Increase in income	Improving the tariff policy and ensuring the financial sustainability of water supply systems, reducing the burden on the republican budget, which will help increase the income of the population and increase the wages of workers
Workplaces	The technology will create jobs related to construction and engineering, the supply of inert materials, the production of sodium hypochlorite, and the operation and maintenance of the drinking water treatment system. The number of employees for maintenance and operation is determined on the example of the PU Gorvodokanal in Bishkek (243 people) for 1 facility - 21 people, for 24 = 496 people.
The economic growth	The scope of services for drinking water supply, the production of sodium hypochlorite, the supply of quartz sand from local sources and materials will expand and improve.
Number of beneficiaries:	The population of the city is about 60.0 thousand people.
Health	The introduction of this Technology will help to preserve the health of the population, reduce the number of diseases transmitted through water, and provide comfortable living conditions.
Education	You will need: qualified teachers; personnel for the design, operation of drinking water treatment systems, marketing, drinking water treatment technologists; creation of a republican training centre for the training of highly qualified personnel and retraining (advanced training) of existing specialists. On the basis of the Department of Water supply and sanitation of KSTU. I. Razzakova, which is determined by the Roadmap; increase in the number of students on a budgetary basis in the Water Supply and Sanitation profile in the amount of 25 students (taking into account digitalization).To attract to the profession, it is necessary to reduce the passing score for ORT to 100 points, the Contract - to 90 points, and it is better without ORT at all.
Gender equality and social inclusion[139]	Enterprises of this type employ women, 16.6% of the total number of employees. With the commissioning of new facilities for the preparation of drinking water, new jobs for women will appear at one enterprise - 4 units, for 25 - 100 people. Women will spend less time caring for children, as diseases will decrease. There will be more time for studying, obtaining the necessary modern skills for income generation, professions, etc.
Environmental benefits	Improving the quality of groundwater from the harmful effects of substances polluting sources of drinking water supply. The use of renewable energy sources and energy efficient equipment (control systems, pumps, bactericidal installations, etc.) to provide the population with drinking water will reduce the anthropogenic load on the environment. Because the permissible limits of the negative impact on the environment are determined and the mechanisms for managing environmental safety are formed
Implementation options	National strategy, State programs, institutions, legal framework
Barriers to implementation	Lack of financial resources, lack of investors, lack of personnel, insufficient qualifications of teachers in the design, operation of systems, insufficient qualifications of personnel in the Gosstroy system. Lack of benefits for admission to universities for the specialty of WSS, high ORT passing score for students

Technology Fact Sheet # 2

Sector	Water resources, water management
Subsector	Subsector: drinking water supply and sanitation

Technology name	**New wastewater treatment plants in the Kyrgyz Republic, the first stage: cities and district centres**
Introduction (Short description)	In the Kyrgyz Republic, only 29.1% of the population has access to sanitation systems. For cities, this figure is 61.1%, and in the regions it does not exceed 10%. Urban wastewater is one of the main sources of water pollution, and the lower the concentration of treated inflow, the greater the pollutant load on wastewater after treatment. In n.v. the volume of treated wastewater in the republic is 129.1 million m^3 per year.
Climate benefits:	
Adaptation	Proactive response to existing and potential risks due to Climate Change. The implementation of this Technology will contribute to the formation of secondary / additional water resources - return water of standard quality, which can be used, which will help reduce the shortage of water resources. Due to the use of new treatment systems, the volume of normatively treated wastewater, which can be further used, will increase, depending on the capacity of treatment facilities, using the example of a city with a population of 60 thousand people - about 77.5 million m^3
Mitigation	GHG emissions from the "Waste" sector of the Kyrgyz Republic have increased significantly in recent years (more than 1000 Gg CO_2-eq.), incl. by wastewater treatment category. Therefore, wastewater treatment will reduce the formation of methane and reduce emissions of CH_4 into the atmosphere.[140](Methane is one of the 6 GHGs), as well as pollution of water and land resources. Additional features: use of organic waste after treatment of wastewater (activated sludge and primary sludge) generated at treatment facilities. reduction of methane emissions. The released gas from digesters can be used as heating for industrial premises, etc.
Specifications	
Productivity / scope of work:	Hardware/Hardware: material components (equipment, machines, products) Improving and expanding access to reliable, sustainable and affordable sanitation services requires: - reconnaissance survey of the planned construction of the sewage pumping station, treatment facilities, facilities for post-treatment of wastewater - conducting surveys: topographic survey, geological, hydrogeological, hydrological, geological, EIA, study and analysis of the quality and quantity of wastewater - preparation of the project, passing the examination by the State Construction Committee - holding public hearings - direct construction and reconstruction of existing wastewater treatment systems, including sewage treatment plants (STP) - construction of pumping stations - laying pipelines - infrastructure equipment - purchase of special equipment - commissioning works - commissioning, transfer to the balance of the mayor's office of cities and a / o At the same time the total capacity of treatment facilities is determined from the specific conditions of the chemical composition of wastewater of each city and settlement and the number of its population.
Resource efficiency:	
Life time:	50 years
National context	
Market potential:	It is necessary to build and rehabilitate treatment facilities in 25 cities: Bishkek, Osh, Jalal-Abad, Toktogul, Mailuu-Suu, Kerben, Tash-Komur, Kara-Balta, Kant, Tokmok, Kemin,

[140]Third National Communication of the Kyrgyz Republic under the UN Framework Convention on Climate Change, Bishkek, 2016

	Batken, Kyzyl-Kiya, Isfana, Aidarken, Kadamjai, Kara-Suu, Uzgen, Nookat, Balykchy, Karakol, Cholpon-Ata, Talas, Naryn, Kok-Yangak.
Advantages:	When designing and constructing wastewater treatment systems, the best practices will be applied on the example of Balykchy and Karakol, which are currently being built at the expense of donors.
Flaws:	High price
Necessary institutional requirements	Existing Institutional Structures: Department of Construction and Engineering Infrastructure under Gosstroy KR. a/o, ARIS
Alignment with national priorities	NDS-2040, Programme for the development of drinking water supply and sanitation until 2026: "providing 70% of the population of district centres with village status with sanitation services" UP KR 2021 "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic": to reduce the adverse impact of wastewater on the environment: "ensure control over treatment facilities in the settlements of the republic and on the territory of tourist facilities and recreation areas, including the water area of Lake Issyk-Kul"[141]. Project implementation: - "Waste water management of Issyk-Kul" (Balykchy and Karakol 2914.9 million som) - "Wastewater Management of Issyk-Kul" (Cholpon-Ata 2258.3 million som) ADB - "Improvement of water management services that are resistant to climate change", which provides for the construction of a sewage system and sewerage in the district centres of Bokonbaevo, Kyzyl-Suu and the village. Kazhy-Sai, Issyk-Kul region Implementation of projects through the WB, AB, IB, SF, PRC, South Kyrgyzstan.
Expert opinion	Proposed by WG members and approved at the WG meeting
Price	
Capital expenditures:	The cost of implementing this Technology for one city can be estimated at = USD 25.0 million, the population is about 60 thousand people. first stage: 24 cities and districts USD 25.0 million * 24=600 million
Operation and maintenance:	Costs are required for monitoring, organizing a sanitary protection zone[142], for operation, training, establishment of MPC for ammonium (mitigation)
Other:	
Contribution to development, additional benefits	
Increase in income	Improving the tariff policy and ensuring the financial sustainability of wastewater systems, reducing the burden on the republican budget, which will help increase the income of the population, increase the wages of employees
Workplaces	The number of employees for maintenance and operation is determined in proportion to the city of Bishkek (243[143]people) for 1 object - 21 people, for 24 = 496 people.
The economic growth	The scope of services for wastewater treatment will expand and improve = about 1.78 million som will be received from one enterprise, 24 - 42.8 million som per year
Number of beneficiaries:	Population of 25 cities: Bishkek, Osh, Jalal-Abad, Toktogul, Mailuu-Suu, Kerben, Tash-Komur, Kara-Balta, Kant, Tokmok, Kemin, Batken, Kyzyl-Kiya, Isfana, Aidarken, Kadamzhai, Kara-Suu, Uzgen, Nookat, Balykchy, Karakol, Cholpon-Ata, Talas, Naryn, Kok-Yangak about 2.0 million people.
Health	Improving the health of the population living near wastewater treatment plants, since Sanitary Protection Zones will be provided in order not to exceed the MPC.The use of recycled/returned treated wastewater for irrigation will help reduce diseases transmitted through irrigated agricultural products by irrigation with raw sewage. There will be a decrease in colds caused by the fact that toilets are located far from the school building, etc.
Education	You will need: Qualified teachers Personnel for the design, operation of treatment plant systems, marketing

[141]UP KR "On measures to ensure environmental safety and climate sustainability" dated March 19, 2021 No. 77,
[142]Decree of the Government of the Kyrgyz Republic dated April 11, 2016 No. 201
[143]https://kg.akipress.org/news:632944

	Creation of a republican training centre for the training of highly qualified personnel and retraining (advanced training) of existing specialists. On the basis of the Department of Water supply and sanitation of KSTU. AND.Razzakov, which is determined by the Roadmap increase in the number of students on a budgetary basis in the Water Supply and Sanitation profile in the amount of 25 students. To attract to the profession, it is necessary to reduce the passing score for ORT to 100 points, the Contract - to 90 points, and it is better without ORT at all.
Gender equality and social inclusion[144]	In n.v. enterprises of this type employ women 16.6%[145]from the total number of employees. With the commissioning of new wastewater treatment facilities, new jobs for women will appear at one enterprise - 4 units, for 25 - 100 people. Women will spend less time caring for children, as colds will decrease due to the improvement of homes, schools, and other warm toilets and sewerage systems. There will be more time for studying, obtaining the necessary modern skills for income generation, professions, etc.
Environmental benefits	Will lead to a reduction in the chemical impact of wastewater on soil and water. The implementation of this Technology will contribute to the formation of secondary / additional water resources of return water of standard quality, which can be reused for various needs: irrigation, car washing, etc. This will relieve the pressure on the quantity and quality of water resources and natural landscapes, and will lead to an improvement in the ecological state environment.
Implementation options	National strategy, State programs, institutions, legal framework
Barriers to implementation	Lack of financial resources, lack of investors, lack of personnel for the design of wastewater treatment systems, insufficient qualifications of personnel in the Gosstroy system, teachers, for the operation of wastewater treatment systems, and especially technologists

Technology Fact Sheet # 3

Sector	Water resources, water management
Subsector	Sub-sector: Water
Technology name	**Automated systems for accounting and distribution of water for irrigation, including instrumentation with the installation of anti-vandal water meters**
Introduction (Short description)	The main consumer of water in the country is irrigated agriculture, more than 90% of available water resources are spent for irrigation needs. In the republic in the present about 450 thousand farms and peasant farms. The average farm size is usually 1-3 hectares. At the same time, this includes the arable land they rent from the National Fund for the Redistribution of Agricultural Land. In fact, in the southern regions it is 0.6 - 1.1 hectares, in the northern regions - from 1 to 5 hectares. Thus, the irrigation sector is faced with the task of providing all farms with irrigation water, mostly with small holdings. One of the factors contributing to the guaranteed, stable, transparent supply of irrigation water is the automation and installation of instrumentation at the points of irrigation water supply to inter-farm / state and on-farm channels and systems.
Climate benefits:	
Adaptation	The installation of instrumentation and automation of the process of supplying irrigation water will reduce the amount of water taken for irrigation and losses during transportation. The technology under consideration contributes to rational water use, and especially in areas with a tight water balance at the present time. And in connection with the forecasts for the reduction of runoff, as a result of global climate change, this Technology will help reduce the shortage of water resources.
Mitigation	Requires additional electrical energy
Specifications	
Productivity / scope of work:	Hardware / Hardware: material components (equipment, machines, products) To install one instrumentation, you need:

[144]denotes the process of inclusion, involvement or entry into something, as part of a whole
[145]http://www.stat.kg/media/publication archive/b057b115-c40b-4180-ae16-28ec7e459117.pdf

	- development of the working draft - production, assembly and adjustment of equipment - preparation of gauging stations for the installation of instrumentation - acquisition of the necessary equipment and instrumentation - installation of instrumentation - preparation of GTS for automation - purchase and installation of equipment for system automation - gauging station certification - system implementation: training, subsequent operation
Resource efficiency:	Allows to reduce the amount of water withdrawn, increase the efficiency of its use
Life time:	
National context	
Market potential:	The scale of the Technology is quite wide, because they cover the main large canals, from which the irrigated agriculture of many farmers depends on the water supply and distribution, and especially in the Talas, Chui, Batken, Osh, Jalal-Abad regions. The total length of the Inter-farm canals of the Republic alone is 5786.7 km
Advantages:	The possibility of introducing the technology by the departmental institute PKTI Vodavtomatika SVR MOA with appropriate financial support. Water accounting at different levels has already been introduced in 4 pilot WUAs in Chuiskaya, there is practical experience in drawing up contracts for the supply of irrigation water to WUAs.
Flaws:	High cost, possibility of vandalism, destruction of DP, equipment
Necessary institutional requirements	Existing Institutional Structures: State Water Resources Service MOA, BUVKh, RUVKh and PKTI Vodavtomatika, no additional institutions required
Alignment with national priorities	NDS 2040, Irrigation Development Programme for the Period up to 2026, Action Plan for Digitalization of Management and Development of Digital Infrastructure in the Kyrgyz Republic for 2022-2023
Expert opinion	Proposed by the JWG, additional consultations were held with the SVR Management
Price	
Capital expenditures:	The cost of installing one instrumentation is 2,699,560 som[146], incl. equipment: control room = 2 106 000, one outlet = 328 120, outlet gate =265 440 som
Operation and maintenance:	Costs are required for the creation/reconstruction of the control room, personnel training, attestation of gauging stations, and for resolving the issue of how to transfer information from instrumentation to the RUVKh, BUVKh, SVR
Other:	
Contribution to development, additional benefits	
Increase in income	Implementation of this Technology will allow eliminating corruption schemes for paying for PIS services, increase the amount of income from PIS to the republican budget, which, in turn, will allow funds to be directed to repair work in the RUVKh, increase the salary of RUVKh employees.
Workplaces	New jobs will be required for the design, installation and maintenance of instrumentation
The economic growth	The introduction of this Technology will improve the quality of services for the supply of irrigation water, increase the volume of income from ISF.
Number of beneficiaries:	About 4500 gauging stations throughout the country, of which it is necessary to carry out verification for 3000 * 2.699 = 8097 million som.
Health	Reducing the heavy manual labour of lifting the gates of water intakes will help maintain the health of service personnel
Education	Personnel will be required for certification, verification, design and training

[146]Consultations with SVR MOA

Gender equality and social inclusion[147]	
Environmental benefits	It will prevent erosive erosion of canals formed during unregulated supply of irrigation water to the distribution network, remove the threat of destruction of hydraulic structures that occurs in this case, reduce the shortage of water resources, irrigation water will be supplied in accordance with irrigation regimes, which will preserve the fertile soil layer. It will also reduce the processes of gully formation, erosion on irrigated lands, reduce the washout of the humus layer of the soil and the flow of solid runoff into rivers, reservoirs, drains
Implementation options	Existing institutions: Water Resources Service of the Ministry of Agriculture and its structural subdivisions – Basin Department of Water Resources, District Department of Water Resources, Design Construction Technical Institute "Vodavtomatika'
Barriers to implementation	Lack of investors, financial resources, high cost of technology, possible vandalism, staff reduction, corruption

Technology Fact Sheet # 4

Sector	Water resources management
Subsector	Irrigation
Technology name	**Energy efficient pumps for irrigation pumping stations in the Kyrgyz Republic"**
Introduction (Short description)	The main consumer of water in the country is irrigated agriculture, more than 90% of available water resources are spent for irrigation needs. In order to grow crops on the irrigated lands of the republic and supply irrigation water, pumping stations were built more than half a century ago; 115 units (365 units) under which 57.0 thousand hectares are suspended (6% of the total irrigation area). Re-equipment of pumping stations, and especially in recent years, has become a necessary task, because. service life of equipment n.s. already expired, morally and physically they are outdated, almost 4-5 times. Despite the fact that in recent years, re-equipment has been carried out, but this is not enough, it is only 20-30% of what is needed. In addition, re-equipment is carried out within the framework of already operating equipment, for example, pumps - 3.5 kW, while 1.5 kW units are needed.
Climate benefits:	
Adaptation	
Mitigation	Electric energy consumption by pumping stations will be reduced by about half, which will help reduce greenhouse gas emissions
Specifications	
Productivity / scope of work:	Hardware/Hardware: material components (equipment, machines, products) For refurbishment you need: - purchase of low-cost electric motors 1.5 kW - holding a tender, pumps d.b. from Russia - transportation - dismantling of the old electric motor and power plants - installation of new power plants - system implementation: training, subsequent operation
Resource efficiency:	
Life time:	10 years
National context	
Market potential:	It is required to replace all 365 pumping units at 115 pumping stations, as well as purchase additional ones for each pumping station
Advantages:	
Flaws:	High price
Necessary institutional requirements	Existing Institutional Structures: The State Water Resources Service of the Ministry of Agriculture, RUWR are working in this direction, but with insufficient scale and pace.

[147]Denotes the process of inclusion, involvement or entry into something, as part of a whole

Alignment with national priorities	NDS 2040
Expert opinion	Proposed by the AWG, supported by the SVR MOA
Price	
Costs	The estimated cost of one installation is 3.5-5.0 thousand roubles. USD
Operation and maintenance:	Costs are required for training the maintenance personnel of the pumping station, about 10 people
Other:	
Contribution to development, additional benefits	
Increase in income	The introduction of this Technology will reduce the heavy manual labour, the staffing of pumping station workers, which will increase the wages of the remaining workers.
Workplaces	Additional jobs d.b. according to the standards for the re-equipment of electrical panels, networks, etc.
The economic growth	Improvement of irrigation water supply services, collection of ISF, reduction of the burden on the republican budget, increase in salaries for pumping station workers Significantly, approximately two times, the consumption of electric V n.v. will be reduced. The SVR pays electricity at the rate of 1.08 som per 1 kWh of the SVR, which is about 244.0 million som per year. When retrofitting n.s. the amount of payment for electricity will be reduced by half.
Number of beneficiaries:	Improved, uninterrupted irrigation water supply for farmers irrigating from a two-unit pumping station, about 780 people. The scope of the Technology is quite wide, these are pumping stations in Talas, Chui, Batken, Osh, Jalal-Abad and Naryn regions. Improved irrigation water services for about 89,700 people across the country
Health	It will allow to remove the burden from workers servicing pumping stations associated with constant breakdowns due to outdated equipment, which will improve the organization of work
Education	More qualified technicians will be required to maintain pumping station equipment
Gender equality and social inclusion[148]	It will allow to relieve the burden on workers servicing pumping stations associated with constant breakdowns due to outdated equipment, which will improve the organization of work, incl. and women
Environmental benefits	Continued operation of already operating n.s. will contribute to the irrigation of gardens, forests
Implementation options	SVR MOA in the present there is a process of replacing pumping units, 70 pcs. out of 365 operating pumping stations, but units of the same capacity
Barriers to implementation	Lack of funds, lack of investors, lack of qualified personnel

Technology Fact Sheet # 5

Sector	Water resources, water management
Subsector	Irrigation
Technology name	"**Application of the Hydraulic Ram system for the supply and distribution of water for irrigation**"
Introduction (Short description)	The global crisis caused by climate change is inextricably linked to water. Climate change is increasing the variability of the water cycle, thereby causing extreme weather events, reducing the predictability of water supply, degrading its quality and threatening sustainable development and biodiversity. The main consumer of water in the country is irrigated agriculture, more than 90% of available water resources are spent for irrigation needs. In the republic in the present about 450 thousand farms and peasant farms. The average farm size is usually 1-3 hectares. Thus, the task is to provide all farms with irrigation water, which mostly have small plots. In addition, there is the possibility of developing rain-fed lands on an area of about 500 thousand hectares.

[148]denotes the process of inclusion, involvement or entry into something, as part of a whole

	To organize the irrigation of agricultural crops, the massifs of which are located above the level of irrigation canals/rivers/irrigation sources, watering of farm animals and restoration of degraded lands, forest lands, forest belts, it is possible to introduce hydraulic pumps "Hydrotaran", which operate without electricity and fuel, using only hydraulic energy water flow. The Hydrotaran pump raises water to a height of several tens of metres and can work continuously for several months without supervision, adjustment and maintenance, providing water to a small eco-village, household, community, farm, greenhouse, drip irrigation site, etc.
Climate benefits:	
Adaptation	The installation of the Hydroram system does not lead to any losses of irrigation water, because water supply is regulated strictly in accordance with irrigation norms. The technology contributes to the rational use of water, and especially in areas with a tight water balance at the present time. And in connection with the forecasts for the reduction of runoff, as a result of Global climate change, this Technology, and especially in combination with drip, subsoil irrigation, will help reduce the shortage of water resources.
Mitigation	This Technology does not use any energy. What does not involve emissions of greenhouse gases from energy sources into the atmosphere
Specifications	
Productivity / scope of work:	Hardware/Hardware: material components (equipment, machines, products) Reconnaissance survey of the intended site Project preparation Design and manufacture of all system components Installation of the Hydroram system on the ground
Resource efficiency:	
Life time:	The hydraulic ram is designed for long-term round-the-clock operation that does not require special maintenance throughout the entire resource. The service life of the pump is 15-20 years.
National context	
Market potential:	The scale of the technology is quite wide, about 450 thousand farmers (of which 380 thousand are peasant farms)
Advantages:	Advantages of the Hydrotaran pump: water supply is carried out without the use of e / energy, uses the natural force of water impact, cheapness, ease of operation, the ability to generate electricity and heat, applicability for drip irrigation systems, subsoil irrigation, development of fisheries, development of rainfed lands, badlands, organization of watering places on pastures, not critical to the impact of traction and suspended sediments - sand, gravel, etc. and the amount of water in the water supply source a minimum level difference is sufficient, starting from a dozen centimetres, and a relatively small water flow the ability to make the most efficient use of the flow energy both at high water flow (during floods) and at very low water flow (during the dry season) simplicity of design and a minimum of parts provide outstanding reliability and durability of the device - continuous operation without repair. payback period - within one growing season. The water pump is patented in Kyrgyzstan, in Russia and in the Eurasian Patent Organization. .
Flaws:	
Necessary institutional requirements	Existing Institutional Structures: Farms, NGO Gidroimpulse.
Alignment with national priorities	NDS 2040, Irrigation Development Programme for the period up to 2026

Expert opinion	Proposed by the Joint Working Group, additional consultations were held with the Head of the NGO Gidroimpuls A.G. Rogozin.
Price	
Capital expenditures:	Technical documentation has been developed for several sizes of Hydroram. And depending on the brand of the pump, the cost ranges from USD 1700-2000[149]
Operation and maintenance:	O&M consists of monitoring and adjusting the operation of the pump and water supply system, annual valve replacement
Other:	
Contribution to development, additional benefits	
Increase in income	Implementation of this Technology will make it possible to eliminate corruption schemes for paying for ISP services, increase the amount of income from ISP to the republican budget, which, in turn, will allow funds to be directed to increase the salary of RUWH employees. Increasing the area used for crop production through improved water availability will help increase farmers' incomes.
Workplaces	New design, installation and maintenance jobs will be required. Increasing the area used for crop production through guaranteed water supply will help increase employment.
The economic growth	The introduction of this Technology will improve the quality of services for the supply of irrigation water, increase the volume of income from ISF, increase the yield of agricultural crops, payback within one season. Development of new lands. Increasing water supply, development of crop production and productivity will contribute to the economic growth of rural communities.
Number of beneficiaries:	About 1000 farmers per year across the country
Health	Reducing the heavy manual labour of lifting the gates of water intakes will help maintain the health of service personnel. Improving nutrition through the cultivation of quality agricultural products will contribute to the health of rural communities.
Education	Personnel required for design and training
Gender equality and social inclusion[150]	Technology does not limit women's participation. On the contrary, it helps to increase the productivity of crop production, which is predominantly done by women. It will free up time for other activities: alternative ways of generating income: housekeeping, gardening, vegetable growing, leisure.
Environmental benefits	It will help prevent erosion resulting from unregulated supply of irrigation water to the distribution network, irrigation water will be supplied in accordance with irrigation regimes, which will preserve the fertile soil layer. It will also reduce the processes of gully formation, erosion on irrigated lands, reduce the washout of the humus layer of the soil and the flow of solid runoff into rivers, reservoirs, drains
Implementation options	Existing institutions: Farms, NGO Gidroimpulse In Kyrgyzstan, the demonstration phase of the introduction of Hydrorams has been completed and it is necessary to begin the scaling phase.
Barriers to implementation	Lack of investors, financial resources, lack of information about this Hydrotaran pump, lack of benefits for obtaining loans for farmers, possible vandalism. For wide distribution, it is necessary to establish mass production of Hydroram. Currently, Hydrorams are manufactured by private organizations that cannot manufacture in large quantities. We need government support for this.

Technology Fact Sheet # 6

Sector	Water resources management
Subsector	Irrigation

[149]https://www.gidrotaran.kg
[150]Denotes the process of inclusion, involvement or entry into something, as part of a whole

Technology name	**"Technology of subsoil irrigation against the background of humidifying closed drainage using the subsoil irrigation method[151]»**
Introduction (Short description)	The main consumer of water in the country is irrigated agriculture, more than 90% of available water resources are spent for irrigation needs, up to 10.0 km^3 per year, of which up to 3.5 km^3 is lost during transportation, 1.5-1.9 km^3 - in the field and intra-farm network.[152] The method of subsoil irrigation using underground pipelines is a simplified version of drip irrigation.
Climate benefits:	
Adaptation	The Technology under consideration contributes to rational water use and in connection with the forecasts for the reduction of runoff, as a result of Global climate change, this technology will help reduce the shortage of water resources.
Mitigation	This Technology, due to its peculiarity, when irrigation is carried out along underground molehill drains, i.e. open-air flood irrigation is excluded, which contributes to evaporation from irrigation arrays, i.e. the formation of water vapor, the main GHG, is prevented
Specifications	
Productivity / scope of work:	Construction/reconstruction of drainage and water supply systems (collector-drainage), sluice-regulators
Resource efficiency:	Increases the efficiency of water and land use
Life time:	25-30 years old
National context	
Market potential:	The scope of the Technology is limited to: the presence of low-mineralized groundwater, up to 1.5 g / l with a depth of level up to 1.0 m, the absence of local saline lenses, the necessary good water permeability and drainage of soils relatively flat terrain without sharp and deep depressions that can be swamped. Basically, according to these indicators, the north-western zone in the Talas and Chui valleys is suitable for the installation of subsoil irrigation systems, about 100 thousand hectares of irrigated land
Advantages:	Sub-irrigation is economically much more efficient than surface irrigation and most fully meets the requirements of agricultural crops, because. optimal conditions are created for the growth and development of plants, higher water use ratio, simplicity of design during construction and operation, irrigator productivity increases by 30-50%, high yields are provided regardless of weather conditions, nutrients and microelements are preserved in the soil, etc.
Flaws:	The need for a collector-drainage network operating in the optimal mode, the high cost of asbestos-cement and polyethylene pipes and flexible nylon hoses, the possibility of vandalism
Necessary institutional requirements	Existing Institutional Structures: State Water Resources Service of the Ministry of Agriculture, Hydroreclamation Expedition of the SVR, KNIIIR, sustainable farms
Alignment with national priorities	NDS 2040, Irrigation Development Programme for the period up to 2026
Expert opinion	Proposed by the AWG, additional consultations were held with KNIIIR
Price	
Capital expenditures:	Reconstruction of collector-drainage networks, installation of subsoil pipes. Cost m.b. defined for the array that will be selected for the implementation of subsoil irrigation, i.e. there is no possibility of point determination of value. Therefore, it can be estimated indirectly, by the volume of annual financing of the SME of the SVR of the Ministry of Agriculture, which is 93.0, of which 68.0 million som are overhaul. Moreover, these funds are not enough.

[151]Rational technologies for water and land use in irrigated conditions of farming in Kyrgyzstan A.O. Naloychenko, A.Zh. Atakanov Bishkek 2016

[152] C. Valentini. 2015. Modern irrigation technologies and the possibility of their application in Kyrgyzstan. National dialogue on water policy in Kyrgyzstan in the field of Integrated Water Resources Management.

Operation and maintenance:	Costs are required for the creation / reconstruction of collector-drainage networks, the maintenance of the Irrigation and Reclamation Expedition of the Ministry of Agriculture
Other:	
Contribution to development, additional benefits	
Increase in income	The introduction of this Technology will increase the yield of agricultural crops, which contributes to an increase in incomes of the population
Workplaces	New jobs will be required to maintain collector-drainage and subsoil irrigation systems
The economic growth	The introduction of this Technology will improve the quality of services for the supply of irrigation water, increase the volume of income from ISF.
Number of beneficiaries:	
Health	Reducing the heavy manual labour of lifting the gates of water intakes will help maintain the health of service personnel, farmers
Education	Staff required for design and maintenance
Gender equality and social inclusion[153]	Reducing heavy manual labour for lifting gates of water intakes will help maintain the health of service personnel, including farmers. women. Will free up time for other activities: alternative ways of generating income: housekeeping, gardening, vegetable growing, women's leisure
Environmental benefits	It will prevent erosive erosion of canals formed during unregulated supply of irrigation water to the distribution network, reduce the shortage of water resources, irrigation water will be supplied in accordance with irrigation regimes, which will preserve the fertile soil layer. It will also allow to reduce the processes of gully formation, erosion on irrigated lands, prevent the washout of the humus layer of the soil, the formation and flow of solid runoff into rivers, reservoirs, drains
Implementation options	Existing institutions: Water Resources Service of the Ministry of Agriculture and structural units - SME, Farms
Barriers to implementation	Lack of investors, financial resources, high-cost technology

Technology Fact Sheet # 7

Sector	**Water resources management**
Subsector	**Irrigation**
Technology name	**Artificial glaciers**
Introduction	The republic is characterized by mountainous conditions, vertical zonality of natural conditions. Of the total area of agricultural land are: - arable land 1367.6 thousand ha (irrigated - 836.6 thousand ha); - fruit plantations - 44.8 thousand ha (irrigated - 43.5 thousand ha); - fallow - 18.5 thousand ha (irrigated - 0.3 thousand ha); - hayfields - 159.5 thousand hectares (irrigated - 7.7 thousand hectares); - pastures - 9089.2 thousand hectares (irrigated - 34.8 thousand hectares). A big problem is the provision of water for drinking, irrigation needs, watering of pastures in inaccessible mountainous areas, where there are no reservoirs, irrigation networks.
Climate benefits	
Adaptation	The accumulation and delivery of water to improve irrigation at the community level increases the climate resilience of communities and households to the impacts of Climate Change. In addition, degraded due to climate change, drought, land and especially pastures are being restored.
Mitigation	The creation of an artificial glacier is an alternative to such structures as BSR / BDR, which prevents possible evaporation from the water surface, the formation and release into the atmosphere of water vapor, the main GHG
Specifications	
Productivity / Scope of work:	An artificial glacier is created by freezing, supplied through the supply and vertical pipes, a gravity flow of water. The source of water may be a small stream. For water supply you need:

[153]denotes the process of inclusion, involvement or entry into something, as part of a whole

	- construction of a well - installation of a pipe with a diameter of 100 mm, at the beginning of which a trash-retaining mesh and a valve are installed to open and close the water supply - installation of a plastic pipe for supplying water along a slope to the place where an artificial glacier is created - installation of another well at the final section with the installation of a tee with a valve for the discharge pipe and for the branch of pipes through which water is supplied to the spouting part - installation of a connecting element so that the water is directed through a vertical pipe. - To ensure the stability of the vertical pipe during flowing, the pipe must be fixed to a previously installed vertical reinforced concrete column - to increase the stability of the structure, the main pressure column of the fountain should be supported at an angle from different sides with wooden beams. Why is it necessary to lay branches of caragana or sea buckthorn (or any other shrub plant with extended branches) around the original structure (and, if possible, at different stages of ice accumulation, approximately every 50-60 cm of thickness) to provide additional surfaces for ice accumulation. In addition, to protect the structure from grazing livestock or other possible damage, several rows of barbed wire can be laid around it, which will also become the basis for ice accumulation. Due to the created pressure of water due to the slope of the terrain, a fountain with a height of up to 10 metres is created. Freezing of the flowing water leads to the creation of an artificial glacier, an ice tower 30-50 metres high.
Resource efficiency:	Improving food security by maintaining the productivity of agricultural land in conditions of lack of irrigation water at the beginning of the growing season is to reduce the vulnerability of food systems at the community level. Saving irrigation water, from 100 to 500 thousand m3, depending on the water supply and the number of vertical pipes for spouting.
Life time:	The installed system for the annual creation of the Glacier can last up to 30 years.
National context	
Market potential:	Depending on the availability of places with the required terrain conditions and the availability of water, the Artificial Glacier can be distributed where there is a need for it, including funds in the local community budget.
Advantages:	The attractiveness of this method lies in the simplicity of design, low cost of its creation, the ability to implement it almost everywhere, and the absence of the need for special training. The project is easily implemented by the efforts of the local community itself. In the case of water supply from the river through pipes with a diameter of 63 mm, 130 thousand m3 of water can be accumulated, which makes it possible to irrigate 260 hectares of pastures during the season and at the same time provide a watering place for the livestock of an entire village, or even Aiyl aimag. Possibility of irrigation, restoration of degraded pastures: weedy, knocked down, eroded more than 3.22 million hectares or 29% of the total area.
Flaws:	Requires agreement with all stakeholders at the local level.
Required Institutional Needs	Implemented by local communities, WUAs, Pasture Committees. Does not require the creation of additional organizations
Alignment with national priorities	Corresponds to national priorities for ensuring food security, improving nutrition of the population and rational use of water resources of the National Development Strategy of the Kyrgyz Republic for 2018-2040, the National Programme for Sustainable Development of the Kyrgyz Republic for 2022-2026 and the Water Code of the Kyrgyz Republic.
Expert opinion	Demo plots show good results, which are supported by experts. Proposed by members of the AWG.
Price	
Capital expenditures:	Depending on the water supply and the number of vertical pipes for spouting, the costs range from 300 - 800 thousand som.
Operation and maintenance:	O&M consists of monitoring and regulating the operation of the water supply system, the cost is about 5,000 som per year.

Other	No other expenses
Contribution to development, additional benefits	
Increase in income	Increasing the area used for crop production through improved water supply, development of new lands, restoration of degraded rainfed and pasture lands, organization of livestock watering will help increase farmers' incomes
Workplaces	Through the development of new lands, the restoration of degraded rainfed and pasture lands, the organization of watering places for agricultural animals, an increase in the area used for crop production through improved water supply will contribute to an increase in employment.
The economic growth	Increasing the water supply for crop and livestock development will contribute to the economic growth of rural communities.
Number of beneficiaries:	1 glacier makes it possible to improve the irrigation of 250 ha, i.e. 125 farmers' plots, i.e. 125 households.
Health	Improving nutrition through obtaining quality agricultural products from livestock and crop production will help improve the health of rural communities. The use of high-quality melt water for drinking helps to reduce the risks of diseases associated with the use of low-quality drinking water.
Education	Gaining knowledge about this technology broadens one's horizons. And the preparation of relevant materials helps to increase the level of self-education of each interested farmer. Special knowledge is not required
Gender equality and social inclusion	Technology does not limit women's participation. On the contrary, it helps to increase the productivity of crop production, which is predominantly done by women.
Environmental benefits	The technology does not have any negative impact on the environment, it contributes to the reduction of pasture degradation and their restoration.
Implementation options	The attractiveness of this method lies in the simplicity of design, low cost of its creation, the ability to implement it almost everywhere, and the absence of the need for special training. The project is easily implemented by the efforts of the local community itself.
Barriers to implementation	Lack of information about this Technology Lack of financial resources. The need for coordination with all stakeholders at the local level.

Annex II: List of Stakeholders involved and their contacts

List of stakeholders involved in technology prioritisation for Agriculture Sector

#	Full name	Organization, position	Contacts
1.	Baydyldaev Murat Kerimbekovich	Deputy Minister. Working group leader	Tel. 0708260794 0550533562
2.	Sooronova Nuria Rakhmanberdievna	Deputy Minister of Agriculture	Tel. 0550 061-333
3.	Kozhogulov Nurlanbek Zhamalidinovich	Director of the Department of agricultural mechanization, cooperation and innovative technologies	Tel. 66 44 81 0555678740
4.	Madyarov Zh.B.	Specialist of the Department of agricultural mechanization, cooperation and innovative technologies	Email: tehinspekzia@mail.ru
5.	Rasul Kyzyl Aigerim	Leading Specialist of the Department of Organic Agriculture under the Ministry of Agriculture of the Kyrgyz Republic	Tel. 0550 353709 Email:aruslankyzy10@gmail.com
6.	Kydykmanov Emilbek Sagyndykovich	Head Department of Agrarian Policy and Forecasting of the Ministry of Agriculture	Email:kydykmanov58@mail.ru
7.	Aidaralieva Nuraiym	Chief Specialist of the Agricultural Policy and Forecasting Department of the Ministry of Agriculture	Email:aydar7676@gmail.com
8.	Japarbekova Gulnara,	Department of Agrarian Policy and Forecasting of the Ministry of Agriculture	
9.	Zhumaev Nurlanbek Kadyrovich	Head of the Forestry Department of the Ministry of Agriculture	Email: n.jumaev@mail.ru
10.	Karabaev Aibek Nurudinovich	Ministry of Natural Resources, Ecology and Technical Supervision. CFC Specialist.	Email:aibekusa@yahoo.com, Tel. 0776831189
11.	Dostukbek Obodoev	CFC Project Coordinator	Email:dostuk.obodoev.88@mail.ru
12.	Mambetov Kumushbek Bekitaevich,	Dean of the Faculty of Agronomy and Forestry of the Kyrgyz National Agrarian University/	Tel +996(312)540535 Email: kumushbek.mambetov@mail.ru
13.	Egemberdiev Adymalik Abdykarovich	General Director of the National Association of Pasture Users	Tel. 550 500 002, E-mail:pasturekj@gmail.com
14.	Burkhanov Aitkul Mustafaevich	General Director of the Association of Forest and Land Users	T. 555 704878, 770 844 844 Email:a.burkhanov58@gmail.com
15.	Aidaraliev Iskenderbek Rysbekovyi	Chairman of the Federation of Organic Movement BIO KG	Tel.0554 51 90 02 Email:federationbiokg@gmail.com
16.	Kadyrkulov Nurlan Maratovich	General Director of LLC EcoAgro	Email: ecoagros@yandex.ru kyrghyz1@yandex.ru

#	Full name	Organization, position	Contacts
17.	Ukubaev Turatbek Galiyarovich	General Director of the Agro-Industrial Holding "Atalyk Group".	Email: office@atalyk.kg Tel.+996 (312) 91-99-99
18.	Vedenev Alexey Gavrilovich	Head of the Association of Farmers and Peasants	Email: agvedenev@yandex.ru Tel.: 0559000104
19.	Isaev Kutman Mukashevich	Republican Soil Agrochemical Station	Email: rpas@mail.ru
20.	Taranova Elena Pavlovna	Crop Farming Development Department of the Ministry of Agriculture	Email:t_dpifl_2004@mail.ru
21.	Alzhanbayeva Zh	Coordinating Council of the Ministry of Agriculture	Email:alzhanbaeva.zh@gmail.com
22.	Tuleev Tamchybek Karybekovich	Director of Agriculture projects implementation unit of IFAD	Tel. (312) 665 625 / 975 974
23.	Chernikova Tatyana Gennadievna	Hydro Meteorological Service of the Ministry of Emergency Situations	Tel. 31 48 35, 0777 900410 Email: chernikova@meteo.ktnet.kg
24.	Nurzhanov Bakytbek	Community Development and Investment Agency (ARIS) Specialist	Email: BNurjanov@aris.kg
25.	Akmatova Cholpon	Kyrgyz Association of Forest and Land Users	E-mail: cholponakmatova7@gmail.com
26.	Naimanbaeva Zamira	CFC, gender specialist	E-mail: zamiranaiman@gmail.com
27.	Barakanova Natalia	ARIS Specialist	Email: NBarakanova@aris.kg
28.	Dosuev Mirbek	ARIS Specialist	Email: MDosuev@aris.kg
29.	Tologonova Gulyayym	ARIS Specialist	Email: GTologonova@aris.kg
30.	Apasov Rysbek Tunguchbaevich	Advisor to the Minister of Agriculture, resource mobilization expert	0772575825 invest305@mail.ru
31.	Zhusupov Matraim	FAO Project Manager	Tel. 0777 909-001, E-mail:matraim.jusupov@fao.org
32.	Mambetov Omurbek	Agronomist FAO	Email: omurbek.mambetov@fao.org
33.	Temirbekov Alexander Marlenovich	Leading National Consultant for Agriculture	atemirbekov@mail.ru

List of stakeholders involved in technology prioritisation for Water Sector

No.	Full name	Organization, position	Contacts
17.	Mr. Dostukbek Obodoev Abdygaparovich	Project and Programme Coordinator of the CCF MNRETS	0999664646
18.	Mr. Abdybai Jailoobaev	Water Resources Service of the Ministry of Agriculture, Deputy Director, Member of the NOC, Chairman of SWG	djailobaev1961@mail.ru basssein@mail.ru
19.	Ms. Asel Raimkulova	Head of the Department of Water Resources Protection of the Department of Water and Land Resources of the Ministry	0552761576 raimkulova.asel@mail.ru

No.	Full name	Organization, position	Contacts
		of Economic Development and Trade of the Kyrgyz Republic, SWG member	
20.	Mr. Bozgunchiev Talai	Water Resources Protection Unit under the Department of Water and Land Resources of the Ministry of Economic Development and Trade of the Kyrgyz Republic	0509 007299 talaiboz@mail.ru
21.	Ms. Orozbakieva Shayyrgul Galievna	State Agency for Architecture, Construction and Communal Utilities. Leading Specialist of the Department for the Development of Drinking Water Supply and Sanitation. SWG Member	312810 orozbakieva@mail.ru
22.	Mr. Bekzhan Mamytov	Senior Specialist of the Water Resources Sector of the Ministry of Agriculture.	625350, 0555301964 mamytov-b@bk.ru
23.	Ms. Gulmira Satymkulova,	Chief Specialist of the Water Resources Department of the Water Resources Service of the Ministry of Agriculture, Head of the Secretariat of the Chu-Talas Interstate Water Commission. SWG Member	541409, 0550401304 gulmirasatymkulova@gmail.com
24.	Mr. Buzurmankul Toktonaliev	Design Institute for Water Metering "Vodoavomatika", Director	541150 pkti@elcat.kg
25.	Mr. Dmitry Borisenko	Design Institute For Water Metering "Vodoavomatika", Director	541150
26.	Mr. Amanzhol Atakhanov	Kyrgyz Research Institute for Irrigation, Deputy Director	0770672252 aatakanov@mail.ru
27.	Mr. Vitaly Shablovsky	Head of Laboratory, Kyrgyz Research Institute of Irrigation. SWG member.	541164, 0555187771 wishab@mail.ru
28.	Mr. Alexander Grigoryevich Rogozin	Kyrgyz Research Institute for Irrigation Hydraulic impulse Supervisor.	0558 626210 hydroimpuls@list.ru
29.	Mr. Kanat Omurzakov	Kyrgyz National Agrarian University, Deputy Dean of the Faculty of Hydroreclamation, Ecology and Land Management	0773571535 kanat3884@gmail.com
30.	Mr. Tashmukhamed Khalmukhamedovich Karimov	Kyrgyz State University for Construction and Architecture, Honorary Professor, Department of "Water supply, sanitation and hydrotechnical construction"	0555520521 tashmukhamied@mail.ru
31.	Mr. Vladimir Ignatenko	Chief Engineer of the Bishkek City Waterworks	561655, vodokanal@mepya.kg
32.	Mr. Talantbek Musaev	Drip irrigation. Businessman.	0551254535 Kitano_kg@mail.ru
33.	Mr. Mirlan Tashtanbekovich Kenzheev	LLC "Marketing-Service" (Kantvodokanal) Director - Kant	
34.	Mr. Erkinbek Imaralievich Kozhoev	Chairman of the National Union of Water Users Associations of the Kyrgyz Republic	0778214421 e.kozhoev@gmail.com
35.	Mr. Ryspek Apasov	Advisor to the Minister of Agriculture	0772575825 invest305@mail.ru
36.	Mr. Azizillaev Salavat	LLC CIC Community International Consulting	0770 902 842 cic.llc@mail.ru

No.	Full name	Organization, position	Contacts
37.	Mr. Ramazan Suleev Dunlarovich	Representative of Asiagrocenter LLC in the Kyrgyz Republic	Ramazan Suleev agc_kg@mail.r >
38.	Mr. Matraim Zhusupov	Project Manager CACILM 2 FAO	0777 909-001,matraim.jusupov@fao.org
39.	Ms. Ekaterina Sakhvaeva	National Expert Consultant	0555354656 tadar51@mail.ru
40.	Mr. Alexander Temirbekov	National Expert Consultant	0700974847 atemirbekov@mail.ru

Annex III: Terms of Reference for the Project National Steering Committee

1. Background:

The purpose of the project is to assist the Kyrgyz Republic update its Technology Needs Assessment (TNA) and develop a technology road map for prioritized technologies to address climate change challenges in the most critical sectors of the economy. TNAs are central to the work of Parties to the Convention on technology transfer and present an opportunity to track an evolving need for new equipment, techniques, practical knowledge and skills, which are necessary to mitigate GHG emissions and/or reduce the vulnerability of sectors and livelihoods to the adverse impacts of climate change. The project will work toward achieving the following four outcomes:

- Outcome 1: Relevant country stakeholders have established adequate capacity, systems, and networks to support the planning, programming, and implementation of GCF-funded activities
- Outcome 2: the Kyrgyz Republic has developed or enhanced strategic frameworks to address policy gaps, improve sectoral expertise, and enhance enabling environments for GCF programming in low emission investment
- Outcome 3: Strategies for transforming and attracting private sector investment for low emissions and resilience developed and being used
- Outcome 4: An increase in the number of quality project concept notes developed and submitted

These outcomes will be achieved by providing support to:

1. Identify and prioritize through country-driven participatory processes, technologies that can contribute to mitigation and adaptation goals of the participant countries, while meeting their national sustainable development goals and priorities. This will result in the delivery of a report on technology needs.
2. Identify barriers hindering the acquisition, deployment, and diffusion of prioritized technologies. This will result in the delivery of a barrier analysis report.
3. Develop Technology Action Plans (TAP) including a policy brief specifying activities and enabling frameworks to overcome the barriers and facilitate the transfer, adoption, and diffusion of selected technologies in the participant countries.

Further, the TNA process will develop Sectoral Policy Briefs and project-specific recommendations for attracting funding to implement selected technologies in priority areas of national relevance, including the engagement of the private sector.

To provide oversight of the process ongoing the National TNA Project Steering Committee (SC) has been formed including all the main stakeholders as members:

10. Ministry of Natural Resources, Ecology and Technical Supervisions
11. Ministry of Energy
12. Ministry of Transport and Communications
13. Ministry of Agriculture (MoA)
14. Ministry of Economy under MoA

15. Water Resources Service
16. State Agency for Architecture, Construction and Communal Utilities
17. Bishkek City Hall.
18. Climate Finance Centre.

Main responsibilities:

The NSC will act as an advisory and oversight body to coordinate TNA Project activities at sector and national levels to ensure a comprehensive approach. The SC has the responsibilities to monitor and conduct quality control over timely implemented activities under the Project and guide it at the highest level.

Throughout the project's implementation, the Steering Committee's role will be to discuss and deliberate on project outcomes and results, provide recommendations, technical oversight and strategic advice to the NDA on various Project-related subjects, ensuring Project alignment to the national and sectoral level development and climate-related priorities. It will also ensure TNA Project contribution and complementarity to the overall national low carbon and adaptation planning processes of Kyrgyzstan, while avoiding overlap or duplication with other under implementation initiatives.

Functional management:

The NSC will provide the functional management in performing the responsibilities under the project through:

- ensuring the project implementation according to its Project Document and work plans.
- ensuring transparency in the use of funds;
- examination of other activities that may occur in coordination with the implementing agency.

NSC functions:

1. The NSC has the following core functions:
   - examines and approves per the Project Document, procedures of the implementing agency and donor organization, the project related documents;
   - approves work plans and project budgets at project's manager proposal;
   - approves significant changes in work plans and project activities;
   - provides consultative support to the national consultants;
   - monitor technically the progress in project implementation;
   - promotes collaboration between national institutions and stakeholders involved in project implementation and arbitrates any conflicts arising between them during project implementation.

2. The NSC promotes sustained efforts for mobilizing additional resources, including for further activities required to accomplish the project.

NSC activities:

- The NSC will meet when necessary but not less frequently than once per semester. The quorum required for the validity of the NSC meeting is 50% + 1 of the total number of members;

- Meetings may be convened by the NSC Chair on his own initiative or at the proposal of one third of SC members and/by national consultants, based on relevant arguments;
- The NSC Chair chairs meetings and in his absence by the Deputy Chair of the NSC, who are the representatives of Ministry of Natural Resources, Environment and Technical Supervision (NDA) and the Climate Finance Centre (CFC) as implementing organization within the NSC;
- The CFC Assistant will inform SC members on the date of meeting and agenda providing all the needed materials at least 7 days before the meeting;
- The documents for the meeting shall be submitted in writing or at the request of NSC members in electronic format by the Assistant at least 5 days before the date of the meeting;
- NSC members submit in writing their proposals and objections regarding the documents presented for examination at least three days before the board meeting;
- Decisions are made by an open vote by a simple majority of those present;
- NSC members that due to objective reasons cannot attend the meeting, delegate another person within the represented institution for meeting attendance;
- Project NSC meeting minutes will be signed by all of the NSC members. Voting „against" or „abstaining from voting" at the Project NSC meeting cannot serve as a reason for not signing the meeting minutes.
- The NSC will approved annual reports prepared by national consultants and UNEP-CCC on project implementation.

NSC Secretariat:

- Climate Finance Centre will serve as NSC secretary and organizes SC meetings;
- Ensures the link and effective communications between the SC, the Implementing Agency, and the national institutions involved in project implementation.

Period of the NSC activity:

The NSC shall exercise its functions during project implementation with the extension of its responsibilities in the case of extension of project duration.

Annex IV: Terms of Reference for the Sectoral Working Groups

1. Background

Project “Technical Guidance and Support for Conducting a Technology Needs Assessment (TNA) of the Sectors and Development of a Technology Action Plan (TAP) in the Kyrgyz Republic” was developed and submitted on September 15, 2020 to the Green Climate Fund (GCF) by the Climate Finance Centre of the MNRETS to expand cooperation with the Climate Technology Centre and Network (CTCN) of the United Nations Framework Convention on Climate Change (UNFCCC).

As the operator of the technology mechanism of the Convention, CTCN is a joint agency of the United Nations Environment Programme (UNEP) and the United Nations Industrial Development Organization (UNIDO).

The Centre promotes the accelerated transfer of environmentally friendly technologies for low carbon and climate resilient development at the request of developing countries. In doing so, CCCT offers technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to each country's needs, drawing on the expertise of a global network of technology companies and institutions.

The project is funded by the GCF under the Readiness and Prepare for Support Programme (Readiness Program), which supports developing country initiatives to strengthen institutional capacity, planning and management mechanisms, and establish programming frameworks towards a transformative long-term climate action agenda. The Readiness Programme offers grants and technical support to GCF National Designated Authorities. In Kyrgyzstan, this is the Ministry of Natural Resources, Ecology and Technical Supervision.

The purpose of the support is to strengthen the capacity of national institutions to effectively collaborate with the GCF through improved policy frameworks and project development. In addition, earmarked preparedness funding can also help countries adapt and improve their strategic framework for collaboration with the GCF.

This GCF Readiness Programme project aims to establish a climate technology framework for sustainable socio-economic development in the country. This will be achieved through a comprehensive sectoral Technology Needs Assessment and the development of a Technology Action Plan in energy, agriculture, water and waste management. This work will help the country achieve international climate targets in line with Kyrgyzstan's country commitments for the updated Nationally Determined Contributions (NDCs), National Communications and the draft Country Programme for the GCF by proposing and promoting the most appropriate technology solutions.

In order to conduct TNA in Kyrgyzstan in the target sectors, it is planned to create TNA sectoral working groups to work with national and international project consultants.

2. Goal

The main purpose of the SWG is to provide a mechanism for coordinating the consultation process, assessing the technological needs of the sector and a platform for cooperation of all stakeholders. The TWG will also ensure that the documents developed during the TNA process are in line with the priorities of the national and sectoral development policy of the Kyrgyz Republic and facilitate the exchange of information between all stakeholders.

3. Objectives/Tasks

The objectives of the SWG are to promote TNAs in the sector through:

- Organization of the work of an industry working group involving all stakeholders with national and international expert consultants.
- Discussion and approval of the selection of priority sub-sectors and technologies for the sector proposed by national and international expert consultants
- Ensuring the provision of information and sector data required for the conduct of a sectoral TNA.
- Ensuring the participation of sector specialists in activities to increase the technical capacity of the project.
- Discussion and approval of the sectoral TNA Technical Report prepared with national and international expert consultants.
- Discussion and approval of the sectoral Technical Report on the analysis of barriers and regulatory frameworks for the introduction and dissemination of selected technologies in the Kyrgyz Republic.
- Discussion and approval of the sectoral Technological Action Plan to overcome barriers to the introduction and dissemination of selected technologies in the Kyrgyz Republic.
- Discussions and approval of a set of project ideas and definitions of a priority Project Concept for the GCF.

4. Roles and responsibilities

The role of the TWG in the project implementation process is to ensure that all developed TNA documents are agreed with all stakeholders in the sector. The OWG is responsible for coordinating all proposals for the introduction and dissemination of selected technologies with national and sectoral development priorities and relevant strategic documents.

The role of the SWG is to support the work of national consultants by providing the necessary information and data, participating in project coordination meetings. The Working Groups contribute to the TNA and the development of relevant sector documents, ensuring that they are aligned with the national development priorities of the country and the sector.

5. Organization of the work of the SWG on TNA

5.1 Membership

- Representatives of the ministry, representatives of other state bodies that determine the policy of the sector, representatives of science, NGOs, the private sector will become members of the SWG of the TNA sectors
- Membership in the TNA SWG is on a voluntary basis as an industry contribution to developing a framework for sector participation in the development and transfer of climate technologies.

5.2 Chair and Vice Chair

- The SWG of the TNA will be led by a representative of the Ministry of the relevant sector as the Chair of the SWG

- To ensure the continuity of the process of work of the Sectoral WG, the Chairman of the SWG will appoint his deputy at the first meeting of the SWG.

5.3. Secretariat

- The project assistant in the CFC, in close contact with the national consultants, will carry out the activities of the secretariat of the SWG of the sector in organizing events: preparing agendas, invitations to participants, preparing handouts and compiling minutes of meetings.
- The official distribution of invitations and project documentation will be provided by the project assistant at the CFC.

6. The working process arrangement

- TNA SWGs will carry out their activities through the following tools:
    - Letters of inquiry and response departments
    - Regular exchange of documentation and reports via e-mail
    - Holding meetings of the SWG, which will be prepared by the project, and which will ensure in advance the distribution of invitations, relevant materials and the preparation of minutes of events.
    - In case of restrictions on holding meetings due to new waves of the COVID-19 pandemic, the secretariat will organize meetings of the Committee and WG online.
- The costs of organizing meetings of the SWG will be covered from the project funds.
- The Climate Finance Centre will provide a venue for TNA SWG meetings.

7. Documentation

- Document flow and distribution of necessary materials will be provided by the project.
- Draft meeting minutes, presentations and analytical reports and other documentation, comments received, information and data collected will be archived at the CFC.
- Minutes of the meetings will be circulated to the members of the SWG by email for comments and then archived as appropriate.

Annex V: Climate change adaptation projects implemented in Kyrgyzstan

#	Code	Title of the project	Duration	Status	Funding Agency / Budget	Brief description	Results	Performance indicators	Links\Contact entity
1	Regional	Balancing and optimizing the multifunctional use of juniper forests in Central Asia.	2020-2022	At the stage of development	German Federal Office for Agriculture and Food (BLE) / 478,235.19 €	Promotion of bilateral forest research projects, guidance for the development of bilateral (Kyrgyzstan, Tajikistan) cooperation in research and knowledge exchange for international forest management).	New research on juniper forest mountain ecosystem, GIS mapping on ecosystem services	Number of climate research papers/	Central-Asian Institute for Applied Geosciences (Kyrgyzstan-Germany), University of Central Asia (Kyrgyzstan, Tajikistan), University of Stuttgart, Germany, University of Stuttgart, Germany.
2	Regional	Adaptation to climate change based on the ecosystem approach in the high mountainous regions of Central Asia	01.02.2019-31.08.2022	In the process of implementation	German Society for International Cooperation (GIZ) / 30,800 €	Adaptation to Climate Change based on the ecosystem approach in high mountain areas of Central Asia is focused on adaptation of local communities to climate change in pilot sites such as the Bartang River Basin (Tajikistan) and the Bash-Kayindy River Basin (Kyrgyzstan).	EbA deployed in the pilot sites such as the Bartang River Basin (Tajikistan) and the Bash-Kayindy River Basin (Kyrgyzstan).	Two pilot communities resilient to climate impacts	Central-Asian Institute for Applied Geosciences (CAIAG), Kyrgyzstan, Berlin Humboldt University
3	Regional	Climate Services of the Cryosphere to Improve Adaptation	2018 -2022	In the process of implementation	Swiss Agency for Development and Cooperation (SDC)	The aim of the Project is to facilitate the systematic exchange of water and climate-related data between data users and decision-makers to improve modelling and forecasting of water flow scenarios and reduce the associated disaster risks in Central Asia.	Improved monitoring observation of the glaciers gathering, processing and reporting using instrumental and remote sensing tools and software.	Number of glacier monitoring research papers	Central-Asian Institute for Applied Geosciences (CAIAG), Kyrgyzstan, University of Fribourg (Switzerland) on behalf of the World Glacier Monitoring Service (WGMS).
4	Regional	Reducing the vulnerability	2019-2024	Project is under	UNESCO / 6,500,000$	The project aims to enhance adaptation to climate change	Enhanced capacities of government institutions to	Improved glaciers lakes endangered with outburts	Central-Asian Institute for

#	Code	Title of the project	Duration	Status	Funding Agency / Budget	Brief description	Results	Performance indicators	Links\Contact entity
		of the population in the Central Asian region from the outburst of glacial lakes under the climate change conditions.		develop ment		in Central Asia by reducing social risks and vulnerability to floods from the outburst of glacial lakes. This is achieved by strengthening monitoring, analytical skills and response capacities for institutions and government officials responsible for disaster risk reduction, through the provision of training for local communities, as well as through awareness campaigns and the installation of Early Warning Systems (EWS) based on the latest monitoring strategies.	monitor, analyze and response to outburst of glacial lakes. Vulnerable communities trained. Early Warning systems (EWS) in place.	observation net equipped and mapped. Data exchange channels in place and operational and integrated into the EWS of the Ministry of Emergencies. Disaster prone communities aware and capacitated to act in emergency situations	Applied Geosciences (CAIAG), Ministry of Emergencies
5	KGZ	Tien Shan Glacial and Periglacial Lakes Research Project (GlaP)	2019-2024	In the process of impleme ntation	Niigata University, Japan	The project aims to enhance adaptation to climate change in Kyrgyzstan by reducing climate change impacts' risks and vulnerability to floods from the outburst of glacial lakes.	(i) Glacial and periglacial studies in the Tien Shan; (ii) Study of glacial and periglacial lakes using remote sensing and GIS methods in the Tien Shan; (iii) Providing information on glacial hazards to the local population;	Research paper on glaciers. Glacier maps available also to communes. Target communities well informed.	Central-Asian Institute for Applied Geosciences (CAIAG), Ministry of Emergencies
6	KGZ	Sustainable Development of Rural Water Supply and Sanitation (SDRWS)	2018-2025	In the process of impleme ntation	International Development Association (IDA), World Bank / 43.2 million USD	The objectives of the Additional Financing for the Sustainable Rural Water Supply and Sanitation Development Project are to assist the Kyrgyz Republic: (i) to improve access and quality of water supply and sanitation services in the participating rural communities; and (ii) to strengthen the capacity of the recipient's institutions in the water supply and sanitation sector. The Additional Financing (AF) responds to the Government of the Kyrgyz Republic's (GoKR) request via letter dated December 1, 2016, to scale	The original project includes 38 participating rural villages in Osh, Chui and Issyk-Kul Oblasts, directly benefiting around 100,000 people. The beneficiaries will be provided with access to piped water services through new household connections. Furthermore, under the original project some 16,000 people (mostly children) will directly benefit through investments in sanitation facilities and associated hygiene and behavior change interventions in schools and other eligible public institutions (for example, health clinics). 3. The AF will	Villages with improved access to safe water - 53; direct beneficiaries - 108,000 people	WB, https://projects.worldbank.org/en/projects-operations/project-detail/P162840 and Community Development and Investment Agency of the Kyrgyz Republic (ARIS) https://www.aris.kg/index.php?option=com_content&view=article&id=9&Itemid=162&lang=en

#	Code	Title of the project	Duration	Status	Funding Agency / Budget	Brief description	Results	Performance indicators	Links\Contact entity
						up the scope of the original activities, target beneficiaries and the resulting development effectiveness of the original project. In addition to the additional financing, management has approved the second order restructuring consisting of: a revision of the results framework, including targets, as necessary, to capture results of the expanded scope of activities to be financed under the AF; and a three-year extension of the original closing date from June 30, 2022 to June 30, 2025 to ensure sufficient time for the completion of additional activities within the framework of the AF, including a one-year period of post-construction operational assistance in the project areas.	continue to focus on rural villages in need within the same Oblasts due to practical considerations and to enable a concentrated level of effort for increased efficiency and development impact. The development impact will be deepened and expanded by increasing the coverage of combined16 project interventions to more than 91 villages, directly benefiting some 208,000 people in total.		
7		The Rural Water Supply and Sanitation Improvement Project (RWSSIP)	2017-2022	In the process of implementation	Islamic Development Bank / 23 million USD	The project objective is to assist the Kyrgyz Republic in (i) improving the access to and quality of water supply in targeted rural communities, (ii) improving sanitation services in selected villages, and (iii) strengthening the capacity of institutions in the water supply and sanitation sector. This objective will be achieved by mobilizing financial resources (i) to improve the quality of municipal services, such as water supply, through the reconstruction or construction of new water supply systems (ii) to	The project results will include the outputs of the following components: Component 1: Rehabilitation of rural water supply and sanitation systems. The objective of this component is to meet the needs of the population in the rehabilitation of existing and/or construction of new water supply and sanitation facilities. Component 2: Supply of O&M machinery, laboratory equipment and IT equipment for the surveillance and billing systems. The objective of this component is to supply machinery for operation and	Villages with improved water and sanitation systems in Dzhalal-Abad Province - 25. Direct beneficiaries - 78,000 people.	IDB https://www.isdb.org/project-procurement/tenders/2019/gpn/general-procurement-notice-rural-water-supply-and-sanitation-improvement-project and Community Development and Investment Agency of the Kyrgyz Republic (ARIS) https://www.aris.kg/index.php?option=com_content&

#	Code	Title of the project	Duration	Status	Funding Agency / Budget	Brief description	Results	Performance indicators	Links\Contact entity
						improve sanitation facilities and supply the necessary laboratory and IT equipment (iii) to build the capacity of public departments, local authorities, rural public associations of drinking water consumers. The main project beneficiaries are residents of the participating villages and water supply companies in Jalal-Abad region.	maintenance, laboratory and IT equipment for sanitary surveillance and billing system and capacity building and institutional strengthening of the Department of Disease Prevention and State Sanitary and Epidemiological Surveillance (SES) at the level of districts, which, within their mandate, are responsible for testing and certification of drinking water quality, and take preventive measures for diseases related to drinking water quality. Component 3: Sanitation capacity strengthening and institutional development. This component aims to assist in improving sanitation conditions in targeted rural communities, and strengthening institutional capacity at the local level to support the implementation of the Government's Strategy and the preparatory work for development of a framework programme. Component 4: Consultant services: design of systems and supervision of civil works. Component 5: Project management.		view=article&id=9&Itemid=162&lang=en
8	KGZ	Rural Water Supply and Sanitation Improvement in Batken and Talas Provinces (RWSSIP BT)	2020–2024	In the process of implementation	Islamic Solidarity Fund for Development of the Islamic Development Bank (ISFD) – USD 20,000,000 and Saudi	Aims to assist the Kyrgyz Republic in improving the availability and quality of water supply in targeted rural communities, improve sanitation services in selected villages, and strengthen the capacity of institutions in the water supply and sanitation sector.	The project will include 5 components: 1. Component 1: Civil Works: Improvement of Rural Water Supply and Sanitation: (i) Rehabilitation and construction of water supply systems; (ii) Rehabilitation of small scale sanitation facilities in social institutions. 2. Component 2:	Villages with improved water and sanitation systems: Batken Province - 44, Talas Province - 17. Direct beneficiaries - 150,000 people.	IDB https://www.isdb.org/project-procurement/tenders/2019/gpn/general-procurement-notice-rural-water-supply-and-sanitation-improvement-

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					Fund for Development (SFD) – USD 30,000,000		Supply of Machinery and Equipment: (i) Supply of operation and maintenance equipment to local utility operators; (ii) Supply of O&M machinery for local municipality; (iii) Supply of Laboratory and IT equipment for the Sanitary Epidemiology Surveillance services/centres; (iv) Supply of IT equipment for establishing billing system and improvement of water service delivery; 3. Component 3: Capacity Building on Sanitation & Institutional Development (i) Sanitation Development and Awareness Raising; (ii) Institutional Development and Billing System; (iii) Baseline Survey & Impact Assessment; 4. Component 4: Consultancy Services: Detailed Design and Supervision: (i) Preparation of detailed engineering design for water supply schemes as well as sanitation facilities; (ii) Contract management and technical supervision; 5. Component 5: Project Management.		project and Community Development and Investment Agency of the Kyrgyz Republic (ARIS) https://www.aris.kg/index.php?option=com_content&view=article&id=9&Itemid=162&lang=en
9	KGZ	Climate services and diversification of climate sensitive livelihoods to empower food insecure and vulnerable communities in the Kyrgyz Republic	2020-2024	In the process of implementation	Green Climate Fund (GCF) / 9.6 million USD	The project will contribute to the capacity of the Government of Kyrgyz Republic, its line ministries, and local authorities and communities to implement climate change adaptation activities in the food security and nutrition and agricultural sectors of the country. The objective is to support the Government of the Kyrgyz Republic to reduce its vulnerability to climate	1. Improved climate services to support vulnerable rural communities to plan for and manage climate risks and increased weather variability; 2. Strengthened and diversified livelihood to increase the adaptive capacity of vulnerable groups and build community resilience; and 3.Built capacities and decision-making to enhance	The proposed GCF project will support 102,000 direct (20,400 households) and 700,000. Dindirect beneficiaries in the Batken, Osh and Naryn provinces	World Food Program, Ministry of Natural Resources, Ecology and Technical Supervision (MNRETS), GCF https://www.greenclimate.fund/project/sap002

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						change and to increase the adaptive capacity and resilience of rural communities in Osh, Batken and Naryn provinces, which are increasingly affected by climate change impacts and suffer from low adaptive capacity. The underlying principle of project implementation is an innovative yet pragmatic set of actions. These include an informed top-down but user-tailored generation and dissemination of climate services, a focused effort to support climate change adaptation actions at community level, and a generation of knowledge, awareness and best practices to inform broad-based capacity building and improved decision making, which taken together will contribute to an enabling environment for climate action in the Kyrgyz Republic.	climate action using a multi-sectoral approach.		
10	KGZ	Carbon Sequestration through Climate Investment in Forests and Rangelands (CS-FOR) in the Kyrgyz Republic	2022-2029	Starting	Green Climate Fund (GCF) / 50 million USD	The project will achieve these sequestration results, while capitalizing important co-benefits from adaptation and disaster risk reduction, through: supporting government's on-going efforts to harmonize relevant policies and legal frameworks, and strengthen its planning, monitoring and evaluation systems (Component 1); introducing a process of local integrated rangeland and forestry resource planning built	M5.0 Strengthened institutional and regulatory systems A5.0 Strengthened institutional and regulatory systems for climate-responsive planning and development M9.0 Improved management of land or forest areas contributing to emissions reductions A7.0 Strengthened adaptive capacity and reduced exposure to climate risks	Mitigation. Sequestration of 19.8 million tCO_2eq in 20 years. These reductions represent 7.6 percent of the country's total emissions, and 22.6 percent of the agricultural share of emissions. Carbon sequestration at a cost of USD 2.5 per tCO_2eq. Adaptation. Strengthening the resilience and improving the livelihoods of 90,000 households (8.9 percent of total county population) by facilitating investment	FAO, MNRETS, GCF https://www.greenclimate.fund/project/fp116

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						around forest, rangeland and livestock management practices that sequester carbon, are responsive to observed changes in the climate and enable the diversification of household income earning activities (Component 2); facilitating market opportunities that provide the financial incentives, funded by the Russian Kyrgyz Development Fund (RKDF), for resource users to adopt and maintain management practices that sequester and preserve stored carbon (Component 3). The targeted project areas were selected due to their high level of exposure and sensitivity to climate change stressors, mitigation potential, human poverty and dependency on natural resources.		towards diversification, increase of efficiency and competitiveness, thus reducing dependency of communities on direct uses of resources (i.e., wood and pasture) and improving their livelihoods through benefits gained by improving ecosystem functions and diversification of livelihood opportunities for women and men.	
11	KGZ	Kyrgyzstan: Enabling Activities for the Preparation of Fourth National Communication and Initial Biennial Update Report under the United Nations Framework Convention on Climate Change (UNFCCC)	2018-2022	In the process of implementation	GEF / 852,000 USD	UNFCCC Financial Mechanism support was mobilized by operational partners of GEF - UNEP to development of the national MRV and M&E capacities, while reporting to conventions. The first objective is to undertake national stocktaking and stakeholder consultations. The second objective is to prepare the FNC and IBUR of Kyrgyzstan under the UNFCCC. The third objective is to undertake National Stakeholders' engagement and institutional arrangement for preparation of subsequent national	First ever Stocktaking Analysis and Stakeholders Consultations were conducted. BUR 1 was developed. NC 4 is under development.	Stocktaking Report on UNFCCC communications. BUR 1. NC 4 Adaptation Section. Stocktaking Report 2.	UNEP, MNETS PIU. GEF https://www.thegef.org/projects-operations/projects/9442

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						communication and biennial update report, also bearing in mind ETF adopted by the Paris Agreement.			
12	KGZ	Advancing development of a National Adaptation Plan (NAP) process for medium and long-term adaptation planning and implementation in the Kyrgyz Republic	2021-2024	In the process of implementation	GCF / 2,610,949 USD	The project supports the Government of the Kyrgyz Republic (GoKR) in establishing its National Adaptation Plan process and is consistent with the government's strategic vision for climate change adaptation. The project objective is to strengthen institutions and enhance vertical and horizontal coordination for climate change adaptation planning, facilitate mainstreaming of climate risks at sectoral and subnational levels, and identify a programme of priority climate change adaptation investments. The GoKR has prioritized adaptation planning through its national long-term strategic planning process and associated medium-term implementation plans, through which the long-term plan is implemented. This broader national planning framework calls for the development of a National Adaptation Plan as well as four adaptation plans for priority sectors to guide mainstreaming and future investments (disaster and emergency management, health, biodiversity conservation, and agriculture and irrigation water). These plans will catalyze investments to enhance	1. Strengthened coordination and institutional arrangements for adaptation planning. This outcome will result in improved cross-sectoral planning, the integration of climate change adaptation into national strategies, and the production of a National Adaptation Plan. 2. Priority sector-focused adaptation plans developed. The outputs associated with this outcome will address institutional weaknesses and capacity gaps within priority sectors' agencies. The activities and outputs will build the technical capacities of the agencies with respect to climate change adaptation and will empower them to iteratively identify and evaluate sector vulnerabilities and develop and implement adaptation measures. This outcome will also result in the production of climate change adaptation plans for the four priority sectors. 3. Sub-national climate change adaptation capacities strengthened. This outcome focuses on addressing institutional and capacity gaps at subnational levels and developing tools to enable subnational governments to begin to consider climate change adaptation in planning and budgeting processes.	Legal/institutional arrangements and responsibilities codified and enacted. Database, gender framework, and M&E system for NAP and climate change adaptation project development in place. Data collection and management procedures in place; procedures for information products and acces in place. 4 priority sectors have adaptation focal points and training programs. 4 priority sectors develop adaptation plans. 4 priority sectors draft secondary legislation for climate change adaptation mainstreaming. Vertical coordination mechanism established and implemented. Province level vulnerability assessments conducted in 3 provinces.	UNDP, MNRETS, GCF https://www.greenclimate.fund/document/adaptation-planning-support-kyrgyzstan-through-undp

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						adaptive capacity in the Kyrgyz Republic.			
13	Regional	Integrated Natural Resources Management in Drought-prone and Salt-affected Agricultural Production Landscapes in Central Asia and Turkey (CACILM2)	2019-2023	In the process of implementation	GEF / 300,000 USD	The aim of the project is to scale up sustainable management practices that minimize pressures and negative impacts on natural resources to reduce risks and vulnerability and, enhance capacity of rural communities to cope with or adapt to drought and salinity. The objective of the project is to "scale up integrated natural resources management in drought-prone and salt-affected agriculture production landscapes in Central Asia and Turkey". It will be achieved through the implementation of 4 components and 7 expected outcomes (see map of project sites and more detailed project expected results in Annexes 1 & 2): Component 1 – multi-country collaboration and partnership to foster the implementation of cost-effective INRM, focusing on drought-prone and salt-affected production landscapes Component 2 – Integration of resilience into policy, legal and institutional frameworks for integrated natural resources management (INRM), Component 3 – Upscaling of climate-smart agricultural practices in drought-prone and/or salt-affected production landscapes.	Outcome 1.1: Enhanced knowledge of the costs of land degradation and benefits of INRM, drought preparedness and biosaline agriculture to national economies and the region as a whole informs policy and investment decisions at all levels, including NAP processes; Outcome 1.2: Enhanced interstate dialogue, multi-country collaboration and information sharing to promote investment for INRM scaling up; Outcome 2.1: Resilience integrated across natural resources management (NRM) sectors and production landscapes; Outcome 2.2: Incentives for climate-smart agriculture in place at national and sub-national levels; Outcome 3.1: Upscaling of a proactive drought risk management (DRM) approach and innovative integrated natural resources management (INRM) technologies in selected production landscapes / land use systems (e.g. pastoral, agro-sylvo-pastoral, tree-based, irrigated, rainfed, home gardens); Outcome 3.2: Adaptation and scaling up of technologies and approaches for management of salt-affected production landscapes (e.g. irrigated, pastoral, agro-sylvo-pastoral, tree-based, home gardens).	Land under integrated management - 7,298,254 ha of demo areas and 2,590,770 ha of upscaling area. GHG emissions reduced on demo areas: 8.65 million tons CO_2eq over a 20 year capitalization phase; or 29.0 tons CO_2e per hectare and on upscaling area - 69.7 million tons CO_2eq or 26.9 tons CO_2e per hectare. Area with improved irrigation efficiency - 146,050 ha of demo area and 1,215,605 of upscaling area. Beneficiaries in pastoral, agro-sylvo-pastoral, tree-based, irrigated and, rainfed systems - 665,294 people in demo areas and 2,661,380 people in upscaling areas. Improvement in incomes from INRM (disaggregated by gender) - 25%.	FAO, MNRETS, GEF https://www.thegef.org/projects-operations/projects/9094

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						Component 4 – Monitoring and evaluation and adaptive learning.			
14	KGZ	Integrated Forest and Land Management	2018-2023	In the process of implementation	GEF / 4,109,589USD ; WB / 12,000,000	The Project Development Objective is to strengthen the institutional capacity for sustainable forest ecosystem management.	Forest policy reforms coupled with increased co-management responsibilities for local communities. A portfolio of replicable activities. Transparent management plans; increased capacity to measure carbon sequestration and forest cover change. Expected results: 1. Land area where sustainable land management practices have been adopted as a result of the Project (ha - core indicator); 2. Forest area brought under management plans (ha- core indicator); 3. Area restored or re/afforested (ha – core indicator); 4.Forest users trained: i.e forest users trained – female (number – core indicator); 5. Government institutions provided with capacity building support to improve management of forest resources (number – core indicator); 6. Reforms in forest policy, legislation and other regulations supported (yes/no-core indicator).	1. Sustainable land management in production systems (agriculture, rangelands, and forest landscapes): 864,175.00 ha; 2. Forest area brought under management plans: 161,000 ha; 3. Area restored: 2,000 ha; 4. Forest users trained: 1,700 (60% - women); 5. Government institutions provided with capacity building support to improve management of forest resources: 46; 6. Reforms in forest policy: Revised Forest Code (1 - SAEPF), Standardised costs (13 – project Leskhozes), Pasture MoUs (one for each 39 Leskhozes), and boundaries mapped (39 Leskhozes).	World Bank, SAEPF, GEF https://www.thegef.org/projects-operations/projects/9037
15	KGZ	Kyrgyzstan Climate Resilience Water Supply Project	2022	Approved	EBRD / 50 mln EURO	The proposed Project will finance the rehabilitation of the irrigation water conveyance infrastructure, including on-farm canals, intake structures and pumping stations in Jalalabad, Naryn and Osh regions of the Kyrgyz Republic. Transition Impact - Green: The Project is expected to enhance	The Project will include the construction and/or rehabilitation of water intakes, pumping stations, main canals and a distribution network with a view to deliver water from rivers to farmland. As a result of the Project, approximately 8,700 hectares of new irrigated land will be available for farmers creating additional jobs for	8,700 ha of new irrigated lands. Bout 14,300 new jobs.	https://www.ebrd.com/work-with-us/projects/psd/49793.html

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						resilience to climate change and enable sustainable and efficient use of water by financing the modernisation of the IWCI in the KR; - Well-governed: The Project will contribute to developing the long-term irrigation tariff policy for the KR and, as the next step, implementing this policy. The Tariff Reform Programme for the SWRA will focus on developing a tariff setting methodology (which is not currently in place in the KR) aiming to gradually transit to operating and maintenance cost recovery.	more than 14,300 rural residents.		
16	KGZ	Kyrgyz Republic Water and Wastewater Rehabilitation Extension	2015-2022	In the process of implementation	EBRD / 20 (+20) mln EURO	In 2011 the EBRD established a sovereign framework of funds to co-finance with international donors priority water and wastewater rehabilitation projects across the Kyrgyz Republic. Under the framework the Bank provides sovereign loans, on-lent or on-granted to participating water companies. The sub-projects address urgently needed water and wastewater infrastructure rehabilitation needs. The original framework is now fully subscribed, and the Bank is considering extending the facility with additional funds. Transition Impact of the extended framework would be: • Access to basic public utilities; • Introduction of tariff reform	The project aims to improve water supply systems and selected waste water treatment facilities in various cities of Kyrgyzstan: Osh, Jalalabad, Karabalta, Talas, Kant, Tokmok, Naryn, Batken, Kara-suu, Cholpon-Ata, Uzgen, Kizyl-Kiya, Toktogul, Balykchi, and Maili-suu.	15 cities with improved water supply and wastewater treatment	EBRD. https://www.ebrd.com/find?keywords=Kyrgyzstan&content-psds=true&dates-range=true&dates-range-from=2015&dates-range-to=2022&search-type=search-all&page=2&order-by-date=false

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						within affordability limits including support to low income groups; • Increased collection rates (possibility with the establishment of the integrated utility bill collection system); • Establishment of the contractual arrangement between the cities and the companies; • Improving operational and financial management of the water companies involved (including a community based shareholder participation programme, preparation and publication of IFRS and business plan, training on procurement, etc). • The expected transition impact rating is 'strong to good'.			