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Analysis of livestock and pasture sub-sectors for the NDC revision in Kyrgyzstan

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ANALYSIS OF LIVESTOCK AND PASTURE SUB-SECTORS FOR THE NDC REVISION IN KYRGYZSTAN

INTRODUCTION

Kyrgyzstan signed the Paris Agreement in 2019, thereby joining the global community in the fight against climate change. The Paris Agreement requires all countries to put forward their best efforts in the so-called Nationally Determined Contributions (NDCs). They present a country's commitments towards reducing greenhouse gas (GHG) emissions and adapting to climate change impacts.

Following the request of the Kyrgyz Government, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (German federal enterprise for international cooperation) is carrying out the Kyrgyz-German project "Development of policy recommendations for reducing greenhouse gas emissions and climate risks in the land use sector as a contribution to the preparation of the Kyrgyz NDCs". The project is financed by the Federal Ministry for Economic Cooperation and Development (BMZ). Since agriculture is the second largest emission intensive sector and most vulnerable to climate change in the country, the project has focused on in-depth assessment of livestock and pasture sub-sectors for potential to raise the ambition to reduce emissions by the Kyrgyz Republic under the Paris Agreement.

The livestock and pasture sector technical assessment was done by experts from the international consulting company UNIQUE forestry and land use GbmH, and local Public Foundation CAMP Alatoo on behalf of GIZ.

The NDC update process requires an inclusive and participatory approach, where all relevant partners, state and non-state entities, jointly agree on GHG reduction targets. The role of development partners in supporting NDC updates and aligning projects in the pipeline with GHG reduction targets is particularly important. Several large-scale livestock investments in the country aim at improving production and reducing GHG emissions from the sector and should therefore be reflected in national climate commitments. For example, the FAO project "Carbon Sequestration through Climate Investment in Forests and Rangelands in Kyrgyz Republic (CS-FOR)" funded by the Green Climate fund (USD 50 million) and the planned IFAD project "Regional Resilient Pastoral Communities Project" (USD 50 million) both include a large component on livestock productivity, for the adoption of climate smart practices in feed, herd and manure management. This assessment therefore includes the climate co-benefits of these projects, using the tool developed by FAO in support of IFAD for low carbon and resilient livestock investments. The tool is Global Livestock Environmental Assessment Model interactive (GLEAM-*i*), an on-line Tier-2 GHG calculator.

Therefore, the document is a result of joint efforts of several international development partner organizations, represented by Samir Bejoui, IFAD Country Director for the Kyrgyz Republic and Oliver Mundy, Technical analyst of IFAD, as well as Anne Mottet and Seyda Ozkan, Animal Production and Health division (NSA) in FAO. The technical assistance provided by IFAD and FAO was possible through funding from IFAD's Adaptation for Smallholder Agriculture Programme (ASAP2).

The NDC update process also included a capacity building component. Since the assessment of the livestock sector has been based on the GLEAM-*i* tool, introduction to the tool and calibration into Kyrgyz context has been conducted. To analyze pasture degradation trends, GIS instruments were used to prepare nationwide maps on pasture conditions. Three webinars on use of GIS to assess the impact of climate change on natural resources were organized by the Climate Resilience Cluster of the Earth Observation for Sustainable Development initiative (EO4SD), represented by Carlos Doménech García and Miguel Ángel Belenguer Plomer.

The analysis of the sector was supported by representatives of the state and non-state sectors who assisted the work of the Technical

expert group with submissions, information, and statistics, organizing meeting, including Azamat Mukashev, Lira Kasymbekova, Baktykan Stalbek kyzy, Natalia Kilyazova, Gulnara Jakypbekova, Almaz Abdiev, Nuria Sooronova, Sotovaldiev Adilet and Torogeldy Tynymseitov (Ministry of agriculture, water resources and rural development of the Kyrgyz Republic), Aisuluu Amanova and Ermek Beksultanov (Ministry of economy and finance of the Kyrgyz Republic), David Ward, Bekenov Malik and other experts from the IFAD -funded LMDP2 project team, Natalia Barakanova, Umut Raimov, Almas Dunganov, Damira Isakulova, Zholdoshbek Dadybaev from ARIS.

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LIST OF ABBREVIATIONS

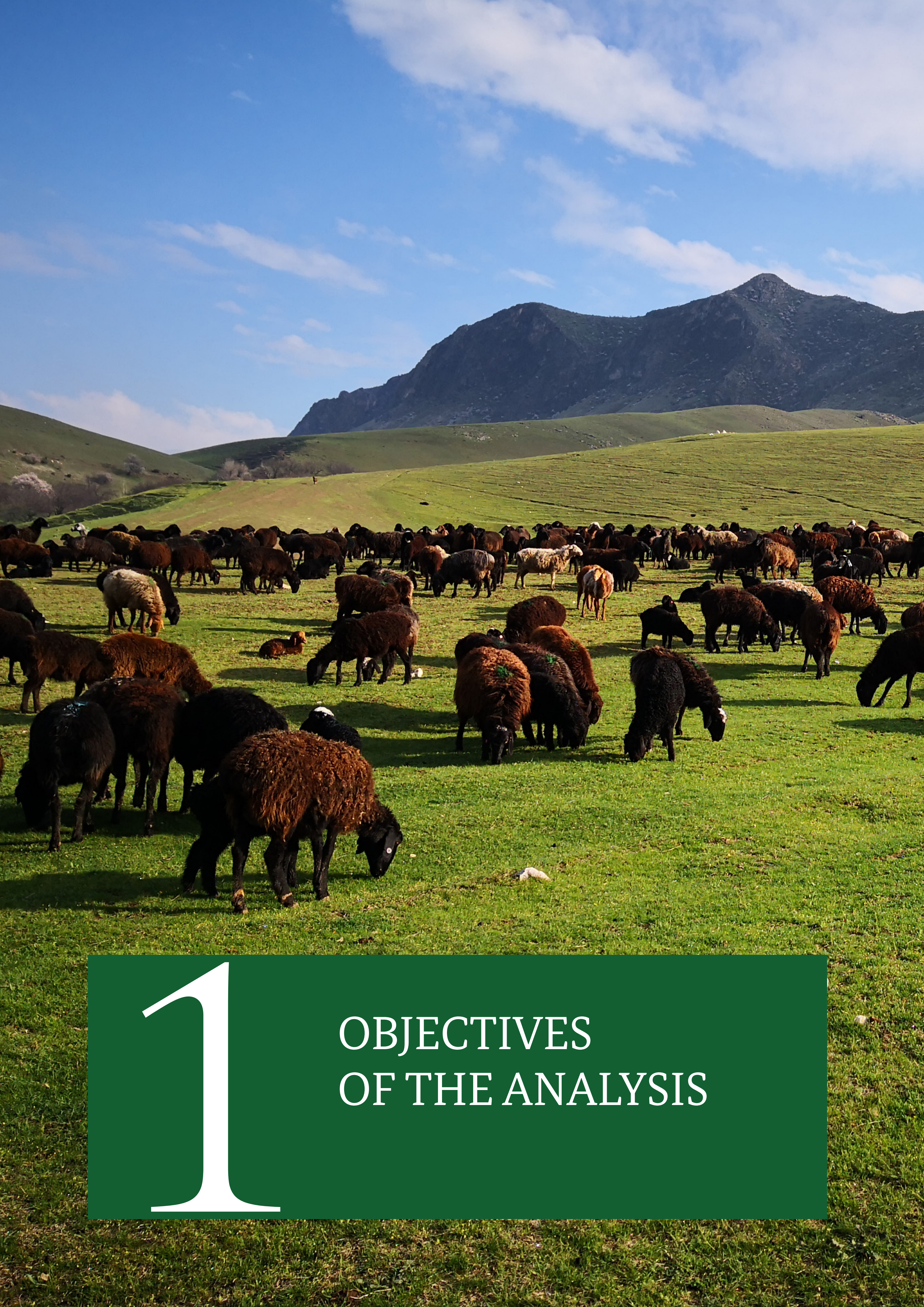
AFOLU	Agriculture, Forestry and Other Land Use
BAU	Business as Usual
CR EO4SD	Climate Resilient Cluster of the European Space Agency's Earth Observation for Sustainable Development Programme
CS-FOR	Carbon Sequestration through Climate Investment in Forests and Rangelands
ER	Emission reduction
GALS	Gender for Action and Learning System
GAO	Gross Agricultural Output
Gg	Gigagram
GHG	Greenhouse gases
GLEAM-*i*	Global Livestock Environmental Assessment Model-Interactive
GWP	Global warming potential
HAS	High activity soil
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
Kt	Kilo ton
LMPD	Livestock and Market Development Programme
masl	Meters above sea level
NDC	Nationally Determined Contribution
PC	Pasture Committee
PESTLE	Political, Economic (and Financial), Social, Technological, Legal (and Institutional), and Environmental multicriteria framework
RRPCP	Regional Resilient Pastoral Communities Project
TNC	Third National Communication
UNDC	Updated Nationally Determined Contribution
WOP	WithOut project
WP	With project

EXECUTIVE SUMMARY

Kyrgyzstan is vulnerable to climate change while having a low contribution to the global greenhouse (GHG) emissions. The country submitted its Intended Nationally Determined Contribution (INDC) in 2015 and ratified the Paris Agreement in 2019. The livestock and pasture sectors provide a great potential to raise the ambition of the Kyrgyz NDC through synergies and multiple benefits from provided by adaptation and mitigation measures. The agriculture sector was the second largest source of GHG emissions in 2019 and at the same time being highly vulnerable to the impacts of climate change. Climate change trends are being observed such as increased average annual temperature and changes in precipitation that impact livestock production including feed shortage, shortage of water, loss of livestock genetic resources, reduced productivity, and decreased weight and milk yield. Current analysis identified priority adaptation measures in livestock and pasture management based on national policies and assessed their mitigation co-benefits using the GLEAM-*i* tool. The livestock management-oriented investment options that aim to improve livestock and herd management practices include animal vaccination campaign, breeding programs, and the upcoming development projects such as IFAD Regional Resilient Pastoral Communities Project (RRPCP) and FAO Carbon Sequestration through Climate Investment in Forests and Rangelands in Kyrgyz Republic (CS-FOR). Planned state programs and development projects contribute to the reduction of emissions in the livestock sector by 2025 and 2030, and result in lower emission intensity, in increased milk production and increase in live weight. Moreover, pasture restoration activities offer extra carbon sequestration potential.

Key recommendations of the analysis are:

- Align Kyrgyz Republic's Green Economy Programme, low GHG country development, and NDC targets.
- Invest in livestock for climate co-benefits.
- Attract climate investments dedicated for SDGs and NDCs.
- Improve Measuring, Reporting and Verification (MRV) under the Enhanced Transparency Framework of the Paris Agreement and improving the national GHG inventory to track the GHG benefits.
- On technical level, identify further entry points at herd, feed, and manure levels.



1 OBJECTIVES OF THE ANALYSIS

OBJECTIVES OF THE ANALYSIS

Livestock and pastures are important agriculture sub-sectors in Kyrgyzstan and offer a great potential to realize the ambition of the Nationally Determined Contribution (NDC) through potential synergies and multiple benefits provided by adaptation and mitigation actions. The agriculture sector was the second largest source of greenhouse gas (GHG) emissions in the country in 2019. The sector is at the same time highly vulnerable to the impacts of climate change, threatening food security and economic growth. The sub-sectors of livestock and pastures are key to the economy of Kyrgyzstan contributing 49 % of agricultural GDP and ensuring vital ecosystem services, food and nutrition security, poverty reduction and sustainable development. Measures reducing climate risk and GHG emissions thus provide a great contribution to the NDC of Kyrgyzstan and provide multiple benefits.

1.1 Livestock and pasture sub-sectors of Kyrgyzstan

1.1.1 General characteristics

Livestock

Livestock is key for the livelihoods of households in rural mountainous areas. Rural households are responsible for 98.5 % of the country's gross agricultural output (GAO) and almost 90 % of total livestock output. Livestock serve not only as a source of income and food, but also as a safety net and coping mechanism to be relied on in cases of unexpected shocks and needs. It is especially important in mountainous areas, where arable land is limited vegetation growth periods are short, and frequent climate shocks such as frosts and droughts occur (Isakov & Thorsson, 2015). Extensive pastoral grazing is the most suitable form of agriculture in the harsh mountain conditions of Kyrgyzstan.

Productivity of livestock is generally low due to poor breeding and feeding practices. Large seasonal variations in animal body weights indicate that animal feeding is geared towards animal survival rather than commercial production.

Farmers in Kyrgyzstan produce limited amounts of fodder, forage and feed grain, mostly due to shortage of arable land, lack of good quality seeds and mechanization services, but also due to **heavy reliance on natural pastures**. The main drivers of growth in livestock numbers are low animal productivity, non-diversified economies, low financial literacy, and traditional cultural patterns of rural residents who perceive livestock as both a source of cash income and a means of savings accumulation. The livestock/pasture ecosystem is trapped in a vicious cycle of productivity collapse: overgrazing and degradation cause lower levels of available forage, which reduces animal productivity, causing households to own more animals to compensate for productivity declines, which in turn increases grazing pressure and leads to more degradation. With higher temperatures and other climate impacts projected for the grassland regions of Kyrgyzstan, pasture degradation due to human interreference is expected to be amplified.

Pastures

Pasture Policy

The pastures are exclusively owned by the Kyrgyz Republic. The total area of pastures is 9 million 147 thousand hectares. They occupy more than 85 % of the total agricultural area.

Pasture use is under different regulatory frameworks and institutional responsibilities. The legal regulation of pasturelands is anchored in the Law of the Kyrgyz Republic “On Pastures”, (2009). The law aims to ensure sustainable and efficient management of pasture resources. The policy confirms the norms of the Land Code on land rights that pasture management and usage are regulated by the **Land Code of the Kyrgyz Republic and Law on Pastures**, as well as other regulatory legal acts of the Kyrgyz Republic.

The majority of 9.1 million ha of pasturelands (80 %) lie in the State Land Fund (SLF) under the jurisdiction of the Ministry of Agriculture. Pasture User Unions (PUUs) administer about 70 % of pastures in Kyrgyzstan (Mestre, 2017). According to the **Law No. 30 “On Pastures”** of the Kyrgyz Republic of January 26, 2009, responsibility for the management of pasture resources is transferred to the local self-government institutions, they, in own turn, have the right to delegate authority for the management and use of pastures to an association of pasture users, where the executive body is the Pasture Committee (Article 4, Law on Pastures). Currently, **there are 454 pasture committees** (PC) in the republic. The main functional responsibilities of the Pasture Committees are the development of plans for the management and use of pastures, monitoring the condition of pastures, issuing pasture tickets and improving the infrastructure of pastures.

The developed legislation and State programs for the development of pasture farming are aimed at improving the well-being of the population, ensuring food security and preserving the ecological integrity of pasture ecosystems. The state **Programme for Development of Pasture Management for 2012-2015** and corresponding **Plan of Actions** (Government Resolution #89) were adopted in February of 2012. The stated aims of the Programme were to improve welfare of the people, achieve food security and preserve environmental integrity of the pasture ecosystems. However, the Programme lacked a coherent vision and roadmap how these aims were to be achieved and which institutions should be tasked with what functions and activities. The **Programme is outdated** and a new one has not been approved yet.

Pasture conditions

In practice, the work of pasture committees are constrained by the available budget, not all pasture committees fulfil the approved budget; fundraising for the use of pastures is only 60-80 %. Of all its functional duties, the Pasture Committees focus on collecting money, since finance is important for works to improve the pasture infrastructure. The low authority of the PC among pasture users leads to chaos in the use of pastures: for instance, pasture users refuse to comply with the grazing schedule. Additionally, the annual growth of livestock increases conflicts over pasture resources and puts pressure on pasture resources.

Almost all livestock is grazed on pastures year-round except for cattle that are kept in barns all winter. Daily grazing occurs on nearby pastures during the fall-winter-early spring months. During the spring-summer months, grazing follows the transhumance migration routes to remote alpine pastures located at altitudes of 2500 masl and above, sometimes as far as 100 km from the village. By the **end of the season, the pasture is often overgrazed**, and this situation is repeated and reinforced from year to year. Daily grazing occurs at pastures near villages and on the post-harvest crop fields during 6-8 months of the fall-winter-early spring seasons, and for 4-6 spring-summer months on more remote and higher-altitude pastures. **Near-village pastures have been severely deteriorated**, caused by the rise in livestock numbers, and absence of infrastructure to remote pastures, decrease in available grazing areas with enlargement of settlements, encroachment of cropping onto good pastureland, and intensive grazing in remaining near-village pasture areas. **It was estimated that productivity of near-village pastures decreased from 300 kg/ha to around 170 kg/ha** or less with heavy encroachment of unpalatable and weedy species. **Summer pastures also experienced deterioration, though at a significantly lower scale**, especially from overgrazing near roads and water sources, and the spread of weeds and unpalatable plants (Fitzherbert 2006, Isakov & Thorsson 2015 cited in PRAGA report).

- The average productivity of summer pastures declined from 640 kg/ha to 410 kg/ha (a reduction of 36 %) from the decade of 1960 to 1990;
- Spring and autumn average pasture yield went from 470 kg/ha to 270 kg/ha (a reduction of 43 %) (Isakov & Thorsson 2015 cited in PRAGA report);
- Winter pastures productivity declined from an average of 300 kg/ha to less than 100 kg/ha (67 % decline) resulting in "50,000 km^2 affected by encroachment of woody and unpalatable species, making over 5,400 km^2 of pasturelands useless for grazing" (Fitzherbert 2005).

The essential features of pastureland degradation are: 1) the composition and structure of vegetation are depleted; 2) plant community diversity is diminished; 3) erosion increases, and soil quality and depth are reduced. These changes are associated with decline in plant production and forage availability, all of which threaten the ability of ecosystems to function properly and limit the ability of natural vegetation to adjust to climate change. Risks to environmental integrity and household economic viability escalate. Livestock plays a critical role in protecting communities against the negative effects of contingencies such as crop failure and unforeseen financial crises. The problem of pasture degradation is an important environmental challenge and is closely linked to the social and economic well-being of rural communities.

There is no systematic monitoring of pasture conditions and no time series data on the conditions of pastures is available at national level. The Pasture Development Programme 2012-2015 provides the latest available information on extent of degradation according to pasture types:

Table 1. Types of pastures and degree of degradation

Type of pastures	Area in ha	% of total	Area of degradation	Degree/extent of degradation (in %)
Summer	3,951,000	43.19 %	1,432,000	36.24 %
Spring and autumn	2,756,000	30.13 %	1,378,000	50.00 %
Winter	2,440,000	26.68 %	1,718,000	70.41 %
Total area	9,147,000		4,528,000	49.50 %

Source: *Pasture Development Programme 2012-2015.*

The role of livestock in national economy and policy

The livestock sector plays an important role for the national economy: 64 % of the population in Kyrgyzstan lives in rural areas where the livestock sector supports the local economies. The sector employs 30 % of the total labor force in the agriculture (Draft Concept of Agrarian Development, 2021).`

Table 2. Agriculture and livestock production in the national economy

Agriculture as % of GDP (2020)	Livestock as % of agricultural production value (2020)	Employment in agriculture (% of workforce 2020)	Proportion population living in rural areas (percentage in 2020)
13.5 %	47.2 %	20 %	66 %

Source: *Draft Concept of Agrarian Development of the Kyrgyz Republic until 2025.*

1.2 Climate change trends in Kyrgyzstan

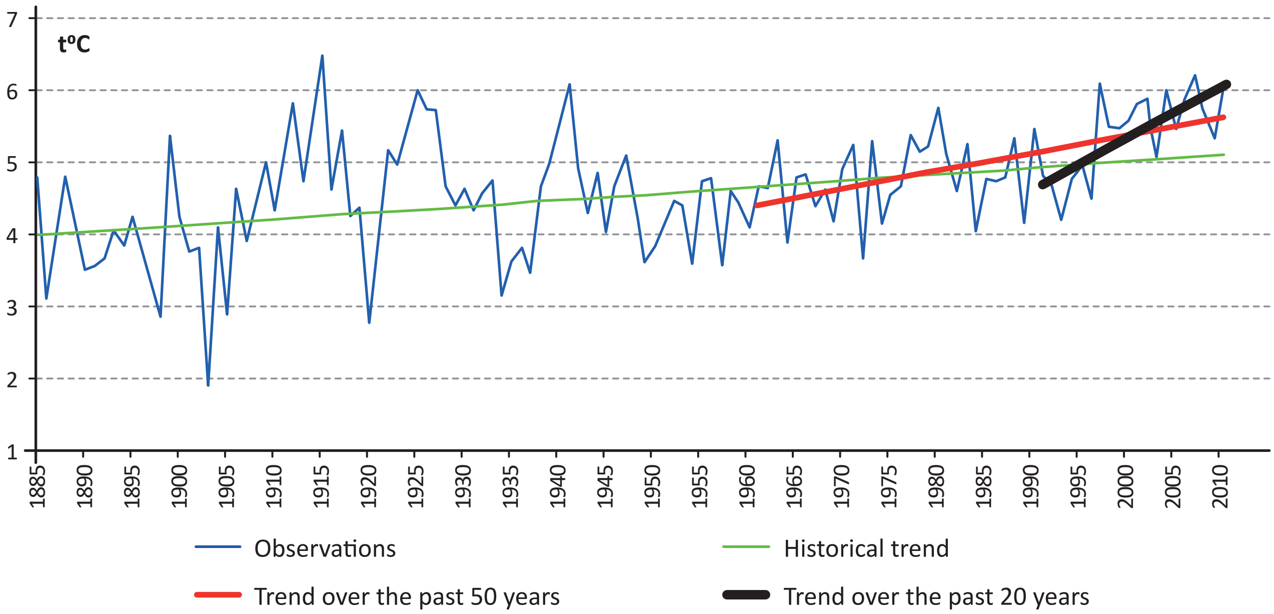
1.2.1 Observed changes

Climate change trends are being observed in Kyrgyzstan.

Temperature changes

According to the Third National Communication (TNC), the average annual temperature over 1885-2010 has increased significantly at the rate of 0.0104°C/year with the significant increase in recent decades reaching the rate of 0.701°C/year for the period of 1990-2010 (Government of the Kyrgyz Republic, 2016).

Figure 1. The change trend of average annual temperature in Kyrgyzstan



Source: Climate profile of the Kyrgyz Republic, cited in the Third National Communication (2016).

Increased average annual temperature has been observed in all climatic zones and regions across Kyrgyzstan, including all altitudes (Government of the Kyrgyz Republic, 2016). For the period of 1976-2019, there is an observed increase in mean annual air temperature of 0.23°C every 10 years, with the highest increase rate in the spring period (0.45°C/10 years) (both trends are statistically significant) (Kretova, 2020).

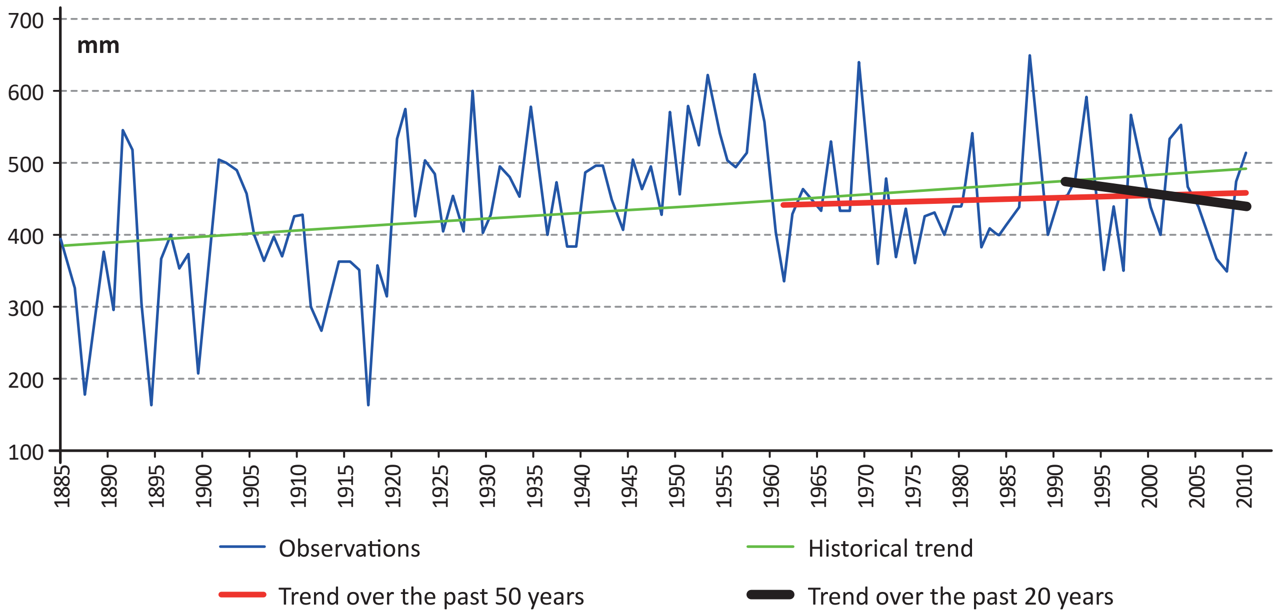
Precipitation changes

Precipitation has changed insignificantly but with extreme changes in certain regions in the last years, with the overall trend downwards (Government of the Kyrgyz Republic, 2016).

For the total period of observation, a slight increase in annual precipitation of 0.847 mm/year has been observed but there has been a downward trend in the last 20 years of observation by – 1.868 mm/year (Government of the Kyrgyz Republic, 2016).

For the period of 1976-2019, in Kyrgyzstan on average there is a trend of increasing annual precipitation by 1.6 %/10 years, with the highest rate of increase of 4.2 %/10 years in the summer period. All obtained trends of changes in annual and seasonal precipitation are statistically insignificant (Kretova, 2020).

Figure 2. General trend of the annual average precipitation over the period observations 1885-2010



Source: Climate profile of the Kyrgyz Republic cited in the Third National Communication (2016).

Extreme weather events

Due to its geographic location in a seismically active and mountainous region, Kyrgyzstan is susceptible to natural disasters with frequent incidence of:

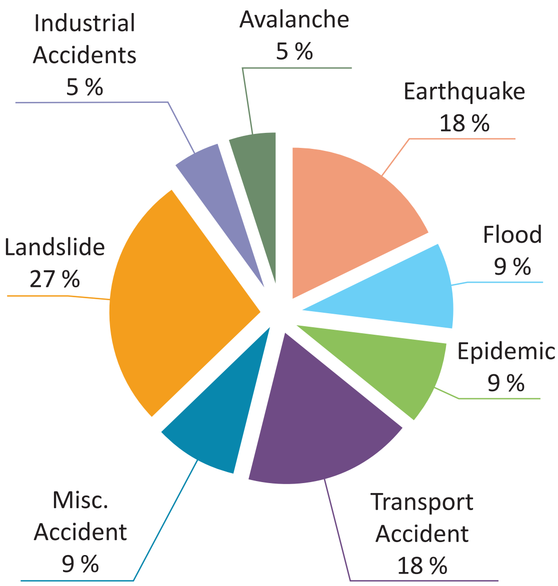
- Mudflows/landslides/avalanches;
- Heat waves and frost;
- Floods and flash floods;
- Earthquakes;
- Mountain lake spills.

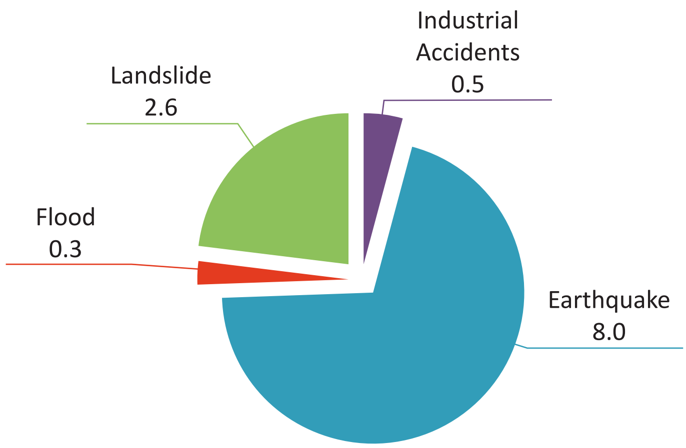
The figure below presents the distribution of various disasters by hazard types for the period of 1988 to 2007 and the economic loss potential. The highest economic loss potential is for earthquake (8.0 USD mil) followed by landslides (2.6 USD mil) and flood (0.3 USD mil) (UNISDR 2010).

Figure 3. Disaster risk statistics (1988-2007)

Disaster Risk Statistics (1988-2007)				
Disaster type	No. of disasters /year	Total no. of deaths	Deaths/ year	Relative vulnerabllity (deaths/year/ million)
Earthquake	0.20	58	2.90	0.55
Flood	0.10	4	0.20	0.04
Landslide	0.30	238	11.90	2.27
Avalanche	0.05	11	0.55	0.10
Epidemic	0.10	22	1.10	0.21
1. Accidents	0.05	4	0.20	0.04
T. Accident	0.20	88	4.40	0.84
M. Accident	0.10	21	1.05	0.20

Percentage distribution of reported disasters in Kyrgyzstan





Average annual economic loss of Kyrgyzstan (in million USD)
Loss data not sufficient for other disasters

Economic Loss Potential		
Annual exceedance probabllity	Economic loss ($ million)	Percentage to GDP (2007)
0.5 %	160	4.57
5.0 %	49	1.40
20.0 %	15	0.42

Source: *UNISDR, 2010.*

1.2.2 Projected changes

Temperature increases are expected to continue in the future in Kyrgyzstan. Based on the ensemble of 25 atmospheric and oceanic general circulation models of the International CMIP6 Project, it is expected that the annual air temperature will increase 1.5-1.9°C is expected in the nearest climatic period 2021-2050 in comparison to 1981-2010 and it will increase by 1.9-4.0°C in for the period of 2051-2080 (Kretova, 2020).

The highest temperature increase is expected in summer period. In the nearest climatic period 2021-2050 interannual variability of precipitation is expected to remain the same with a slight tendency of 5-6 % increase, and by 2051-2080 by 6-10 %. The highest rate of increase in precipitation is predicted in winter, a slight increase in precipitation in summer.

Exposure to climate risk

The most common categories relevant for a climate risk exposure assessment in the sub-sectors of livestock and pasture are livestock, pastures and livelihoods, following the latest IPCC terminology (IPCC, 2014). For the purposes of the current analysis, we have selected population numbers, livestock numbers and area of pastures. The results in the table below are presented on national level.

Table 3. Exposure elements in livestock and pasture sub-sectors to climate risk in Kyrgyzstan

Exposure element	Value
Total households (2009)	1,146,000
Households in rural area	676,140
Total livestock number (2019)	
Cattle	1,680,750[1]
Sheep and goat	6,266,739
Horses	522,611
Total pasture area in hectares (2010)	
Summer pastures	3,951,000
Spring and autumn	2,756,000

1 National Statistical Committee, 2019.

Exposure element	Value
Winter pastures	2,440,000
Total pasture area	9,147,000

Source: *National Statistical Committee 2009, 2019 and Pasture Development Programme 2012-2015.*

1.2.3 Livestock and pasture greenhouse gas emissions in Kyrgyzstan

Kyrgyzstan submitted its Third National Communication (TNC) in 2016. The TNC covers a GHG inventory from 2006 to 2010 calendar year, with time series for 1990-2005 re-estimated. Total emissions from the agricultural sector were estimated at 4376 Gg CO_2e, representing 33.5 % of total emissions (TNC, 2016). Of these emissions, the livestock sector contributed approximately 2732.8 Gg CO_2e or 62.5 % of agricultural emissions. The main sources of emissions were methane from enteric fermentation and methane (CH_4) and nitrous oxide (N_2O) from manure management. These emissions were estimated using a Tier-1 approach of the 1996 IPCC guidelines.

1.2.4 The Nationally Determined Contribution of Kyrgyzstan

Kyrgyzstan submitted its Intended Nationally Determined Contribution (INDC) in 2015. The INDC highlights that the country belongs to one of the vulnerable countries to climate change and that the GHG emissions are relatively low, the per capita GHG emission being less than one-third of the world average (the Government of the Kyrgyz Republic, 2015). Agriculture is

one of the most vulnerable sectors resulting in USD 70 million (2005) of expected economic losses in absence of adaptation actions. The adaptation target of the INDC of Kyrgyzstan is to prevent the climate change related damage and losses. The INDC pledged to reduce GHG emissions unconditionally in the range of 11.49 %-13.75 % below business as usual (BAU) levels by 2030, increasing to between 29 % and 30.89 % with international support. The first NDC of Kyrgyzstan has not addressed specifically the contributions from the livestock and pastures.

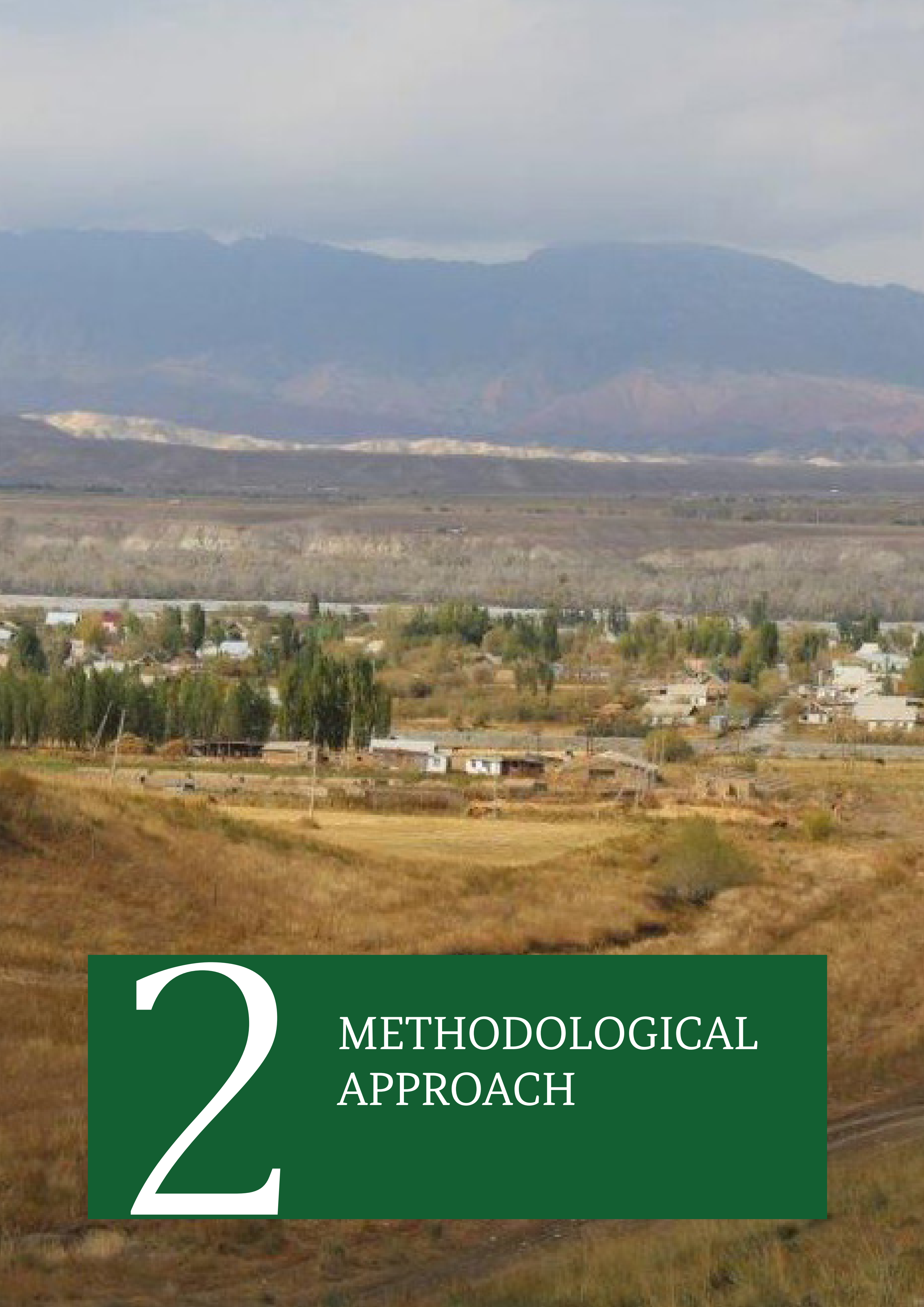
1.3 Objectives of the analysis

While Kyrgyzstan is one of the most vulnerable countries to climate change, it is among the countries with the lowest contribution to the global GHG emissions. As reiterated in the INDC and the Third National Communication, adaptation actions remain a priority for the country. The policy document on Priorities for Adaptation to Climate Change in the Kyrgyz Republic till 2017 (updated to 2020) highlights the agriculture sector as one of the vulnerable sectors to climate change including water resources, energy, health, emergency, forest and biodiversity as well as cross cutting sectors such as education and science.

Livestock and pasture are important agriculture sub-sectors in Kyrgyzstan and offer a great potential to raise the ambition of the NDC through the potential synergies and multiple benefits provided by adaptation and mitigation actions. While adaptation actions remain a priority for Kyrgyzstan, the mitigation potential should be thoroughly considered to strengthen the adaptation measures and deliver multiple benefits.

The sub-sectors of livestock and pastures are key in contributing to the economy of Kyrgyzstan and ensure vital ecosystem services, food and nutrition security, poverty reduction and sustainable development. However, the agriculture sector in general is the second largest national GHG emitter in 2019 and at the same time highly vulnerable to the impacts of climate change, threatening food security and economic growth.

The objective of this analysis is to conduct an in-depth analysis of the livestock and pasture sub-sectors of Kyrgyzstan for providing clear and comprehensive recommendations for adaptation and mitigation measures and their effective integration into the Kyrgyz NDC. The results of the analysis identify action areas necessary (including policy recommendations, investments road map and MRV system) to contribute and implement NDC commitments of Kyrgyzstan.



2 METHODOLOGICAL APPROACH

METHODOLOGICAL APPROACH

The analysis of livestock and pasture sectors for the NDC revision in Kyrgyzstan had the objective to identify priority adaptation measures and assess their mitigation co-benefits.

The overall methodological approach of the analysis is presented in the figure below.

Figure 4. Methodological approach, steps, and activities

Steps	**1. Rapid climate risk and vulnerability assessment**	**2. Priority adaptation measures**	**3. Mitigation co-benefit**
Activity	Analysis of climate risks and impacts on livestock and pasture sectors in Kyrgyzstan	Alignment of identified adaptation measures with **P**olitical, **E**conomic, **S**ocial, **T**echnological, **L**egal, and **E**nvironmental criteria and benefits	Modelling GHG effects of priority adaptation measures Develop scenarios: BAU scenario and NDC scenario
Data source	Existing national climate communications and scientific literature	• State Programmes • Donor projects • International best practice	• Expert judgement • Emission factors (IPCC or GLEAM-*i*)

Source: *Authors' elaboration.*

2.1 Rapid climate risk and vulnerability assessment

The vulnerability of the sub-sectors was analyzed based on existing national climate communications and scientific literature with the specific focus of climate risks and impacts on livestock and pastures in Kyrgyzstan. The following policies and reports were analyzed:

- National climate communications: Third National Communication to the United Nations Climate Change Convention, Government of the Kyrgyz Republic 2016;
- Draft Fourth National Communication to the UNFCCC, Government of the Kyrgyz Republic 2021 (Kretova, 2020);
- Summary technical report: Climate Change Impact on Pastures and Livestock Systems in Kyrgyzstan, IFAD 2013;

- Climate Investment Programme Operational Framework for Managing and Accessing Climate Finance in the Kyrgyz Republic, Government of the Kyrgyz Republic, 2018;
- Climate Risk and Adaptation Country Profile, GFDRR, 2011;
- Priority areas of adaptation to climate change in the Kyrgyz Republic till 2017 (updated till 2020), Government of the Kyrgyz Republic, 2017;
- Turn Down the Heat: Confronting the New Climate Normal, World Bank, 2014;
- ENVSEC. (n.d.). Climate Change and Security in Central Asia. https://doi.org/10.1093/oxfordhb/9780199566600.003.0017.
- CIAT & World Bank. (2018). Climate-Smart Agriculture for the Kyrgyz Republic. CSA Country Profiles for Asia Series. Washington DC: International Center for Tropical Agriculture (CIAT), World Bank;
- Gitz V., Meybeck A., Lipper L., Young C., & Braatz S. (2016). Climate change and food security: Risks and responses. Food and Agriculture Organization of the United Nations. https://doi.org/10.1080/14767058.2017.1347921;
- Ilyasov S., Zabenko O., Gaydamak N., Kirilenko A., Myrsaliev N., Shevchenko V., & Penkina L. (2013). Climate profile of the Kyrgyz Republic. United Nations Development Programme, 99.

2.2 Adaptation option analysis and prioritization

For the priority sub-sectors, adaptation options were identified from existing policies and measures (e.g., state programmes, donor, and NGO projects). National partners were consulted to ensure that planned measures are captured. In cases where information was missing or further clarifications necessary, expert judgement was used to estimate the effects of policies and measures. Additional adaptation options were identified based on relevant international good practice. The result of this step was a long list of adaptation options (See Annex 6.1).

The PESTLE framework – Political, Economic, Social, Technological, Legal, and Environmental groups of criteria – was used in order to prioritize the long list of adaptation measures.

The PESTLE framework is a multi-criteria analytical framework adapted from the field of strategic business planning and organizational development[2] designed to support decision-making. Prioritization criteria in the PESTLE framework were developed to select the optimal interventions along the categories of political, economic (and financial), social, technological, legal (and institutional), and environmental. The criteria of the PESTLE framework and guiding questions are presented in *Table 4*.

2 For more, see Rastogi, N., & Trivedi, M. K. (2016). PESTLE Technique - A Tool to Identify External Risks in Construction Projects. *International Research Journal of Engineering and Technology*, 03(01), 384–388. https://www.irjet.net/archives/V3/i1/IRJET-V3I165.pdf.

Table 4. PESTLE framework, criteria and guiding questions

Political	Alignment with Green Economy Concept and Green Economy Programme	To what extent is the adaptation intervention in alignment with country's green economy vision, in terms of aims and objectives?
	Alignment with National Sustainable Development Strategy 2040 and Government programme 2019-2023	To what extent is the adaptation intervention in alignment with country's intended development vision, in terms of aims and objectives?
	Alignment with Agriculture and Water Sector Adaptation Action Plan 2020	To what extent is the adaptation intervention in alignment with the relevant sector's own climate resilience strategy?
	Draft programme on pasture and tribal livestock management 2020-2024	To what extent is the adaptation intervention in alignment with the relevant sector's strategy?
Economic (and Financial)	Cost-effectiveness	How cost-effective is the adaptation intervention, relative to other potential options to reduce the same vulnerability?
	Suitability for resource mobilization	How strong a candidate is the adaptation intervention, in terms of attracting funding from climate adaptation finance sources?
Social	Alignment with Sustainable Development Goals (SDGs)	To what extent is the adaptation intervention in alignment with or reflective of the Sustainable Development Goals and Agenda 2030?
	Contribution to food security goals	To what extent is the adaptation intervention in alignment with or reflective of the Food Security and Nutrition Program in the Kyrgyz Republic for 2019-2023?
	Gender-responsiveness and equity	To what extent is the adaptation intervention suitable for gender responsiveness and gender mainstreaming in implementation?
	Ability to support sustainable livelihoods and job-creation	To what extent is the adaptation intervention likely to generate and maintain sustainable livelihoods, and to create new jobs (economic development co-benefit)?

Technological	Technological ease	How easy is the adaptation intervention to implement, in terms of technological tools and investment needed?
Legal (and institutional)	Suitability for existing institutional arrangements	To what extent is the adaptation intervention implementable effectively within existing institutional architecture, mandates, and mechanisms?
	Feasibility within existing legal and regulatory frameworks	How feasible is the adaptation intervention within the current legal and regulatory set-up, without requiring legal or regulatory changes?
Environmental (alignment with nature-based solutions)	Ability to reduce vulnerability and build adaptive capacity	How effective is the adaptation intervention in terms of targeting the major vulnerabilities of the sector, and building adaptive capacity in the sector?
	Environmental co-benefits (biodiversity)	To what extent does the adaptation intervention bring co-benefits for environmental protection, management, resource-efficiency, and conservation?
	Mitigation co-benefits	To what extent does the adaptation intervention bring co-benefits in terms of reduced green-house gas emissions, or carbon sequestration and abatement?
	Environmental risks	How minimal are the environmental risks of implementing the adaptation intervention, in terms of unintended consequences?

Source: *Authors' elaboration.*

Stakeholders and national experts identified the most important adaptation measures from the long list by filling out the PESTLE framework. This resulted in a short-list of 10 priority adaptation measure packages, six of which have mitigation co-benefits. The list of all stakeholder meetings conducted during the assignment is included in Annex 6.4.

There are number of national strategic and framework documents analyzed by the expert group. They are very generic and provide overview on the situation, but the implementation of these documents with existing action plans are far from addressing identified issues and challenges. The action plan usually limited by the state budget, therefore most of the measures are very basic. Therefore, it should be noted that PESTLE framework had identified the gap in the legislation of the Kyrgyz Republic. It became clear that the nature-based solutions, market orientated agriculture development, cluster development, etc. are less prominent in national documents. Therefore, new strategic documents should be developed, not only based on analysis of the existing policies and strategies, but include innovative approaches, technologies and multi-task interventions.

2.2.1 Setting targets for priority adaptation measures

For the prioritized adaptation measures, targets were set until 2025 and 2030 based on the analysis of state programmes and donor projects. Additional stakeholder consultations were conducted to collect missing data. Unconditional targets are the activities that are already planned and will be implemented. Conditional targets are the activities that could be implemented with additional financial and technical support.
The list of state programmes and donor projects reviewed are in the Annex 6.3 and 6.4, as well as the list of stakeholder consultations.

2.3 Mapping trends in grassland vegetation in Kyrgyzstan

IFAD requested the Climate Resilience Cluster of the Earth Observation for Sustainable Development (EO4SD) of the European Space Agency to compute pasture condition maps with remote sensing imagery. Nine Landsat – based vegetation indices were calculated in order to compare average pasture conditions of 2000-2004 and 2016-2020. The analysis took into account pasture types and grazing periods of different oblasts and districts that were provided by CAMP Alatoo. Five-year averages were taken in order to mitigate the effect of seasons having exceptionally high or low rainfall and other climate parameters. Field measurements taken by FAO's Participatory Assessment of Land Degradation and Sustainable Land management in Grassland and Pastoral Systems (PRAGA) were used to assess the effectiveness of each index. Auto-correlation identified the best composition of indices to represent pasture conditions for a given area. The changes observed in the two periods (2000-2004 vs. 2016-2020) were combined to estimate the rangeland condition changes and classified as degradation levels following the IPCC's guidelines of grasslands degradation. The final step was to exclude areas that are not classified as grasslands according to land-cover maps. A detailed write-up of the methodology can be found in Annex 6.5.

2.4 GHG scenario assessment of the livestock and pasture sub-sectors

GHG inventory and Business-as-Usual (BAU) scenario

The time series livestock population data from 1990-2019 was obtained from the Kyrgyz National Statistics office. Three national GDP growth scenario (high, medium, low forecast GDP) were utilized to project the national agricultural GDP growth. Afterwards, the linear association between agricultural GDP and national populations of each livestock species from 2000-2019 was used to predict livestock populations up to 2030. To ensure comparability and consistency with other sector reports for the NDC update, the livestock inventory followed Tier-1 approach of the 2006 IPCC Guidelines to ensure that calculation methods and default values used are based on the latest available science. In this report, GHG emissions are estimated from dairy cattle, other cattle, sheep and goats, pigs, donkey, horses, camels, and poultry for the main livestock emission sources. These sources are:

a. Methane (CH_4) from enteric fermentation (3A1);

b. CH_4 and nitrous oxide (N_2O) from manure management (3A2);

c. Direct N_2O emissions from managed soils, dung and urine deposit on pasture (3C4);

d. Indirect N_2O emissions from managed soils, dung and urine deposit on pasture (3C5);

e. Indirect N_2O emissions from manure management (3C6).

The Kyrgyz's GHG inventory covers the period 1990 until 2019. The livestock GHG inventory uses the most up-to-date numbers concerning heads of animals, emission factors and related statistics to adjust the GHG model data inputs for the livestock sector to reflect the most recent and robust data and information. Further improvements to the robustness of the GHG modelling was achieved though consulting different sectors. The enteric emission factors used were 58 kg CH_4/head/year for other cattle, and 5 kg CH_4/head/year for sheep and goats, 1 kg CH_4/head/year for pigs, 18 kg CH_4/head/year for horses, 10 kg CH_4/head/year for donkeys, 46 kg CH_4/head/year for camels. All calculations of livestock emissions benefit from the updated livestock inventory that was conducted according to Tier-1 2006 IPCC methodology. Using the inventory data, livestock sector emissions were projected to 2030 to represent the business-as-usual scenario (BAU).

For prioritized adaptation options, GHG assessment estimated the effects of these measures on GHG emissions. For modelling livestock adaptation measure with co-mitigation options, the Global Livestock Environmental Assessment Model-*interactive* (GLEAM-*i*) tool was used to estimate the Tier-2 emission factors and applied to each policy and measure. For more details regarding the policy interventions,

development projects, and assumptions, please refer to Annex 6.1-6.7. Inspection of the financing sources listed in state programme documents and international cooperation projects was conducted to identify measures to be implemented solely with domestic funds in order to distinguish between conditional and unconditional scenarios.

2.5 Assessment of Tier-2 emissions with GLEAM-*i* model

The tool GLEAM-*i* developed by the Food and Agriculture Organization (FAO) of the United Nations was used for the assessment. The model simulates the bio-physical processes and activities along livestock supply chains using a life cycle assessment approach. It estimates GHG emissions with Intergovernmental Panel on Climate Change (IPCC) Tier-2 methodology and generates baseline and improved scenarios of herd management (including reproduction and health), feeding and manure management systems. Three gases are considered in GLEAM-*i*: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The global warming potential (GWP) from IPCC second assessment report (IPCC, 1996) are used to convert all emissions into CO_2 equivalents (CO_2e) as these were the GWPs used for GHG inventory in the country baselines. GWPs were 21 for CH_4 and 310 for N_2O. For the purpose of NDC update and in order to again comply with the inventory reporting, the results only represent the direct emissions. That is, only CH_4 emissions from enteric fermentation, CH_4 and N_2O emissions from manure management are reported.

2.5.1 Livestock management: animal health and breeding programs

Kyrgyzstan through the (draft) Program for Adaptation of Agriculture to the Effects of Climate Change 2016-2020 aims to improve livestock production and productivity through better health system (vaccination) and genetics (artificial insemination). These measures will result in improved breed composition and controlling further growth of animal population.

The livestock sector involves a set of policy interventions, based on state (draft) programs and a variety of expert inputs. This includes the feedback provided by sector representatives after the first validation workshop on March 29, 2021. Kyrgyzstan's adaptation measure with co-mitigation benefit related to livestock sector policies includes the following:

- Vaccination campaign and use of artificial insemination that aimed to reduce mortality, increase milk yield, live weight and fertility and replacement rate;
- Reduction of herd of cattle and sheep (controlling the growth of the herd) that results from gains in productivity at herd level (mainly from improved fertility, reduced mortality and increase in average litter size for sheep).

Because of the lack of available description of the livestock development plan for livestock sector interventions, the livestock sector policy interventions were modelled based on expert consultations. *Table 5* shows the unconditional NDC intervention packages identified in the country development programs.

Table 5. State funded NDC intervention targets by 2025 and 2030

State program abatement lever	NDC intervention packages			
	Cattle		Sheep	
	2025	2030	2025	2030
Vaccination campaign	75 %	80 %	75 %	80 %
Artificial insemination	40 % of cows and heifers	80 % of cows and heifers	120,000 sheep[3]	240,000 sheep[4]

Note: The state program related to vaccination campaign could be implemented if there is *additional financing and support from donors*.

Cattle

The intervention of improved breeding is promoted in the (draft) Program for Adaptation of Agriculture to the Effects of Climate Change 2016-2020. It involves artificial insemination (AI) combined with improved health interventions. It is targeted to areas where AI has been found to be profitable and feasible.

Assumptions: Following national expert consultation, it was assumed that improvement through improved breeding (artificial insemination) could target 40 % and 80 % of the cows and heifers by 2025 and 2030, respectively. It was also assumed that the proportion of cows and heifers in the total herd is 48 %. Thus, the proportion of cows and heifers from the total cattle herd receiving artificial insemination would be 19 % (40*48) and 38 % (80*48) by 2025 and 2030, respectively. It is reasonable to assume that those cows and heifers receiving artificial insemination should have access to improved health system. Furthermore, with additional resources 75 % and 80 % of the cattle herd could receive vaccination by 2025 and 2030, respectively *(Table 5)*. After consultation with national experts, it was assumed that improvement through improved breeding (artificial insemination) and improved animal health system could increase live weight by 20 %, milk yield by 20 % and fertility rate by 3 %, reduce the age at first calving by 15 % and reduce mortality rate by 20 % over 5-10 years. Furthermore, evidence suggests that cattle improvement through improved animal health system (vaccination campaign) could increase live weight by 7.5 %, milk yield by 8 % and reduce mortality rate by 20 % over 5-10 years (Demir et al. 2017). It is also expected that the milk fat content is likely to increase as a result of the combined interventions. A 20 % reduction in replacement rates can be expected due to improved herd structure where fewer replacement animals would be needed.

Scale of implementation: The AI intervention increases the number of cross-bred cattle inseminated from 81,143 in 2020 (CBD 2019) to 330,049 in 2025 and 766,199 in 2030. This represents a 3-times (by 2025) and 8-times (by 2030) increase compared to 2020 figures. The vaccination campaign alone increases the number of vaccinated cattle from 450,000 in 2020 to 1,476,000 in 2025 and 1,827,383 in 2030.

3 Source: (Draft) Programm on Development of fine-wool sheep breeding in the KR 2021-2025.

4 An assumption was made that the target set for 2025 would double by 2030 based on expert judgement.

Sheep

The intervention is called improved breeding program on Development of fine-wool sheep breeding in the KR 2021-2025 (draft). It involves breeding and mating techniques combined and improved animal health system. It is targeted to areas where a market for both wool and meat of merino sheep has been found to be profitable and feasible.

Assumptions: With additional resources from donors, it was assumed that improvement through improved breeding (mating) could target 120,000 and 240,000 female sheep by 2025 and 2030, respectively. These female number make the target 2.3 % and 3.9 % of the total herd by 2025 and 2030, respectively by assuming that the proportion of female sheep makes 35 % of the total herd. Like cattle, it is also reasonable to assume that those female sheep targeted by breeding and mating technique should have access to improved health system (vaccination). Furthermore, with additional resources 75 % and 80 % of the sheep herd could receive vaccination alone by 2025 and 2030, respectively *(Table 5)*. After consultation with national experts, it is assumed that sheep improvement through breeding (mating) techniques combined and improved animal health system (vaccination campaign) could increase live weight by 20 %, reduction in age at first calving by 15 %, reproduction rate by 3 % and could reduce mortality rate by 20 % over 5-10 years. A 20 % reduction in replacement rates can be expected due to improved herd structure where fewer replacement animals would be needed. Furthermore, evidence (Demir et al. 2017) suggests that sheep improvement through improved animal health system (vaccination campaign) could increase live weight by 9 % and reduce mortality rate by 20 % over 5-10 years. It is expected the improved feeding and animal health will increase the twin births (1.5 lambs per parturition).

Scale of implementation: The intervention increases the number of pedigree sheep from 60,000 in 2021 to 120,000 in 2025 and 240,000 in 2030. This represents a 2-times (by 2025) and 4-times (by 2030) increase compared to 2020 figures. The vaccination campaign alone increases the number of vaccinated sheep from 1,310,906 in 2020 to 4,344,927 in 2025 and 5,595,288 in 2030.

No improvements or changes are foreseen to manure management and feeding system in the livestock sector policy interventions.

2.5.2 IFAD project - Resilient Regional Pastoral Communities Project (RRPCP)

Assumptions

The Resilient Regional Pastoral Communities Project (RRPCP) aims to target household dairy cattle and small ruminant (sheep and goat) systems in the country. Since the majority of cattle grazes in Kyrgyzstan in summer, the production system selected in GLEAM-*i* was grassland-based dairy. For small ruminants, the selected production systems were grassland-based meat sheep and goats. The input parameters and the assumptions for specific scenarios were inserted on the online version of GLEAM-*i* (https://gleami.apps.fao.org/). Raw results were used to extract the direct emissions only. Main results presented are: total emissions (t CO_2e/year), emissions intensity (t CO_2e/t protein), protein production (t protein/year), and feed consumption (t dry matter (DM)/year).

A number of assumptions were made to reflect the expected changes to data in scenarios. Three stakeholder consultations were performed to collect and validate the data and the assumptions. A follow up with national experts complemented the missing data. Finally, published studies were used to fill any remaining data gaps. The number of animals covered in the assessment is presented below.

Table 6. Animals covered in the IFAD RRPCP project calculations

Species	2022 (Baseline)	WP	WOP 2025	WOP 2030
Cattle	659,700	610,404	729,668	847,615
Sheep	3,973,567	4,143,063	4,437,082	5,210,729
Goats	993,014	1,026,451	1,109,929	1,302,762

Source: *WP – With Project; WOP – Without Project.*

The project design document (IFAD, 2019) refers to two specific development objectives: 20 % increases in milk yields and 20 % increase in productivity per animal. Therefore, live weights of cattle were assumed to increase by 20 % during the project period due mainly to the introduction of a breeding program. For sheep and goats, no breeding program was planned in the project, therefore, live weights of sheep and goats were assumed not to change. However, for sheep and goats, the overall productivity increase of 20 % was still assumed to apply due to the increased occurrence of twin births (1.5 and 1.4 offspring per parturition for sheep and goats, respectively). The rate of twin births is expected to increase due to selective natural breeding, improved feeding and animal health. The vaccination program and the concomitant improvements in animal health services are expected to reduce the mortality rates of animals by 20 % (Demir et al. 2017). The improvements in age at first parturition in all three species and the slight increase in fertility rate of dairy cattle were attributed to improved reproduction, health and feeding. A 20 %

reduction in replacement rates was attributed to improved herd structure where fewer replacement males and females would be needed.

The feeding of all species in the baseline consisted of crop residues from other grains and wheat, hay or silage from alfalfa, grass, and legumes as well as some silage (cattle) from grain plants. The majority of the ration included fresh grass in all species due to grazing. The improved feeding included crop residues from sugar beet and maize instead of crop residues from other grains, less (cattle) or no (sheep and goats) crop residues from wheat, reduced hay or silage from alfalfa (cattle) and reduced hay or silage from grass and legumes, and inclusion of some grains and molasses (cattle). The reduction in low quality hay or silage was compensated by increase percentage of silage from maize plants. The percent share of fresh grass was also reduced in the improved case in line with the pasture improvement strategy and the expected increase in higher quality fodder crops. By-products from sugar beet were added to the diets of all animals by 5 %. Fodder beets are not purposefully grown. Sugar beet is grown as there are two sugar factories in the country and there is a lot of residual sugar beet in the form of Jom. However, Jom even though good in energy is high in potassium so they can only be fed in limited amounts.

Manure management was not specifically targeted in the project. However, the assessment also included a suggestion to increase the share of manure managed under solid storage from 50 % to 65 % while reducing the share of manure deposited on pastures from 50 % to 35 % (cattle only). This suggestion made an additional reduction in absolute emissions.

Three scenarios were developed

Baseline: This scenario represents year 0 the project starts. The project is expected to start in 2022, so baseline year also represents the situation in 2022.

With Project (WP): This scenario represents the situation with improvements made to herd structure, feeding and manure management in 2025 and 2030. Number of adult females and males are kept as they are in the baseline scenario (except where indicated for cattle), assuming that the project aims to limit the growth of livestock. However, since the number of adult females and males determined the herd structure, the number of total animals in the herd in scenario WP varied *(shown in Table 6)*. A reduction in animal numbers was not found realistic and these figures may be subjected to change depending on the success rate of measures during the implementation phase of the project.

WithOut Project (WOP): This scenario represents the situation without any improvements to herd, feed and manure in 2025 and 2030 (just like in the baseline). The difference from baseline in WOP is that livestock numbers increase in this scenario. The increases in animal numbers are projected based on the projected Gross Domestic Product (GDP) agriculture. This scenario can also be called the business as usual (BAU) scenario. The projected numbers were used in GLEAM-*i* to calculate the number of adult female animals in respective years.

> The comparison in the results represents the changes in scenario WP in relation to the changes in scenario WOP. It is important to note that these emissions are the quantitative changes at specific years, and not the cumulative changes by those years, as this is the approach used in inventory compilation.

2.5.3 FAO-GCF: Carbon sequestration through climate investment in forests and rangelands (CS-FOR)

Assumptions

A number of assumptions were made to reflect the expected changes to data in scenarios. The approach followed in calculation of animal numbers covered in the project is reported in Annex 6.6. The project was based on implementing the project and improved practices but controlling the growth of the herd that results from gains in productivity at herd level (mainly from improved fertility, reduced mortality and increase in average litter size for sheep). In practices, the number of adult females was reduced by 10 % in each specie compared to the current situation This results in a decrease of total cattle herd and goat herd of 4 % and 13 % respectively. Given the high gains in productivity at herd level in sheep production, total number of sheep still increased by 20 % despite the decrease of 10 % in the number of adult females.

2.6 Assessment of carbon sequestration in grasslands

To calculate the carbon sequestration potential of pastures in Kyrgyzstan, the following methodological steps were taken:

1. The baseline carbon stock is estimated using a reference soil organic carbon (SOC) stock that is the weighted average of different

climate zones. The assumption is that all soils are high activity clay (HAC) soils according to the IPCC definition, and that alpine, mid-mountain and foothill grassland types correspond to boreal, temperate, and tropical climate zones, respectively;

2. Stock change factors from IPCC (2019) for severely and moderately degraded grassland are applied to the reference carbon stocks to estimate SOC stocks prior to intervention to the pasture categories as presented in *Table 1* of section 1.1;
3. The only management measures considered is grazing management (e.g. timing and intensity of grazing). Hay making, fertilization, irrigation or any other measures are not considered;
4. The stock change factors entered in the with-intervention scenario assume that after 20 years of improved management, severely and moderately degraded pasture soils could return to the reference (non-degraded) state. No consideration is given for use of auxiliary measures such as reseeding or fertilization;[5]
5. The final mitigation potential is presented in (Gg CO_2e) per year.

The analysis used the grassland degradation categories according to the IPCC definition:

- **Non-degraded grassland** (low or medium intensity grazing with no significant artificial improvements);
- **Moderately degraded grassland** (overgrazed with reduced productivity relative to native grassland and receiving no management inputs);
- **Severely degraded grassland** (Implies major long-term loss of productivity and vegetation cover, due to severe mechanical damage to the vegetation and/or severe soil erosion);
- **Improved grassland** (grassland which is sustainably managed with moderate grazing pressure and that receive at least one improvement (e.g., fertilization, species improvement, irrigation).

5 These could be accounted for by weighting the value of F(MG) by the area under additional measures and the area under improved grazing measures in the provided Excel sheet.

3 RESULTS

RESULTS

3.1 Impact of climate change on the livestock and pasture sub-sectors

The major effects of climate change on livestock production include feed shortage, shortage of water, loss of livestock genetic resources, reduced productivity, and decreased weight and milk yield. Climate change may also increase the frequency and severity of pest and disease outbreaks which can result in reduced milk production, loss of weight, delayed maturity age, decreased reproductive rates, and increased mortality rate. Furthermore, the spatial distribution and availability of pasture and water are highly dependent on the pattern and availability of rainfall. The shortage of feed can reduce productivity and reproductive performance of livestock.

Analysis of climate changes on pasture areas for 1976-2019 showed (Kretova, 2020):

- An increase in the length of the growing season, with the highest rates occurring in valley zones;
- Increase in the sum of active temperatures (0.5, 10°C) in most of the territory, with the highest growth rate in the valley zones;
- Statistically insignificant tendency of decrease in dry period (except for Jalal-Abad and Uzgen weather stations);
- Longer duration of heat waves (mainly in valley zones);
- An increase in the duration and number of cases of heat waves during May-September (mainly in valley zones);
- Increase in the number of days with daytime temperatures above 25°C and 30°C in the valley zones;
- An increase in the number of days with daytime temperatures above 10°C, mainly in the foothills and highlands;
- Statistically significant increase in aridity (considering evapotranspiration), except for areas of Chatkal and It-Agar in the Jalal-Abad region.

The summary of the expected climate change impacts is presented in the table below:

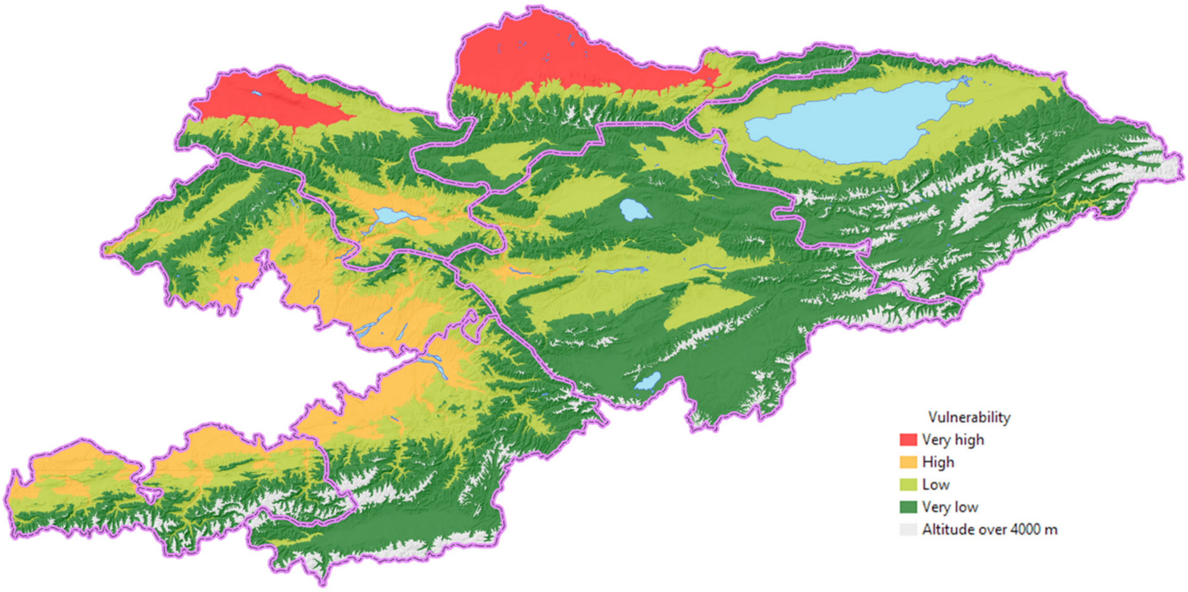
Table 7. Climate change trends and impacts on livestock and pastures in Kyrgyzstan

Climate change trends and events (observed and expected)	Expected impact on livestock and pastures in Kyrgyzstan
Altitude 1: below 1500 mts (RCP45)	
• Maximum temperatures will increase (more in autumn and summer) +2.5°C	• Warmer rains in spring

Climate change trends and events (observed and expected)	Expected impact on livestock and pastures in Kyrgyzstan
• Minimum temperatures will increase in winter • Precipitation is likely to increase in spring, autumn and winter, not changing in summer	• More heat stress for livestock in summer • Droughts would reduce pasture availability • Water needs in arable land (fodder crops) will be higher • Milder winters, less cold stress for livestock
Altitude 2: 1500 – 2500 mts (RCP45)	
• Maximum temperatures will increase (more in autumn and summer) +2°C-3.2°C. • Minimum temperatures will increase in winter • Precipitation is likely to increase in spring, autumn and winter (up to 20 %), not changing in summer	• Rains warmer in spring • Slight increase in heat stress for livestock • Milder winters. Less cold stress for livestock • Better climate conditions for pasture development in spring • Droughts could be more frequent and intense in some locations • Growing period will start 10 days earlier. Livestock could benefit earlier from spring pastures • The recovery period will last 10 more days (delay in the first snow) • Cold periods will be 20 days shorter – longer grazing periods
Altitude 3: Above 2500 mts (RCP45)	
• Maximum temperature will increase in all seasons (more in summer) +2.4°C • Minimum temperatures will increase in winter. • Precipitation is likely to increase in spring, autumn and winter (up to 20%), not changing in summer	• Better growing conditions for pastures • Milder winters. Less cold stress for livestock • Longer grazing period in summer pastures. Livestock would benefit more time from summer pastures

Source: *IFAD, 2013.*

Figure 5. Map of livestock and pasture vulnerability based on changes in temperature and rainfall



Source: *IFAD, 2013.*

Additionally, multiple hazards will have impact on the livestock and pastures:

River floods and water logging in spring:

More intense rainfall at low altitudes in spring are expected to affect areas susceptible to flooding. Infrastructure would be affected more frequently and pastures less accessible and livestock could suffer more stress.

Mudslides in spring:

- Rainfall more intense in spring, increasing the risks of mudslides at medium altitudes;
- This could affect the access of livestock to spring pastures.

Heat stress in summer:

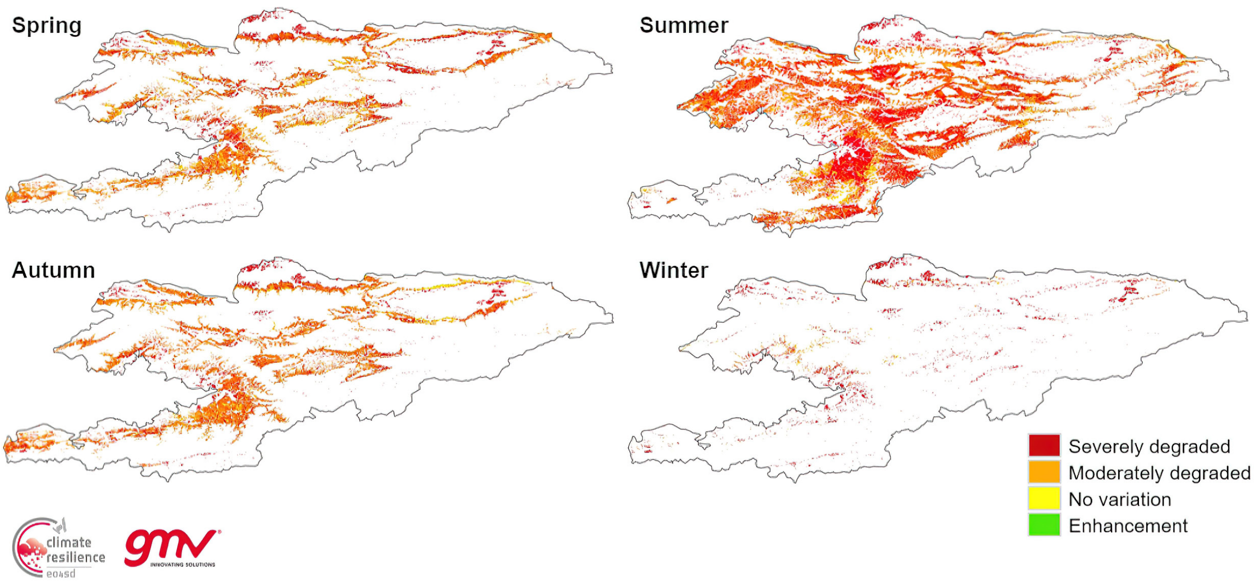
- Summer maximum temperatures will more frequently be over 30°C;
- Livestock (and people) will suffer more heat stress episodes;
- More probable droughts will reduce the availability of water needed to face heat stress.

Trends in grassland vegetation in Kyrgyzstan

The results of the EO4SD study comparing the average pasture conditions of 2000-2004 and 2016-2020 with remote sensing data reveals that pasture conditions are worsening. The maps below show the combined effect of all pressures on grasslands. The maps show an ongoing trend of degradation caused by livestock grazing and climate change and the need for increased efforts on pasture restoration.

The results of this study were not used to estimate the carbon sequestration potential and restoration needs of pasturelands, because the newly developed methodology and its results require more time to get reviewed and validated in order to be included into the NDC update.

Figure 6. Pasture conditions according to IPCC Guidelines comparing the period 2000-2004 to 2016-2020



Source: *Climate Resilience Cluster of the Earth Observation for Sustainable Development (EO4SD) of the European Space Agency.*

Table 8. Pasture conditions according to IPCC Guidelines for different types of pastures in Kyrgyzstan

Types of pastures	Winter		Spring		Summer		Autumn	
Pasture conditions	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

Source: *Climate Resilience Cluster of the Earth Observation for Sustainable Development (EO4SD) of the European Space Agency.*

Vulnerabilities in the pasture sub-sector

Climate change. The Second National Communication of the Kyrgyz Republic on the UNCCCF outlined future climate projections for the country. The general trend indicates that the mean temperatures will continue to rise, and the level of precipitation will fall. Specifically, grassland productivity will decline in the semi-arid and arid regions of Asia by as much as 40-90 % due to an increase in temperature of 2-3°C This will result in greater aridity and variability with the increased probability of extreme events such as droughts and frosts. Climate change (temperatures, precipitation, variability, etc.) will affect the livestock sector with respect to animal health, nutrition and availability of fodder. For instance, rising temperatures, the frequency and severity of events may result in heat stress in animals which in turn will lead to lower productivity. The indirect effects include reduced pasture productivity and increased exposure to new pests, invasive plants and diseases. Projected climate changes will affect water availability and thus the availability of fodder, especially in rain-fed areas.

The agricultural sector, including the livestock sub-sector, will need to develop measures to address issues of adverse climate change impact such as: (a) use of efficient irrigation systems (e.g. drip irrigation); (b) introduction of drought (frost) resistant varieties of crops and species of livestock; (c) changes in cropping patterns to take advantage of prolonged growing period; (d) soil conservation practices (e.g. minimum/zero tillage); and (e) improved pasture management, including pasture rotation and rehabilitation.

3.2 Priority adaptation options

Pastoral systems in Kyrgyzstan, if well managed, are the best suited and adaptive form of agriculture for the majority of the country's land area that is too dry, cold, or mountainous to practice crop farming. The production system relies on livestock mobility as a key adaptation strategy. Mobility makes it possible for herders to mitigate risks and manage pasture and water resources in an opportunistic manner allowing them to respond to climate shocks and extreme weather events such as drought, heavy snowfall, heavy rainfall and strong winds.

Adapting to climate change requires a combination of technological, environmental and policy responses. Adaptation of livestock systems is closely linked to adaptation of pastures. There is no one adaption measure that can strengthen the resilience of the livestock and pasture sectors. A holistic and balanced approach is needed.

Ten priority adaptation measures were identified. They can be categorized into four main categories: livestock management, pasture management, information and communication services, and crosscutting measures. All presented measures are listed as adaptation measures for livestock and pastures according to IFAD's Adaptation Framework. The ten measures include technical actions, targets until 2025 and 2030, and costing information. Detailed information is provided in the Action Plan in Appendix. Below is a brief overview of priority adaptation measures.

Table 9. Priority adaptation measures and their rational

Adaptation measure	Adaptation rational
A. Livestock management	
1. Animal health and veterinary services	Changes in climate can lead to new animal pests and diseases, or the return of previously eradicated diseases, to which animals in poor health will be more susceptible. Improving veterinary services and strengthening the animal health system support mitigating this risk.
2. Breeding productive farm animals adapted to climate change	Climate change affects livestock in various ways. Breeding efforts should not only aim to increase livestock productivity, but also maintain traits of indigenous breeds that make them well adapted to the harsh mountain conditions of Kyrgyzstan. Many breeds have unique characteristics that can contribute to meeting challenges related to climate change. Adaptive traits include heat and cold tolerance, thriving on poor-quality feed and the capability of walking long distances.
3. Animal and herd management	Adjusting herd size and composition to favor smaller herds that are more productive is an important step to manage pasture resources sustainably and increase resilience. More active measures to manage and control herd growth are necessary.
B. Pasture management	
4. Pasture related infrastructure	Infrastructure on pastures such as water points, bridges, sheds, and rural roads improves water supply and access to pastures. This gives herders more options and flexibility to adapt to changing conditions by moving their herds to areas where pasture and water availability are better and to where they can avoid extreme weather events.
5. Sustainable grazing management	Unsustainable grazing practices interact with climate change impacts, resulting in degradation. Improved pasture management (through seasonal migration and rotational grazing) increases feed availability and the grassland habitat's capacity to withstand unfavorable climate stressors. Good management practices also increase the amount of carbon sequestered in the soil of grasslands.

Adaptation measure	Adaptation rational
6. Pasture rehabilitation	Climate-related hazards such as landslides, mudslides, flooding and erosion can cause further degradation of grasslands, when bare soil is washed out. Invasive weeds can intensify the degradation of grasslands. Measures such as pasture resting, control of harmful vegetation, protection of water sources and soil control structures can support to mitigate such hazards.
C. Information and communication services	
7. Pasture monitoring and inventories	Monitoring pasture conditions and setting up pasture management plans is key in order to adapt to changing conditions and managing pasture resources sustainably. Plans include for example dedicating areas as emergency fodder reserves, adjusting migratory routes, adjusting herd size and composition, planning for pasture resting, reseeding degraded areas, etc.
D. Crosscutting measures	
8. Capacity building	Adaptation interventions at field level can only be effective and have a wide coverage if institutions have sufficient capacity to implement them and enforce change. The main actors are herders and livestock keepers represented in Pasture User Unions.
9. Enabling environment	A strong enabling environment is key to strengthen resilience. This includes policy-related work, setting standards and regulations, establishing mechanisms to strengthen community-based pasture management, and mobilizing finance to overcome initial investment barriers.
10. Research and development	Scientific data and evidence are needed to understand the effects of climate change and assess the effectiveness of different adaptation measures for livestock and pastures. Research should take into account the characteristics of different areas and altitudes of the topographically diverse country.

Source: *Authors' elaboration.*

Livestock management and pasture management measures have direct impact on GHG emissions and carbon sequestration. The details of the priority adaptation measures are presented in Annex 6.2.

Gender aspects

Women play a key role in the livestock sector and are pivotal in increasing the resilience of the sector. Activities under donor-funded projects such as the planned IFAD project RRPCP and the associated RRPCP-ADAPT project have targets to increase income levels of rural women in livestock value chains. Also, these projects aim to increase the number of women in pasture committees. If approved by the Adaptation Fund, the RRPCP-ADAPT project will further upscale the Gender for Action and Learning System (GALS), a commu-nityled empowerment methodology that has been piloted by the Joint Programme for Rural Women Economic Empowerment project (here https://www.ifad.org/documents/38714170/39148759/Five+years+of+the+AAF%E2%80%99S+technical+assistance+facility).

Nature-based solutions

Nature-based Solutions (NbS) offer multiple benefits including adaptation and mitigation co-benefits. Many of the technical options in priority adaptation measures qualify as NbS, particularly the options that aim at increasing the productivity and resilience of pastures and pasture resources. Pasture restoration activities provide multiple benefits, which can be harnessed through the nature-based solutions.

The beekeeping sub-sector was identified as being important for the agriculture sector of Kyrgyzstan as it offers numerous biodiversity benefits through pollination and social benefits through alternative income to livestock. While this sub-sector will remain a priority for the development of the agriculture sector of Kyrgyzstan, beekeeping and associated social and ecosystem benefits have not been analyzed as the focus of the analysis is on ruminants.

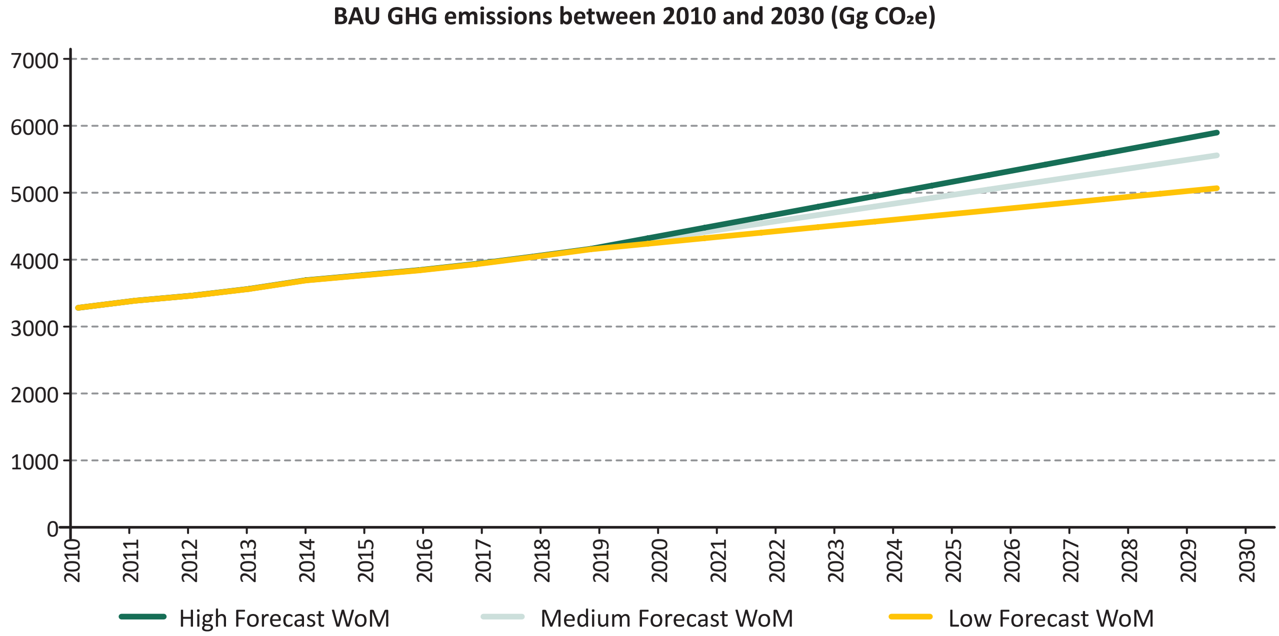
3.3 Mitigation co-benefits: GHG emissions and mitigation options

This section presents an overview of historical livestock population and GHG emissions in the livestock sector and projects GHG emissions to 2030. Baseline scenarios and a mitigation scenario with additional measures are elaborated. The implications for GHG management in the livestock sector are highlighted.

Note: All analysis presented here has been conducted using GWPs from the SAR (i.e., CO_2=1, CH_4=21, N_2O = 310) and uses methods consistent with the IPCC (2006 and 2019) Guidelines, unless otherwise noted. The data spreadsheet used in the analysis is presented in as a separate Appendix to the report.

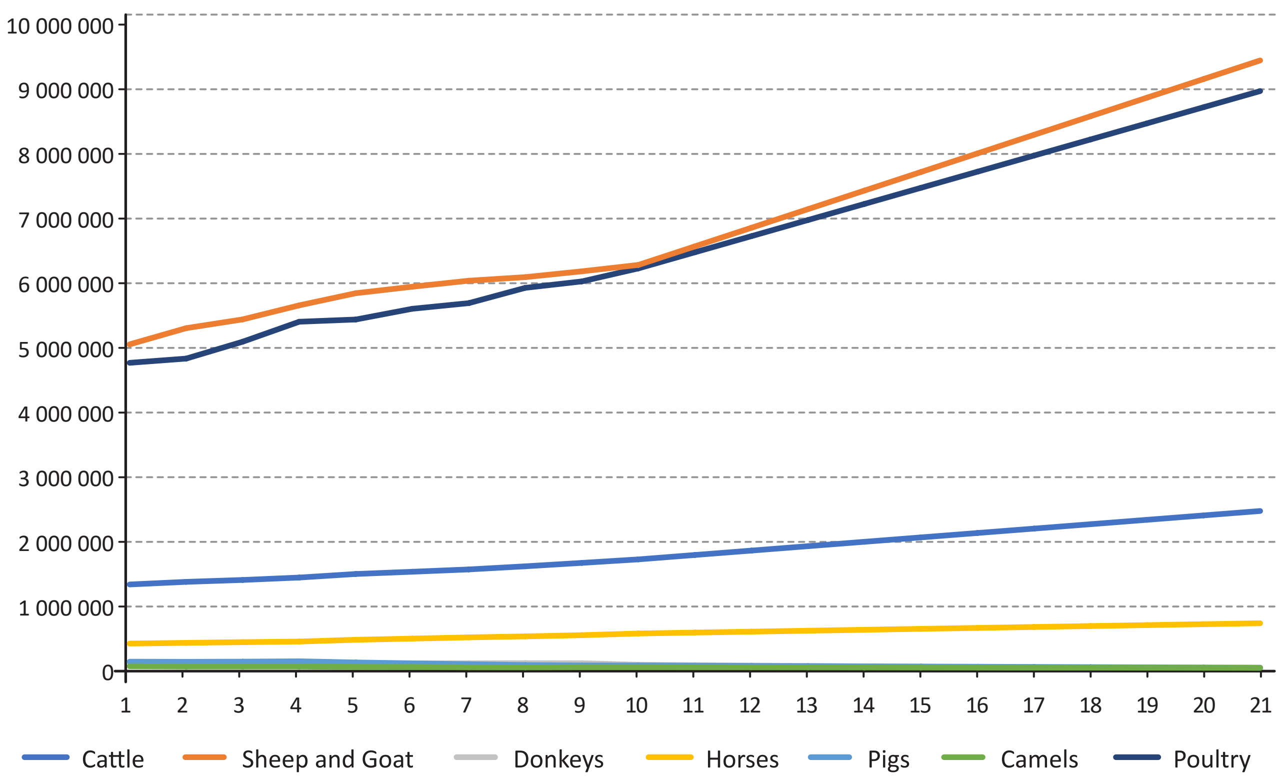
GHG inventory results and the projections according to three development scenarios are presented in *Figure 6* and *Table 10*. GHG calculations were conducted and presented separately for each mitigation measure (vaccination campaign, artificial insemination, IFAD RRPCP project, and FAO GCF CS-FOR project) using the GLEAM-*i* tool. The merged results are presented in the tables below.

Figure 7. GHG inventory of the livestock sector in Kyrgyzstan



Source: *Authors' elaboration.*

Figure 8. Historical and project livestock population 2015-2030



Source: *Authors' elaboration.*

Table 10. Projected GHG emissions from the livestock sector from 2020 to 2030 (Gg CO_2e)

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
High forecast	4281	4439	4596	4754	4911	5069	5226	5384	5542	5700	5859
Medium forecast	4251	4378	4506	4633	4760	4888	5015	5143	5270	5397	5525
Low forecast	4207	4291	4375	4458	4542	4625	4709	4793	4876	4960	5044

Source: *Authors' elaboration.*

3.3.1 Livestock management-oriented investment options

The measures that are included in the livestock management investment package include the state and donor programs on animal vaccination, breeding, and upcoming donor projects (IFAD RRPCP and FAO CS-FOR) that aim to improve livestock and herd management practices.

Table 11. Emissions projected using high forecast agricultural GDP for specific projects

Interventions and scenarios	BAU		Unconditional total net mitigation potential (Gg CO_2e)						Conditional total net mitigation potential (Gg CO_2e)					
	2025	2030	2025			2030			2025			2030		
			WOP	WP	ER	WOP	WP	ER	WOP	WP	ER	WOP	WP	ER
Breeding program (Gg CO_2e)			2,878	2,818	60	3,340	3,190	150						
Vaccination campaign (Gg CO_2e)									4,747	4,503	245	5,414	5,401	14
IFAD RRPCP (Gg CO_2e)			1,811	1,612	199	2,114	1,612	502						
FAO-GCF (Gg CO_2e)			411	364	47	946	838	47						
High-forecast scenario (Gg CO_2e)	**5,069**	**5,859**	6,034	5,728	**306**	6,968	6,267	**699**			**245**			**14**
Medium-forecast scenario (Gg CO_2e)	4,888	5,525	5,819	5,524	**294**	6,572	5,911	**659**			**237**			**13**
Low-forecast scenario (Gg CO_2e)	4,625	5,044	5,507	5,227	**278**	5,999	5,395	**602**			**224**			**12**

Source: *Authors' elaboration.*

The livestock sector consists of two sub-sectors, namely livestock management and pastureland management. Given its economic importance, the livestock sector is expected to increase output of livestock product substantially over the next decade whilst concurrently decreasing emission intensity of agricultural GDP. This is notably due to efficiency and productivity gains in cattle, sheep and goat and pasture improvement plan as proposed under the Kyrgyz livestock development program. The results are summarized in *Table 11*.

The total cattle population is estimated to have increased from 1.3 million head in 2015 to 2.4 million head in 2030 *(Figure 7)*. This represents an increase of 62 % since 1994 and accounts for 11 % of the total livestock population in 2030. Similarly, the total sheep and goat to have increased from 5.9 million head to 9.4 million head in 2030 and accounts for 43 % of the total livestock population in 2030.

The GHG inventory has been estimated using Tier-1 approach of IPCC 2006 guidelines for livestock GHG inventory emission, which has been applied to dairy cattle, other cattle, sheep and goats, pigs, horses, donkeys, camels, and poultry. Using the Tier-1 approach, it is estimated that in 2010 total GHG emissions from enteric and manure management sources amounted to 3244 Gg CO_2e and increased to 4281 Gg CO_2e in 2020 *(Table 10)*. With high forecast projection, the total GHG emission further increased to 5859 CO_2e by 2030. This increase is mainly related to an increase in animal numbers *(Figure 7)*. In 2020, ruminant animals (cattle, sheep, goat), pigs, horses, donkey, camels, and poultry accounted for 91.8 %, 0.2 %, 8.0 %, 0.2 %, 0.01 %, and 0.4 % of total GHG emissions. In 2020, of the 4281 Gg CO_2e in 2020, enteric CH_4 represents about 70 % of the total GHG emissions from livestock production.

State funded measures: artificial insemination combined with animal health interventions of cattle, results in the absolute emissions decease by 2 % compared without project, which equals in an emission reduction of 60 Gg CO_2e and 150 Gg CO_2e by 2025 and 2030, respectively *(Table 11)*. This is due to the fact that improved practices lead to productivity per animal (higher milk yield, live weight, less mortality and higher fertility, and larger litter size for sheep). With the additional resources, intervention of vaccination campaign alone (cattle and sheep) and sheep breeding program can further save 245 Gg CO_2e and 14 Gg CO_2e by 2025 and 2030, respectively. The higher emission reduction potential with vaccination campaign is related to the fact that the vaccination campaign covered higher % of the cattle and sheep herd compared to project with artificial insemination combined with vaccination campaign.

Donor funded projects (IFAD): With project's improved practices, total emissions in scenario with project reduce by 11 %, and 24 % in 2025, and 2030, respectively compared to the without project. This is due to the fact that improved practices such 20 % increases in milk yields and 20 % increase in live weights per animal during the project period due mainly to the introduction of a breeding program and improved feeding system.

The results are presented as % changes in scenario WP compared to WOP and to baseline. Total emissions in scenario WP reduce by 11 % and 24 % 52 % in 2025 and 2030, respectively compared to the WOP. Emissions intensity is 21 % lower in scenario WP compared to WOP. The constant increase in animal numbers from 2030 onwards result in lower protein production in scenario WP (though the protein production at year 2025 is still 12 % higher than that of WOP). Protein production WP is 26 % higher than that of baseline in 2022.

It is important to note that the animal numbers in scenario WP are likely to increase and contribute further to the protein production. Similarly, the animal numbers in the future (WOP) may not increase as aggressively as it has been projected since the project also aims to introduce culling and herd management. The carbon sequestration potential of the RRPCP has not been reflected in the results since it is accounted for separately at the NDC update. The emissions presented here are only the direct emissions and figures reflect the results at particular years and not the cumulative changes.

Donor funded projects (FAO-GCF): With project's improved practices, total emissions in scenario WP reduce by 11 %, and 11 % in 2025, and 2030, respectively compared to the without project. This is due to a relative control in animal numbers is carried out resulting from higher fertility and lower mortality, improved feeding system.

Without project scenario emissions from cattle and sheep/goat calculated using Tier-2 method of GLEAM-*i* tool for mitigation project are 19.1 and 18.9 % higher than the BAU emission from all livestock emissions calculated using Tier-1 approach of 2006 IPCC guidelines activity data at year 2025 and 2030, respectively *(Table 10)*. This reasons for these discrepancies are that the Tier-2 enteric CH_4 emission factors for cattle (68 kg CH_4/head/year) and sheep/goats (6 kg CH_4/head/year) used without project scenarios are 17 % and 20 % higher than the enteric CH_4 emission factors used in BAU emission estimates for cattle (58 kg CH_4/head/year) and sheep/goat (5 kg CH_4/head/year).

3.3.2 Pasture management-oriented investment options

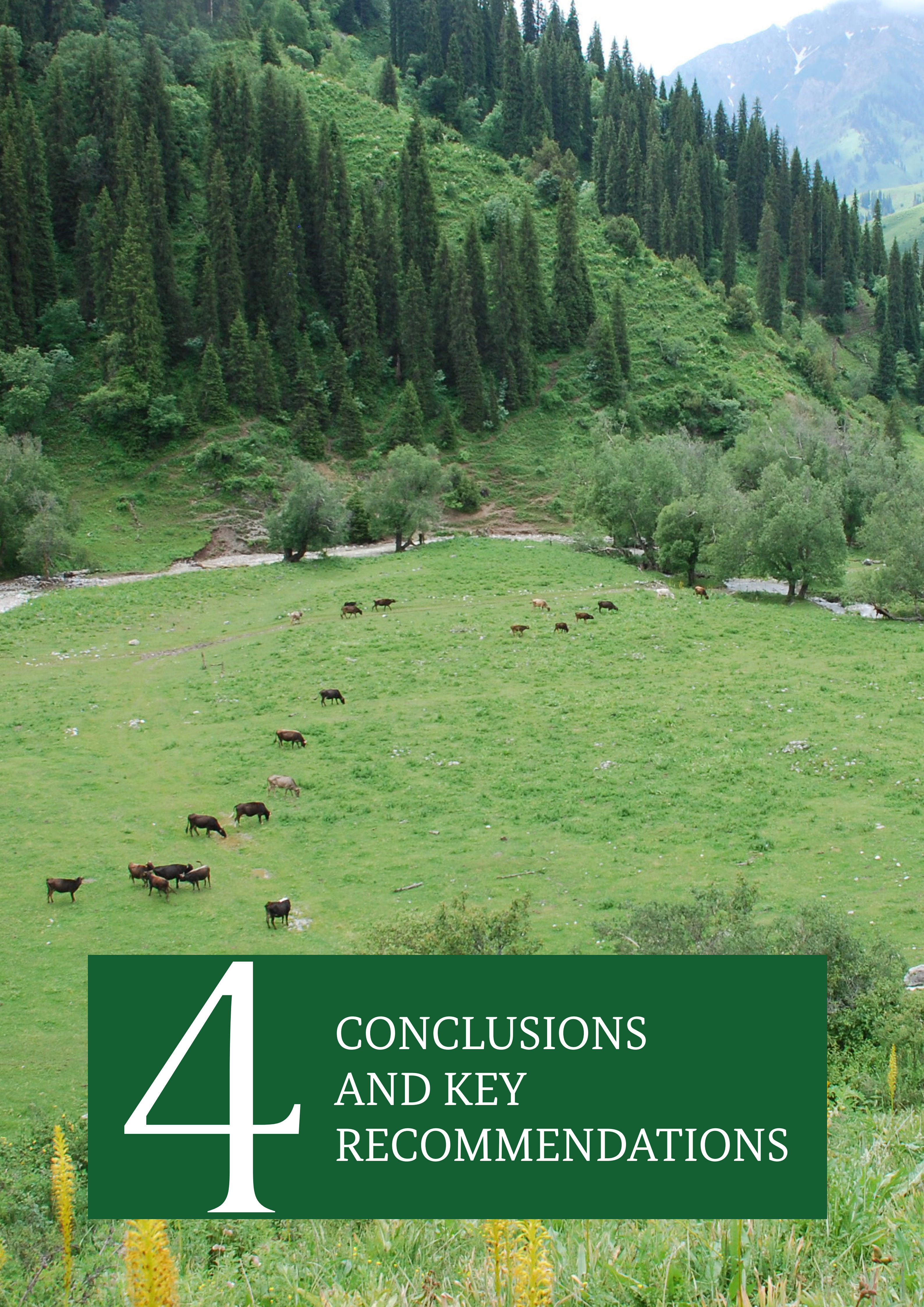
The grasslands provide the largest mitigation potential over the next decade. The pasture sub-sector is crucial for the achievement of Kyrgyz's mitigation contributions since it is the only sector that currently achieves net removals of emissions and therefore balances emissions from livestock management activities. For instance, *Table 12* shows if Kyrgyzstan plans to improve 1 million ha the mitigation potential of pasture would be 480 Gg CO_2e, which can potentially off-set the emission generated by livestock conditionally.

Table 12. Conditional total net potential (Gg CO_2e) from pasture improvement measures

	Pasture improvement measures (ha)	Conditional total net mitigation potential (Gg CO_2e)	
		2025	2030
1	500,000	240	240
2	1,000,000	480	480

Source: *Authors' elaboration.*

*** Please note that it is impossible to off-set all the surplus emission livestock sector. If you even plan to improve all the 9 million pastureland you can only off-set 4327 Gg CO_2e which is still less than the amount of surplus emission by 2025 (4993 CO_2e).*



4 CONCLUSIONS AND KEY RECOMMENDATIONS

CONCLUSIONS AND KEY RECOMMENDATIONS

This report presents the main findings and recommendations of the in-depth analysis of adaptation options with greenhouse gas (GHG) mitigation effects in Kyrgyzstan's livestock and pasture sub-sectors to consider for including in the updated NDC of Kyrgyzstan (UNDC). It supports enhancement of NDC by integrating priority adaptation measures with mitigation co-benefits informed by national development priorities; updating GHG baseline and projections; and providing solid analysis of mitigation potential in the livestock sector using Tier-2 emission factors that are specific to Kyrgyzstan.

Livestock sub-sector emissions are essential in contributing towards NDC targets

The total population of Kyrgyzstan is projected to reach around 7.4 million people in 2030 and 9.1 million in 2050 from 6.5 million 2020[6], representing an increase of 13 % and 28 % respectively. Livestock population is also projected to increase in the scenarios of low, medium, and high forecast, which has effects on emissions in the livestock sector. Planned state programmes (breeding) and donor projects (IFAD, FAO) contribute to the reduction of emissions in the livestock sector by 306 Gg CO_2e by 2025 and by 245 Gg CO_2e in 2030, and result in lower emission intensity. Additionally, the planned project measures result in increased milk production by 20 % and increase in liveweight by 20 %. Pastures provide additional opportunity to decrease emissions through carbon sequestration. For example, implementing pasture improvements on 1million ha results in 480 Gg CO_2e.

An enhanced NDC is helpful for aligning domestic and international support

The current analysis presents prioritized adaptation measures with GHG mitigation co-benefits. These measures reflect national policy priorities in the livestock and pasture sub-sectors. The analysis of mitigation options and scenarios contribute to an enhanced NDC by providing transparent and in-depth analysis of mitigation options and their impacts using Tier-2 emission factors thus contributing to an improved methodology. Including the livestock and pasture sub-sectors in the updated NDC explicitly could also support Kyrgyzstan to mobilize external climate finance (for conditional targets) which would enable to implement measures at scale and thus raise the ambition of Kyrgyzstan towards achieving the goal of the Paris Agreement. Implementing the measures at scale will effectively contribute to climate change mitigation and strengthen the resilience of local livelihoods, food systems, and ecosystems. Green and climate funding sources support measures aligned with ambitious NDCs such as Green Climate Fund, Adaptation Fund, NAMA Facility, along with many other donors. This is a window of opportunities for Kyrgyzstan and many other countries to enhance their NDCs to access such sources of funding.

6 United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, custom data acquired via website (https://population.un.org/wpp/DataQuery/).

4.1 Key recommendations

4.1.1 Policy level

- Kyrgyzstan expressed its commitment to sustainable development through promotion of Green Economy priorities at a UN conference on sustainable development in 2012. In 2018, the Parliament of the Kyrgyz Republic adopted the Green economy concept and the Government has adopted the Green Economy Programme for the period of 2019-2023. The Green Economy Programme needs to align with low-GHG country development of the country, as well as with the targets set in the NDC. The need for NDC alignment applies also to national legislation, planning and strategic vision relevant to the sectors being addressed in the NDC. This can be achieved through interagency coordination.
- Investing in livestock for climate co-benefits. The livestock sector is a major source of GHGs in Kyrgyzstan and vulnerable to the impacts of climate change. Current public and private finance in the sector are not sufficient to meet the sector's need for sustainable, low emission and climate-resilient development. Investments are needed for activities with multiple co-benefits that aim to:
  - increase animal productivity through animal vaccination and breeding;
  - build farmers capacity to adapt to climate change through improved management practices;
  - increase pasture productivity.
- Available estimates indicate that the Paris Agreement opened up opportunities for climate investments in emerging markets by 2030[7]. The major multilateral development banks have made pledges to significantly increase their funding for SDGs and NDCs[8]. Key bilateral and multilateral funding sources for the Central Asian region in agriculture sector include: Adaptation Fund (AF), Asian Development Bank (ADB), Austrian Development Agency (ADA), Climate Investment Funds (CIF), GIZ, EBRD, French Development Agency (AFD), Global Environment Facility (GEF), Green Climate Fund (GCF), International Development Association (IDA), International Finance Corporation (IFC), International Fund for Agricultural Development (IFAD), International Finance Corporation (IFC), KfW, NAMA Facility, United Nations (UN) agencies and the World Bank.

4.1.2 Institutional level

- The Paris Agreement establishes an Enhanced Transparency Framework in its Article 13. The specific reporting requirements - the modalities, procedures and guidelines (MPGs) for the ETF are laid down in Decision 18/CMA.1[9]. Collecting reporting information in order to track progress towards climate targets is a new reporting requirement for the Kyrgyz Republic and all signatories of Paris Agreement. Using indicators to track NDC progress

7 NDC Partnership, 2020. Navigating International Climate Finance.

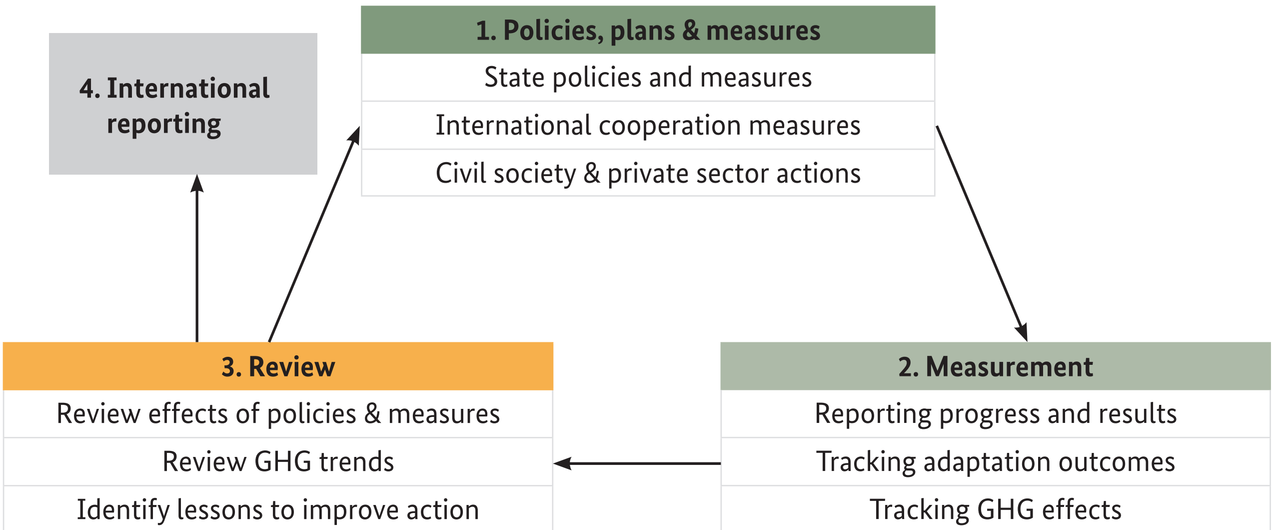
8 Joint statement by the Multilateral Development Banks at Paris, COP 21.

9 See decision 18/CMA.1, https://unfccc.int/sites/default/files/resource/cma2018_3_add2_new_advance.pdf.

will also support national development processes such as contributing towards informed policy-decision making, providing better overview on contribution of mitigation and adaptation actions towards the overall NDC target, and allowing adjustments depending on the progress. A system for monitoring is key to track the progress of achieving targets set in NDCs. The specific reporting formats to be used for reporting under the MPGs, including for progress tracking, remain to be agreed at COP 26, currently planned to take place in November 2021 in Glasgow. However, it is clear that there is a need for improved monitoring, evaluation and learning to track progress, identify lessons and continually improve the effectiveness of actions.

- In the context of NDC implementation, Measuring, Reporting and Verification (MRV) refers to the process and framework by which countries track and report on the implementation and impacts of mitigation and adaptation actions, and the finance used to support these actions. Mitigation, adaptation and finance are the core elements of the MRV system. They can be elements of one integrated, national MRV system, or separate MRV systems (NDC Guide n.d.).
- A sector level **MRV** system is crucial for monitoring the synergies of mitigation and adaptation measures. A cycle to introduce such a system is presented in *Figure 8*.

Figure 9. Concept for sector level MRV system for adaptation and mitigation synergies tracking



Source: *UNIQUE, 2018.*

- For tracking GHG benefits, there is a need to improve the national GHG inventory with a focus on:
    a. Using the IPCC Tier-2 method for livestock emissions to be able to reflect effects of productivity on livestock GHG emissions and include all the relevant livestock emission sources (categories 3A1, 3A2, 3C4, 3C5, 3C6). This would make the inventory helpful in tracking the effects of policies and measures, but also increase compliance of the GHG inventory with the IPCC principle of accuracy and completeness;
    b. Using the Tier-1 method to estimate grassland soil carbon stock change (category 3b3a). This would increase compliance of the GHG inventory with the IPCC principle of completeness.

- When these improvements are implemented, the inventory will have greater functionality, and the main effects of NDC measures can be measured and reported using the national GHG inventory. This will help Kyrgyzstan to meet its obligations under the Enhanced Transparency Framework.
- There are existing institutional frameworks that can serve towards monitoring, namely:
  a. Regulations on the Procedures for Attracting and Using International Grants and Technical Assistance in the Kyrgyz Republic (19.06.2017 #389);
  b. Regulations on Public Investments Management (28.05.2019 #232);
- Both regulations provide with instructions and templates for monitoring, reporting and evaluation of investments. These can be used for tracking progress of achieving NDC targets. It is recommended to include an additional field on tracking GHG emissions to the existing templates. This would serve as an entry point to track the NDC update.

4.1.3 Technical level

- Identify technical entry points at herd level. This includes among others earlier age at first calving, reduced mortality rates and increased fertility rate, which can be achieved by improving feed quality, animal health as well as introducing better breeding practices. In an optimum herd structure, there would be only enough number of young animals kept for replacement purposes as more of them would contribute to absolute emissions without producing any products and thus leading to a compromise in emissions intensity.
- Identify technical entry points at feed level. Improved feed quality from locally grown feed ingredients has the potential to reduce the CH_4 emissions from enteric fermentation. Compared to import feeds, locally grown

feeds would also be associated with fewer CO_2 emissions coming from transport of feed. In order to reduce the GHG emissions, maize production can be further developed and made into silage to feed animals. Similarly crop residues from maize and sugar beet can replace those of wheat. The improvements of pastures will reflect a reduction of proportion of fresh grass in the diet of animals due to i) increased quality of pastures, and ii) increase in higher quality fodder crops. Introducing more energy-efficient ways to produce and process the feed will reduce the CO_2 emissions associated with feed.

- Identify technical entry points at manure level. Manure can be a source of both CH_4 and N_2O emissions and there can be trade-offs between these two gasses depending on the type of management system. For example, CH_4 can be higher when manure is stored in liquid form while N_2O can be higher in dry lot or solid systems. However, emissions from manure are usually low in most systems where manure is stored in solid form. The extent to which biogas plants reduce emissions from manure requires an in-depth assessment that factors in local temperatures and the types of digesters. What is important to note here is that manure is product rich source of nutrients and organic matter that is key for soil health and fertility and can contribute to a more circular bioeconomy.

- The extent to which feedlot systems should be established requires further assessment. On one hand, they can contribute to food security by raising a large number of animals at a shorter period time. The high productivity in this case may lead to lower emissions produced per kg of meat compared to grassland systems. On the other hand, these systems require special diet composition in different periods e.g., high fibrous ingredients in growing period, and high-energy grains during finishing periods. This can lead to two challenges: i) Feeding ruminants too much cereals can cause health problems; and ii) If the feed is imported, this can lead to increases in CO_2 emissions associated with feed production, processing and transport. Therefore, before such decisions are taken, much emphasis should be given to the source and type of feed that will be fed to the animals. In addition, systems like feedlots where animals are concentrated over small areas can lead to challenges in manure management and eventually higher emissions but also water pollution. Finally, they also raise issues in terms of animal health and animal welfare.

5 REFERENCE LIST

REFERENCE LIST

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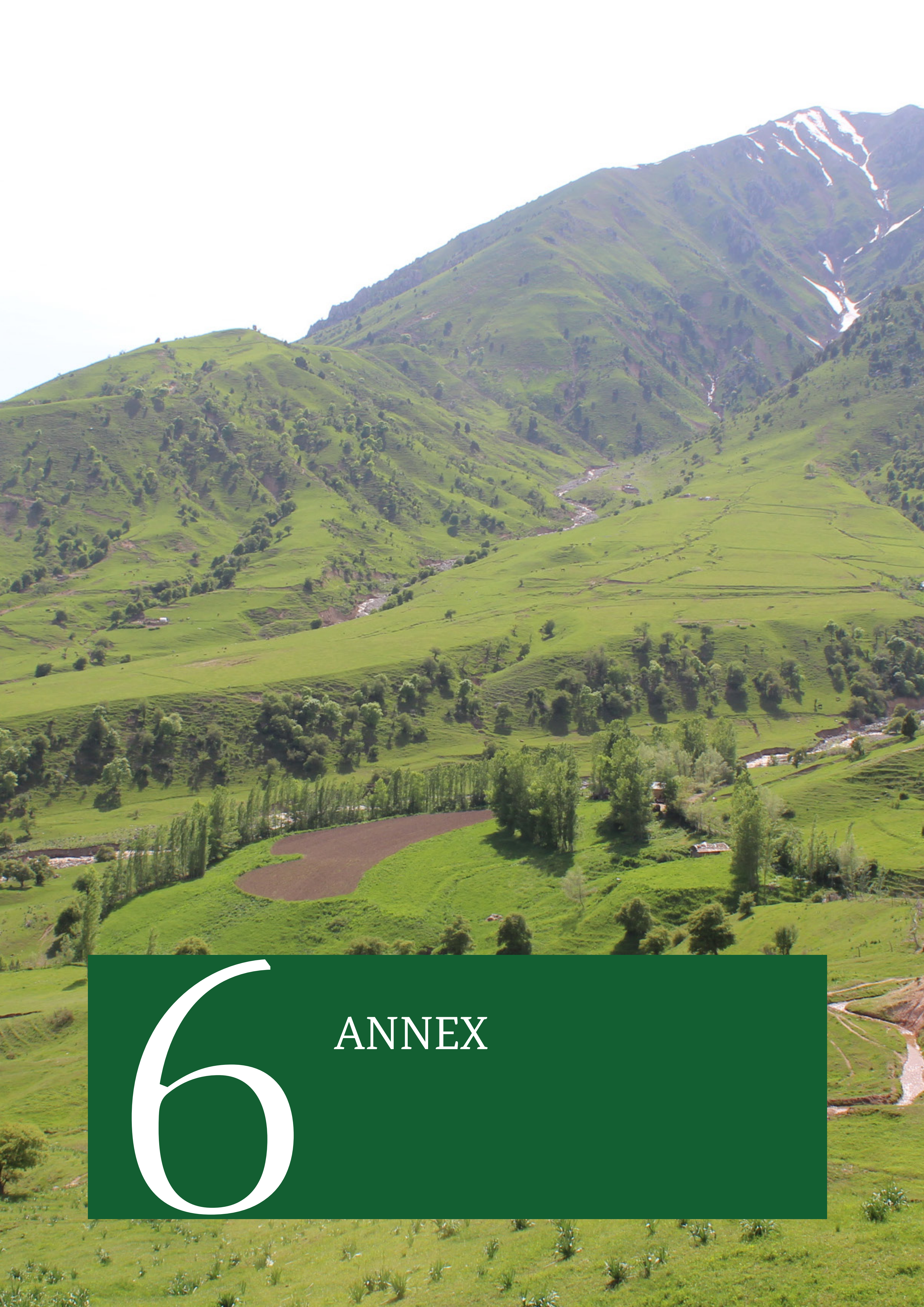


6 ANNEX

ANNEX

6.1 Long list of adaptation measures

A. Livestock management

Animal and herd management

- Offtake of animals
- Control of herd size and composition
- Manure management

Animal health and veterinary services

- Training animal health workers
- Animal health facilities
- Animal disease forecasting and monitoring
- Strengthen veterinary laboratories.
- Emergency vaccine fund
- Animal tracking systems
- Vaccination campaigns

Breeding productive farm animals adapted to climate change

- Artificial insemination
- Selection of adapted breeds
- Breeding enterprises
- Crossbreeding
- Importing genetic material

Feed management and fodder production

- More productive fodder crops
- Storage facilities
- Stocking fodder
- Community seed funds
- Cut and carry stall feeding.
- Agricultural machinery
- Production of silage, pellets and other fodder types

B. Rangeland and grazing management

Agroforestry and silvopastoral systems

- Tree planting
- Tree nurseries

Pasture rehabilitation

- (Re)seeding
- Pasture resting
- Control of harmful and poisonous vegetation
- Protection of water sources
- Measures to retain water in the soil
- Gully control measures
- Control measures against landslides, mudslides and floods
- Fire prevention measures

Pasture-related infrastructure

- Water points
- Housing
- Roads and bridges

Sustainable grazing management

- Rotational grazing
- Mobile livestock keeping
- Pasture management plans
- Irrigating pastures
- Fencing

C. Market oriented development

Intensification

- Processing facilities and machines
- New businesses
- Mechanized livestock production farms

Marketing and certification

- Marketing
- Organic livestock production
- Certification

D. Information and communication services

Pasture monitoring and inventories

- Pasture inventories
- Remote sensing of pasture conditions
- Data standards and bases

Weather and climate information and early warning

- Extension of monitoring stations
- Early warning systems

Weather indexed insurance

- Insurance

E. Crosscutting

Capacity building

- Community-based trainings
- Specialist trainings
- Institutional strengthening and partnerships
- Climate-related tools and assessments
- Extension services
- Community-based organizations

Enabling environment

- Standards and regulations
- Pasture fees
- Finance
- Pasture legislation

Research and development

- Research programmes
- University courses

To ensure that all identified measures can be classified as adaption options, the long list of measures was cross-checked with IFAD's Adaptation Framework Tool that presents a repository of adaptation actions for small-scale agriculture, including livestock and pasture sub-sectors (IFAD 2021).

6.2 Priority adaptation measures

Adaptation category	Technical measures	State programs and projects
A1: Livestock Management: Animal health and veterinary services	Activity 1: Training animal health workers Activity 2: Animal health facilities Activity 3: Animal disease forecasting and monitoring Activity 4: Strengthen veterinary laboratories Activity 5: Emergency vaccine fund Activity 6: Animal tracking systems Activity 7: Vaccination campaigns	**State programs:** PROGRAM on a pilot project for the development of the dairy industry in the Issyk-Kul region for 2016-2019 with extension 2021-2024 (Draft) Program for the Development of Pasture and Livestock Breeding in the Kyrgyz Republic for 2020-2024 Program for Adaptation of Agriculture to the Effects of Climate Change 2016-2020 **Projects:** IFAD-AMTP project (2016-2023) World Bank Integrated productivity improvement in the dairy sector, 2017-2021 and 2021-2024 GIZ Green Economy and Sustainable Private Sector Development, 2021-2023 JICA Project for Market Oriented Milk Production in Chuy Province (MOMP), 2017-2022

Adaptation category	Technical measures	State programs and projects
A2: Livestock management: Breeding productive farm animals adapted to climate change	Activity 1. Artificial insemination Activity 2. Selection/breeding of adapted breeds Activity 3. Breeding enterprises Activity 4. Crossbreeding Activity 5. Importing genetic material	**State programs:** (Draft) Program for the Development of Pasture and Livestock Breeding in the Kyrgyz Republic for 2020-2024 (Draft) Programme on Development of fine-wool sheep breeding in the KR 2021-2025 Program for Adaptation of Agriculture to the Effects of Climate Change 2016-2020 **Projects:** GIZ Green Economy and Sustainable Private Sector Development, 2021-2023 JICA Project for Market Oriented Milk Production in Chuy Province (MOMP), 2017-2022
A3: Livestock management: Animal and herd management	Activity 1. Offtake of animals Activity 2. Control of herd size and composition Activity 3. Manure management	**State programs:** PROGRAM on a pilot project for the development of the dairy industry in the Issyk-Kul region for 2016-2019 with extension 2021-2024 Green Economy Program of the Kyrgyz Republic 2019-2023

Adaptation category	Technical measures	State programs and projects
A3: Livestock management: Animal and herd management		**Projects:** FAO GCF project “carbon sequestration through climate investment in forests and rangelands”, 2020-2026 GIZ Green Economy and Sustainable Private Sector Development, 2021-2023 IFAD Regional Resilient Pastoral Communities Project (RRPCP), 2022-2026 JICA Project for Market Oriented Milk Production in Chuy Province (MOMP), 2017-2022 World Bank Integrated productivity improvement in the dairy sector, 2017-2021 and 2021-2024
A4: Rangeland and grazing management: Pasture-related infrastructure	Activity 1. Water points Activity 2. Housing Activity 3. Roads and bridges	**State programs:** Program of agriculture adaptation to climate change consequences 2016-2020 **Projects:** IFAD Regional Resilient Pastoral Communities Project (RRPCP), 2022-2026

Adaptation category	Technical measures	State programs and projects
A5: Rangeland and grazing management: Sustainable grazing management	Activity 1. Rotational grazing Activity 2. Mobile livestock keeping Activity 3. Pasture management plans Activity 4. Irrigating pastures Activity 5. Fencing	**State programs:** Program for the Development of Pasture and Livestock Breeding in the Kyrgyz Republic for 2020-2024 Program for Adaptation of Agriculture to the Effects of Climate Change 2016-2020 **Projects:** FAO GCF project "carbon sequestration through climate investment in forests and rangelands", 2020-2026 IFAD Regional Resilient Pastoral Communities Project (RRPCP), 2022-2026 and IFAD AF Regional Resilient Pastoral Communities Project - Adapt (RRPCP-Adapt), 2022-2026
A6: Rangeland and grazing management: Pasture rehabilitation	Activity 1. (Re)seeding Activity 2. Pasture resting Activity 3. Control of harmful and poisonous vegetation Activity 4. Protection of water sources Activity 5. Measures to retain water in the soil	**State programs:** Program on a pilot project for the development of the dairy industry in the Issyk-Kul region for 2016-2019 with extension 2021-2024 **Projects:** IFAD AF Regional Resilient Pastoral Communities Project - Adapt (RRPCP-Adapt), 2022-2026 FAO GCF project "carbon sequestration through climate investment in forests and rangelands", 2020-2026

Adaptation category	Technical measures	State programs and projects
A6: Rangeland and grazing management: Pasture rehabilitation	Activity 6. Fire prevention measures Activity 7. Gully control measures Activity 8. Control measures against landslides, mudslides and floods Activity 9. Agroforestry	Program on dairy industry in the Issyk-Kul region WFP GCF Climate services and diversification of climate sensitive livelihoods to empower food insecure and vulnerable communities in the Kyrgyz Republic, 2021-2025
A7: Information and communication services: Pasture monitoring and inventories	Activity 1. Pasture inventories Activity 2. Remote sensing of pasture conditions Activity 3. Data standards and bases	**State programs:** (Draft) Program of pasture and livestock breeding development of KR for 2020-2024 Program of green economy of KR 2019-2023 Program of agriculture adaptation to climate change consequences 2016-2020 **Projects:** GIZ Technology based Climate Change Adaptation in rural Areas of Tajikistan and Kyrgyzstan (TCCA-RA), 2019-2022 WFP GCF Climate services and diversification of climate sensitive livelihoods to empower food insecure and vulnerable communities in the Kyrgyz Republic, 2021-2025

Adaptation category	Technical measures	State programs and projects
A8: Crosscutting: Capacity building	Community-based trainings Specialist trainings Institutional strengthening and partnerships Climate-related tools and assessments Extension services Community-based organizations	**State programs:** PROGRAM on a pilot project for the development of the dairy industry in the Issyk-Kul region for 2016-2019 with extension 2021-2024 (Draft) Program for the Development of Pasture and Livestock Breeding in the Kyrgyz Republic for 2020-2024 (Draft) Program for the development of fine-fleece sheep breeding in the Kyrgyz Republic 2021-2025 Program of agriculture adaptation to climate change consequences 2016-2020 **Projects:** IFAD ATMP project, 2020-2025 and IFAD RRPCP World Bank Integrated productivity improvement in the dairy sector, 2017-2021 and 2021-2024 WFP GCF Climate services and diversification of climate sensitive livelihoods to empower food insecure and vulnerable communities in the Kyrgyz Republic, 2021-2025

Adaptation category	Technical measures	State programs and projects
A9: Crosscutting: Enabling environment	Standards and regulations Pasture fees Finance Pasture legislation	**State programs:** Program on dairy industry in the Issyk-Kul region (Draft) Program for Pasture and Livestock Breeding Green economy programme 2019-2023 and action plan **Projects:** IFAD ATMP project, 2020-2025 IFAD Regional Resilient Pastoral Communities Project (RRPCP), 2022-2026 JICA Project for Market Oriented Milk Production in Chuy Province (MOMP), 2017-2022 World Bank Integrated productivity improvement in the dairy sector, 2017-2021 and 2021-2024
A10: Crosscutting: Research and Development	Research programs University courses	**State programs:** PROGRAM on a pilot project for the development of the dairy industry in the Issyk-Kul region for 2016-2019 with extension 2021-2024 **Projects:** IFAD ATMP project, 2020-2025 World Bank Integrated productivity improvement in the dairy sector, 2017-2021 and 2021-2024

6.3 State programmes and development projects reviewed for setting the targets

State programmes

- (Draft) Program for the Development of Pasture and Livestock Breeding in the Kyrgyz Republic for 2020-2024.
- Program on a pilot project for the development of the dairy industry in the Issyk-Kul region for 2016-2019 with extension 2021-2024.
- Green Economy Programme 2019-2023 and action plan.
- (Draft) Program for the development of fine-fleece sheep breeding in the Kyrgyz Republic 2021-2025.
- Program of agriculture adaptation to climate change consequences 2016-2020.

Development projects

FAO GCF	Carbon Sequestration through Climate Investment in Forests and Rangelands in Kyrgyz Republic (CS-FOR)	2020-2026
GIZ	Green Economy and Sustainable Private Sector Development	2021-2023
GIZ	Technology based Climate Change Adaptation in rural Areas of Tajikistan and Kyrgyzstan (TCCA-RA)	2019-2022
IFAD	Access to Markets Project (ATMP)	2018-2023
IFAD	Livestock and Market Development Programme II (LMDP2)	2014-2021
IFAD	Regional Resilient Pastoral Communities Project (RRPCP)	2022-2026
IFAD AF	Regional Resilient Pastoral Communities Project - Adapt (RRPCP-Adapt)	2022-2026
JICA	Project for Market Oriented Milk Production in Chuy Province (MOMP)	2017-2022
World Bank	Integrated productivity improvement in the dairy sector	2017-2021 and 2021-2024
WFP GCF	Climate services and diversification of climate sensitive livelihoods to empower food insecure and vulnerable communities in the Kyrgyz Republic	2021-2025

6.4 Workshops, meetings, discussions conducted during the assessment

#	Data	Topic	Participants
1	21 December 2020	First meeting between GIZ, UNIQUE and CAMP under the project. Identification of next steps. Livestock and pasture sector were identified.	GIZ, CAMP Alatoo, UNIQUE
2	20 January 2021	First meeting between GIZ consultants and IFAD, establishing cooperation and action plan for NDC update. Livestock and Grassland NDC update in Kyrgyzstan.	GIZ, CAMP Alatoo, UNIQUE, IFAD
3	21 January 2021	First call between GIZ, IFAD and UNDP.	
4	27 January 2021	First coordinating technical level meeting between UNDP and GIZ consultants focusing on agriculture sector for NDC update at UNDP office.	International Consultant (UNDP) International consultant (GIZ) Local consultants
5	3 February 2021	IFAD, GIZ and UNDP workshop on remote sensing for NDC Working members and consultants.	
6	9 February 2021	GLEAM-*i* tool discussion, integration of FAO into the workstream.	GIZ, IFAD, UNIQUE, CAMP Alatoo, FAO
7	10 February 2021	NDC Update, IFAD, EO4ESD, ROAM study.	UNIQUE, CAMP Alatoo, IFAD, EO4SD, UNIQUE WB consultants

#	Data	Topic	Participants
8	12 February 2021	Internal planning workshop. Two main goals for this internal workshop: 1. To categorize the long list of livestock and pasture management measures that we have identified and finalize our PESTLE framework (# of criteria); 2. To prepare to the stakeholder consultation workshop planned for February 18/19, 2021 (content, logistics, roles and responsibilities).	GIZ, CAMP Alatoo, UNIQUE IFAD
9	17 February 2021	Coordination call with UNDP.	
10	24 February 2021	The first stakeholder consultations. Prioritization of adaptation measures for the livestock and pasture sub-sectors in Kyrgyzstan for the NDC update contribution.	State institutions Civil society, scientific institutions Private sector International organizations, projects
11	26 February 2021	Discussion on data needs for modelling.	GIZ, IFAD, UNIQUE and CAMP Alatoo
12	1 March 2021	Coordination meeting, coordination of approaches of activities on the updating of NDC of KR to the Paris Agreement Agriculture and Water Sectors.	UNDP meeting on agriculture sector NDC update at MoA
13	2 March 2021	Discussion on data needs for modelling.	GIZ, IFAD, UNIQUE and CAMP Alatoo
14	4 March 2021	UNDP meeting on forestry sector.	
15	10 March 2021	1st resource expert meeting for assessing livestock emissions.	GIZ, CAMP Alatoo, UNIQUE IFAD ARIS, Ministry of Agriculture

#	Data	Topic	Participants
16	11 March 2021	GHG inventory in forest and biodiversity.	SAEPF, CAMP Alatoo, GIZ, UNDP
17	12 March 2021	2nd resource expert meeting for assessing livestock emissions.	GIZ, CAMP Alatoo, UNIQUE IFAD ARIS, Ministry of Agriculture
18	15 March 2021	Discussion of the expert meeting and questionnaire.	GIZ, CAMP Alatoo, UNIQUE
19	23 March, 2021	3rd resource expert meeting for assessing livestock emissions.	GIZ, CAMP Alatoo, UNIQUE IFAD ARIS, Ministry of Agriculture
20	24 March 2021	Discussion on adaptation measures for livestock and pasture sub-sectors in Kyrgyzstan.	Minagro, interministerial working group members, ARIS, JICA, LMDP project staff, WB
21	29 March 2021	The second stakeholder consultations. Validation workshop on the livestock and pasture sub-sectors contribution to NDC of Kyrgyzstan.	State institutions Civil society, scientific institutions Private sector International organizations, projects
22	1 April 2021	Targets discussion with Ministry of agriculture.	
23	2 April 2021	Meeting with livestock experts (NDC).	ARIS, Pasture department, Ministry of Agriculture, Institute of Animal Husbandry

#	Data	Topic	Participants
24	5 April 2021	Discussion on costing data requirements and modeling requirements.	UNIQUE, UNDP, GIZ
25	8 April 2021	Inter-ministerial WG meeting.	Pasture department, Ministry of Agriculture, Institute of Animal Husbandry
26	12 April 2021	Meeting with veterinary specialist (ARIS) Collecting data for GLEAM-*i*.	ARIS
27	14 April 2021	Meeting with SALR on NDC.	Specialists
28	14 April 2021	Meeting with State Agency on land resources on pasture data.	Pasture department, Ministry of Agriculture, Institute of Animal Husbandry
29	16 April 2021	Discussion of maps, data on the state of pastures.	
30	19 April 2021	Joint discussion to finalize livestock and pasture indicators and budgets.	GIZ, CAMP Alatoo, UNIQUE IFAD
31	20 April 2021	Meeting with veterinary specialist (ARIS). Collecting data for GLEAM-*i*.	ARIS
32	20 April	Meeting with Ministry of economy on NDC methodological guide.	Ministry of economy
33	21 April 2022	Meeting with Minagro – discussion on mobilization of funds for NDC measures.	UNIQUE and GIZ
34	23 April 2021	Meeting with veterinary specialist (ARIS). Collecting data for GLEAM-*i*.	ARIS, GIZ, CAMP Alatoo
35	23 April 2021	Meeting with the Vet Inspectorate.	Veterinary specialists, Ministry of Agriculture

#	Data	Topic	Participants
36	26 April 2021	Discussion on GIS and pasture maps.	GIZ, IFAD, EO4SD
37	28 April 2021	Online meeting with Minagro.	GIZ, UNIQUE and CAMP Alatoo
38	29 April 2021	Inter-ministerial working group meeting at Ministry of economy.	
39	7 May 2021	Roundtable "Risk and Vulnerability Assessment to Increase Ambition to Renew the Nationally Determined Contribution of the Kyrgyz Republic (NDC) to the Paris Agreement of the UN Framework Convention on Climate Change".	UNDP, GIZ, and others
40	10 May 2021	Coordination call – Discussion on further activities remaining.	GIZ, CAMP Alatoo, UNIQUE IFAD
41	11 May 2021	Meeting with UNDP, FCDO consultant.	UNIQUE, GIZ
42	12 May 2021	Meeting with deputy minister of agriculture.	GIZ, Minagro
43	12 May 2021	Discussion of the Agriculture Sector.	UNDP, GIZ
44	20 May 2021	Meeting with Ministry of agriculture – technical level.	GIZ, UNDP, IFAD, FAO, Minagro
45	21 May 2021	Workshop "The livestock and pasture sub-sectors contribution to NDC of Kyrgyzstan" for development partners.	Pasture department, Ministry of Agriculture, Institute of Animal Husbandry
46	1 June 2021	EO4SD webinar preps discussion.	GIZ, IFAD, EO4SD
47	2 June 2021	Discussion with Ministry of economy on MRV.	GIZ, UNIQUE

#	Data	Topic	Participants
49	3 June 2021	EO4SD webinar-1 – climate risks and GIS.	GIZ, IFAD, EO4SD, SALR
50	9 June 2021	Training on Kyrgyzstan livestock GHG inventory and mitigation.	GIZ, IFAD, FAO, Ministry of Agriculture, Ministry of economy
51	10 June 2021	EO4SD webinar-2 – pasture degradation monitoring and GIS.	GIZ, IFAD, EO4SD, SALR
52	17 June 2021	EO4SD webinar-3- EO4SD platform.	GIZ, IFAD, EO4SD, SALR

6.5 Methodology for pasture condition maps

6.5.1 Introduction

IFAD requested the Climate Resilience Cluster of the Earth Observation for Sustainable Development (EO4SD) of the European Space Agency to compute pasture condition maps using remote sensing imagery.

The study compared the average pasture conditions of 2000-2004 and 2016-2020. The results show that pasture conditions at the beginning of the century were better than in the last 5 years.

The experts from the GMV company (belonging to the EO4SD cluster) calculated Landsat-based vegetation indices and identified the best composition of indices to represent pasture conditions for a given area. The remote sensing analysis took pasture types and grazing periods into account. Field measurements taken by FAO's Participatory Assessment of Land Degradation and Sustainable Land management in Grassland and Pastoral Systems (PRAGA) were used to assess the effectiveness of the analysis results.

The data products were used to inform NDC update and IFAD operations in Kyrgyzstan. This work would have not been possible through the close collaboration with GIZ, UNIQUE and CAMP Alatoo who have provided valuable inputs.

6.5.2 Methodology

Data inputs

Landsat imagery. The analysis used satellite imagery, atmospherically and radiometrically corrected, from Landsat-5, -7 and -8.

Land cover maps. A land-cover and land-use (LCLU) product at 30 m resolution, developed by FAO in 2019 for Kyrgyzstan, was used to identify grassland areas. This product was used to compute a land cover product for each period by classifying Landsat images with an artificial intelligence-based model. This was done because current global land cover products are not detailed enough (i.e., pixel spacing is greater than 30 m) or do not cover the 2000-2005 period. This approach captures pasture areas converted into cropland, bare soils or settlements and classifies them as degraded rangelands in the change map.

Pasture types and grazing periods. Grazing practices in Kyrgyzstan differ from oblast, district or PUU. The Camp Alatoo Public Foundation provided information on grazing periods, seasonal-based altitudinal ranges and maximum distance of pastures to villages for each administrative area *(see Table 1)*. Surface altitude was used to select the grassland areas used for grazing in every season.

Elevation model. The elevation is obtained from the Shuttle Radar Terrain Mission Digital Elevation Model (STRM-DEM) at 30 m.

Field measurements. For model training purposes, results from FAO's Participatory Assessment of Land Degradation and Sustainable Land management in Grassland and Pastoral Systems (PRAGA) project on the pastures state for different locations were used.

Table 13. Grazing periods and pasture types

Oblast	District	AA	Grazing periods				Pasture types (altitudes)			Buffer size*
			Winter	Spring	Autumn	Summer	Winter	Spring/ autumn	Summer	
Jalalabad	Aksy	Jergetal	11 Nov - 31 Mar	1 Apr - 20 May	1 Sep - 10 Nov	20 May - 1 Sep	900-1000	1300-1500	1400-2200	500 m
		Kerben	11 Nov - 31 Mar	1 Apr - 20 May	1 Sep - 10 Nov	20 May - 1 Sep	1300	1500-1800	1700-3200	500 m
	Toguz-Toro	Atay	16 Nov - 31 Mar	1 Apr - 31 May	1 Sep - 15 Nov	1 Jun - 31 Aug	1500-1800	1500-1900	1900-3100	200 m
Osh	Aravan	Too-Moun	1 Dec - 31 Mar	1 Apr - 30 May	1 Oct - 30 Nov	1 Jun - 1 Oct	600-700	700-1600	1160-3000	200 m
		Chek-Abad	1 Dec - 19 Mar	20 Mar - 30 May	1 Oct - 30 Nov	1 Jun - 1 Oct	700	700-1200	2200-2400	700 m
		Usupov	1 Dec - 19 Mar	20 Mar - 30 May	1 Oct - 30 Nov	1 Jun - 1 Oct	700-800	800-1000	2100-2600	200 m
	Kara-Kulja	Kara-Guz	1 Nov - 31 Mar	1 Apr - 30 May	1 Sep - 1 Nov	1 Jun - 1 Sep	1260-1900	1260-2300	1800-2800	100 m
		Kara-Kochkor	1 Nov - 31 Mar	1 Apr - 30 May	1 Sep - 1 Nov	1 Jun - 1 Sep	1300-2000	1300-2300	2300-2500	200 m
		Kara-Kulja	1 Nov - 31 Mar	1 Apr - 30 May	1 Sep - 1 Nov	1 Jun - 1 Sep	1200-2100	1200-2500	2500-3500	100 m

Oblast	District	AA	Grazing periods				Pasture types (altitudes)			Buffer size*
			Winter	Spring	Autumn	Summer	Winter	Spring/ autumn	Summer	
Osh	Nookat	Kara-Tash	1 Dec - 31 Mar	1 Apr - 30 May	1 Oct - 30 Nov	1 Jun - 1 Oct	1000-1300	1200-1300	1600-3000	100 m
		Toolos	1 Dec - 31 Mar	1 Apr - 30 May	1 Oct - 30 Nov	1 Jun - 1 Oct	1000	1000-2000	3000	100 m
Batken	Batken	Kara-Bak	Nov - Mar	Sep - Oct	Apr - May	Jun - Aug	850-1200	850-1200	2700-3800	100 m
		Suu-Bashy	Nov - Mar	Sep - Oct	Apr - May	Jun - Aug	1200-1600	1200-1600	1800-2000	100 m
	Leilek	Beshkent	Nov - Mar	Sep - Oct	Apr - May	Jun - Aug	650-1100	650-1100	650-1100	100 m
		Katran	21 Nov - 9 Apr	10 Apr - 10 Jun	21 Aug - 20 Nov	11 Jun - 20 Aug	1200-2000	1200-2000	1200-2000	100 m
Naryn			1 Dec - 1 Feb	1 Apr - 31 May	1 Sep - 31 Nov	1 Jun - 31 Aug	2000-2500	1800-2500	2500-3300	500 m
Issyk-Kul			Dec - Apr	May - Jun	Oct - Nov	Jun - Sep	1800-2200	1800-2500	2400-3300	500-1000 m
Chui			Dec - Mar	Apr - Jun	Oct - Nov	Jun - Sep	1000-1500	1000-2000	2000-3000	500-1000 m
Talas			Dec - Apr	May - Jun	Oct - Nov	Jun - Sep	1500-2000	1500-2200	2000-300	500-1000 m

***of winter pastures around villages**

6.5.3 Processing steps

1. Ensuring radiometric consistency

As spectral bands of the imagery from different sensors have distinct bandwidths, the first step was to adjust reflectances radiometrically in order to ensure time series consistency. Radiometrically stable targets, e.g. bare soil, were selected and used as reference for the inter-calibration exercise.

2. Calculation of Landsat-based vegetation indices

The spectral indices from *Table 1* were calculated for each grazing season period in both five-year timeframes. These indices are used as proxy to assess the grassland changes over time. However, it is the maximum value for each index of 15-days averages over the grazing periods the metric used for analyzing condition changes of the grasslands in the two periods.

Table 14. Indices considered for estimation of the changes in rangelands condition

Index	Formula*	Reference
NDVI (Normalized Difference Vegetation Index)	$\frac{NIR-RED}{NIR+RED}$	(Rouse Jr et al. 1974)
EVI (Enhanced Vegetation Index)	$G\times\frac{NIR-RED}{NIR+C1\times RED-C2\times BLUE+L1}$	(Liu and Huete 1995)
SAVI (Soil Adjusted Vegetation Index)	$\frac{NIR-RED}{NIR+RED+L2}\times 1+L2$	(Huete 1988)
MSAVI (Modified Soil Adjusted Vegetation Index)	$\frac{2\times NIR+1-\sqrt{(2\times NIR+1)^2-8\times(NIR-RED)}}{NIR+RED+L2}$	(Qi et al. 1994)
NDMI (Normalized Difference Moisture Index)	$\frac{NIR-SWIR_1}{NIR+SWIR_1}$	(Gao 1996)
NBR (Normalized Burn Ratio)	$\frac{NIR-SWIR_2}{NIR+SWIR_2}$	(López-García and Caselles 1991)
NBR2 (Normalized Burn Ratio 2)	$\frac{SWIR_1-SWIR_2}{SWIR_1+SWIR_2}$	(Key and Benson 2004)
VCI (Vegetation Condition Index)	$\frac{NDVI_i-NDVI_{min}}{NDVI_{max}-NDVI_{min}}$	(Kogan 1990)

Index	Formula*	Reference
VHI (Vegetation Health Index)	$\frac{VCI+TCI}{2}$	(Kogan 1995)

*RED, NIR, BLUE, SWIR1 and SWIR2 correspond to bands 3, 4, 1, 5 and 7 as well as 4, 5, 2, 6 and 7 for Landsat-5 -7 and Landsat-8, respectively. When computing the EVI and SAVI G is 2.5, C1 is 6, C2 is 7.5, L1 is 1 and L2 is 0.2, respectively. Regarding the VCI, i refers to a specific date of a considered temporal period. Finally, TCI is the Thermal Condition Index, expressed as $(LST_i\text{-}LST_{min})/(LST_{max}\text{-}LST_{min})$, where LST is the Landsat-based Land Surface Temperature.

3. Auto-correlation analysis of the indexes

We analyzed not only the auto-correlation of the indices but also the significance of each of them for monitoring the state of the rangelands. These two analyses are independently performed for every grazing seasonal area. Indices with observed similarity greater than 75 % are discarded. Regarding the significance, a random forest feature importance calculation was performed. The local measurements of pastures condition from PRAGA project were used to estimate how effective each index is for estimating condition changes.

4. Weighted composite of indexes

The non-correlated rangelands changes products were weighted by the importance of each index and combined applying a weighted sum model (Eq. 1). This approach is widely used in geospatial applications (Belenguer-Plomer 2016; Rahman and Saha 2008). Additionally, a level of confidence product was also derived considering the weighted differences of each index-based product with respect to the combined result.

5. Rangeland condition changes

The changes observed in the two periods by the different indexes were combined to estimate the rangeland condition changes.

$$\textit{Rangeland condition changes}_i = \sum\nolimits^{n}_{j=1} w_j c_{ji} \quad (1)$$

where ***i*** is a single geospatial observed unit (i.e., an image pixel), ***n*** is the number of considered indices, ***w*** is the weight of the index ***j*** and c is the qualitative class of the rangeland condition change of the index ***j***.

The rangeland condition changes were reported as degradation levels following the IPCC's guidelines of grasslands degradation *(Table 2).*

Table 15. Classes of rangeland condition changes from IPCC's guidelines

Qualitative classes	Index variation of post-period with respect to pre-period
Severely degraded	<70 %
Moderately degraded	70.1-95 %
Non-variation	95.1-105 %
Enhancement	>105 %

6. Masking pasture areas

The final step was to define the target areas where the rangelands condition changes are applicable. These include areas identified as grasslands in the LULC map, with non-steep slopes (i.e., below 45°C) and close to villages for winter results.

For GHG modelling purposes, the areas where the coefficient of variation of annual precipitation exceeds the 33 % were discarded because GHG emission/absorption models cannot provide realistic results for higher values.

7. Results

Summary statistics and maps

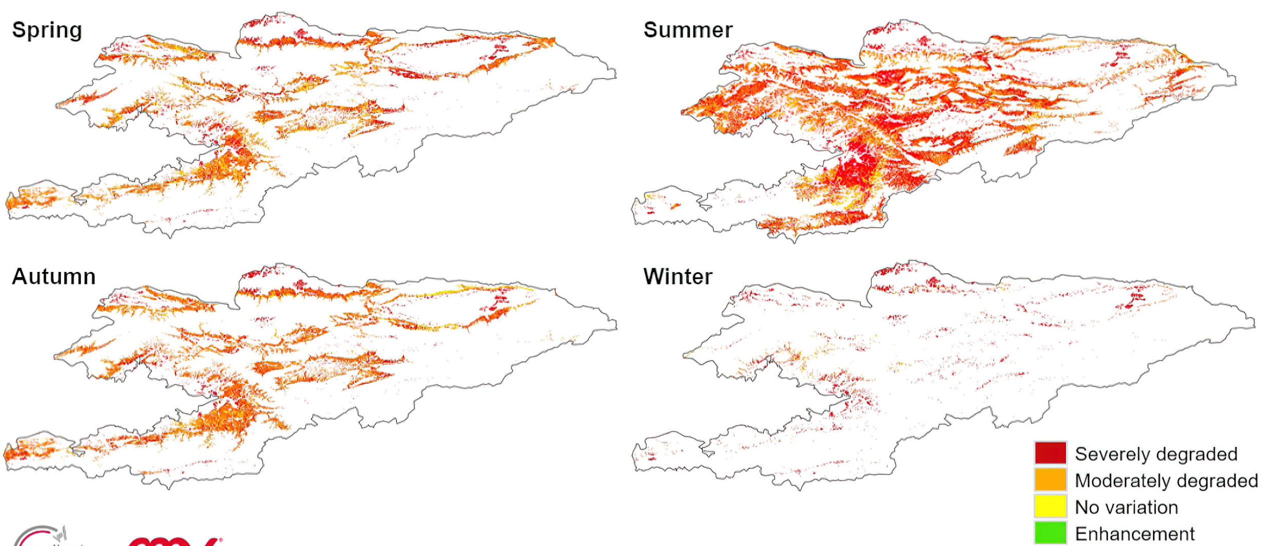
Table 5 and *Figure 1* summarize the results and present the levels of degradation in Kyrgyzstan.

Table 16. Hectares (ha) and percentage of each rangeland condition change class per season

Percentage is given with respect to the total of grazing areas.

	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	2571	0.1

Figure 10. Seasonal maps of rangeland condition changes

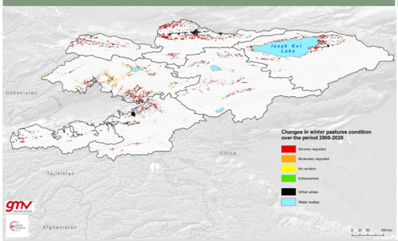
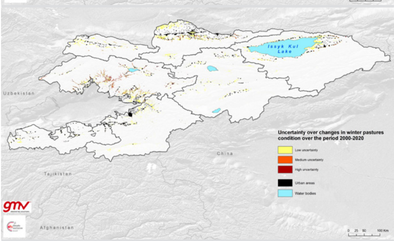
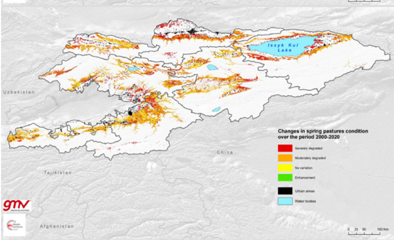
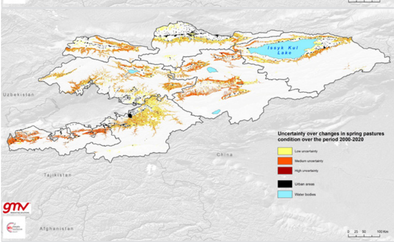
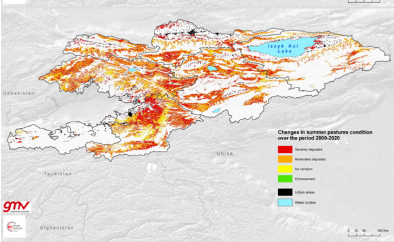
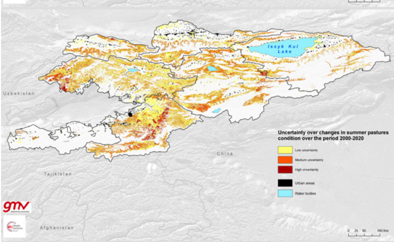


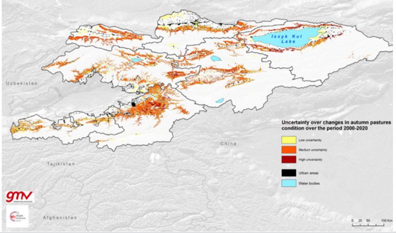
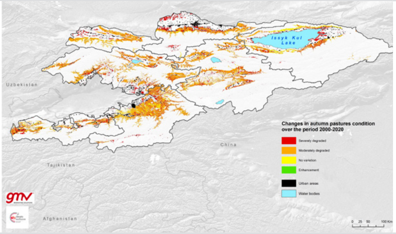
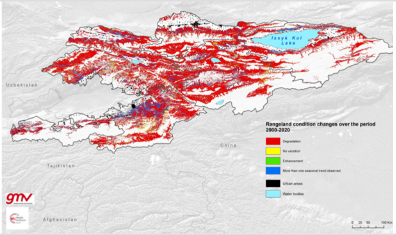
Source: *Climate Resilience Cluster of the Earth Observation for Sustainable Development (EO4SD) of the European Space Agency.*

6.5.4 Mapping products

The following products have been developed and can be downloaded here: https://gmvdrive.gmv.com/index.php/s/aYyrbKzJrNXAMBb.

Table 17. List of products

Thumbnail	Product name	Description
	Degradation_winter.tif	Winter's rangeland condition changes
	Uncertainty_winter.tif	Winter's rangeland condition changes uncertainty
	Degradation_spring.tif	Spring's rangeland condition changes
	Uncertainty_spring.tif	Spring's rangeland condition changes uncertainty
	Degradation_summer.tif	Summer's rangeland condition changes
	Uncertainty_summer.tif	Summer's rangeland condition changes uncertainty

Thumbnail	Product name	Description
	Degradation_autumn.tif	Autumn's rangeland condition changes
	Uncertainty_autumn.tif	Autumn's rangeland condition changes uncertainty
	Pasturelands_status.tif	Rangeland condition changes in all seasons

6.5.5 Discussion

The following table summarizes the strengths and weaknesses of the methodology.

Table 18. Strengths and weaknesses of the proposed methodology

Strengths	Weaknesses
• Adaptability to specific regional-based grazing patterns • Low-cost production when compared to field campaigns • Replicability for some other time periods or regions	• Precise local information is required. The method is non-applicable to other re-gions with no grazing information availa-ble. • Unbalanced availability of satellite data depending on the period. The more re-cent, the more data available. • Local measurements on rangeland status are required to calculate the weights in the index composite.

Field validation of the results is still an issue. The achieved results might be improved with field-measured data on the rangelands conditions or preferably, the degradation observed during the timeframe assessed. For the weighting factors, having rangeland information of a wide range of seasons, regions and altitudes will enhance the results as PRAGA project focused in very specific regions in Kyrgyzstan.

Further information

Find here a presentation and webinar recording on how the pasture conditions maps were calculated: http://eo4sd-climate.gmv.com/content/capacity-building-kyrgyzstan.

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6.6 Data parameters and assumptions

Table 19. Herd parameters and assumptions

Project targets shown in red. Baseline obtained through stakeholder consultations and expert opinions. Figures where there is no source provided are expert opinions.

Parameters	Unit	Description & rationale	Cattle	Sheep	Goats
Age at first calving[10]	months	Average age at which adult females have their first parturition, either it is a successful one or not	29 25	23 20	23 19
Death rate of adult animals[11]	%	Annual average percentage of non-intended deaths of animals (males and females) after reaching maturity	6 4.8	7 5.6	7 5.6
Death rate of young females[12]	%	Annual average percentage of non-intended deaths of female animals before reaching maturity	8 6.4	9 7.2	9 7.2
Death rate of young males[13]	%	Annual average percentage of non-intended deaths of male animals before reaching maturity	8 6.4	9 7.2	9 7.2
Fertility rate of adult females	%	% of calving adult females over the total amount of adult females. This includes born calves that die before reaching maturity	80 82.4	80 unchanged	90 unchanged

10 Stakeholder consultations, expert opinions, personal communication with (national) experts (Almaz Dunganov, Zholdoshbek Dadybaev, David Ward).

11 This assumes a 20 % reduction in mortality rates due to vaccination campaign and improved veterinary services. Source: Demir et al. (2017).

12 This assumes a 20 % reduction in mortality rates due to vaccination campaign and improved veterinary services. Source: Demir et al. (2017).

13 This assumes a 20 % reduction in mortality rates due to vaccination campaign and improved veterinary services. Source: Demir et al. (2017).

Parameters	Unit	Description & rationale	Cattle	Sheep	Goats
Litter size[14]	number	Average number of lambs or kids born in each parturition, including the ones that die before reaching maturity	-	1.2 1.5	1.1 1.4
Live weight of adult females[15]	kg	Average live weight of adult females once they reach maturity	370 444	55 unchanged	45 unchanged
Live weight of adult males[16]	kg	Average live weight of adult males once they reach maturity	520[17] 624	85 unchanged	60 unchanged
Live weight of meat females at slaughter[18]	kg	Average live weight at slaughter of adult females culled for meat	400 480	55 unchanged	50 unchanged
Live weight of meat males at slaughter[19]	kg	Average live weight at slaughter of adult males culled for meat	470 564	75 unchanged	60 unchanged

14 The change in litter size assumes that breeding and feeding increase twinning rates. Source: pers. comm. (David Ward).

15 Live weight of cattle is assumed to increase by 20 %. Source: IFAD RRPCP design report (2019). However, The live weights of sheep and goats are not expected to grow in WP because there is no breeding program targeting this specie. Source: pers. comm. (Almaz Dunganov).

16 Live weight of cattle is assumed to increase by 20 %. Source: IFAD RRPCP design report (2019). However, The live weights of sheep and goats are not expected to grow in WP because there is no breeding program targeting this specie. Source: pers. comm. (Almaz Dunganov).

17 Stakeholder consultations, expert opinions, personal communication with (national) experts (Almaz Dunganov, Zholdoshbek Dadybaev, David Ward).

18 Live weight of cattle is assumed to increase by 20 %. Source: IFAD RRPCP design report (2019). However, The live weights of sheep and goats are not expected to grow in WP because there is no breeding program targeting this specie. Source: pers. comm. (Almaz Dunganov).

19 Live weight of cattle is assumed to increase by 20 %. Source: IFAD RRPCP design report (2019). However, The live weights of sheep and goats are not expected to grow in WP because there is no breeding program targeting this specie. Source: pers. comm. (Almaz Dunganov).

Parameters	Unit	Description & rationale	Cattle	Sheep	Goats
Milk fat[20]	%	Average milk total fat content	3.4 3.6	-	-
Milk protein	%	Average milk total protein content	3.5 unchanged	-	-
Milk yield[21]	kg/year	Annual average milk yield per milking cow	2000 2400	-	-
Number of adult reproductive females	heads	Number of adult females in the project. The total number of animals in the project is output from the model	231000[22] unchanged	1422200[23] unchanged	327000[24] unchanged
Number of adult reproductive males	heads	Number of adult males in the project. The total number of animals in the project is output from the model	9240[25] 1848[26]	56888[27] unchanged	13080[28] unchanged

20 This reflects that the HH farmers improve feeding of cows by adding high quality fodder and concentrates Source: pers. comm. (Almaz Dunganov).

21 This assumes a 20 % increase in milk yields. Source: IFAD RRPCP design report (2019).

22 See 6.7 for calculating the number of adult reproductive females. In WOP, this figure is 255500 in 2025 and 296800 in 2030.

23 See 6.7 for calculating the number of adult reproductive females. In WOP, this figure is 1588100 in 2025 and 1865000 in 2030.

24 See 6.7 for calculating the number of adult reproductive females. In WOP, this figure is 365500 in 2025 and 429000 in 2030.

25 Number of adult males is based on male to female ratio of 1:25. In WOP, it is 10220 in 2025 and 11872 in 2030.

26 This assumes an 80 % reduction in the number of adult males due to breeding.

27 Number of adult males is based on male to female ratio of 1:25. In WOP, it is 63524 in 2025 and 74600 in 2030.

28 Number of adult males is based on male to female ratio of 1:25. In WOP, it is 14620 in 2025 and 17160 in 2030.

Parameters	Unit	Description & rationale	Cattle	Sheep	Goats
Parturition interval[29]	days	Average interval between two parturitions	-	365 unchanged	365 unchanged
Replacement rate of adult females[30]	%	Annual average rate of reproductive adult female replacement	15 12	15 12	15 12
Weight at birth[31]	kg	Average live weight of offspring at birth	40 44	5 unchanged	3 unchanged

29 Stakeholder consultations, expert opinions, personal communication with (national) experts (Almaz Dunganov, David Ward).

30 This assumes a 20 % reduction in female replacements due to better herd dynamics. Source: expert opinion.

31 Live weight of cattle is assumed to increase by 20 %. Source: IFAD RRPCP design report (2019). However, The live weights of sheep and goats are not expected to grow in WP because there is no breeding program targeting this specie. Source: pers. comm. (Almaz Dunganov).

Table 20. Feed parameters and assumptions

Project targets shown in red. Baseline obtained through stakeholder consultations and expert opinions. Values are % share of each feed ingredient of the total dry matter fed on average per year. Total equals 100.

Feed ingredient	Description	Cattle	Sheep	Goats
By-products from sugar beet	Also known as "beet pulp", is the remaining material after the juice extraction for sugar production from the sugar beet (Beta vulgaris)	0 5	0 5	0 5
Crop residues from maize	Fibrous residual plant material such as straw, brans, leaves, etc. from maize (Zea mays) cultivation	0 5	0 5	0 5
Crop residues from other grains	Fibrous residual plant material such as straw, brans, leaves, etc. from barley (Hordeum vulgare), rye (Secale cereale) or oat (Avena sativa) cultivation	10 0	10 0	10 0
Crop residues from wheat	Fibrous residual plant material such as straw, brans, leaves, etc. from wheat (Triticum spp.) cultivation	10 4	3 0	3 0
Fresh grass	Any type of natural or cultivated fresh grass grazed or fed to the animals	40 36	60 54	60 54
Fresh mixture of grass and legumes	Fresh mixture of any type of grass and leguminous plants that is fed to the animals	10 10	7 7	7 7
Grains	Grains from barley (Hordeum vulgare), oat (Avena sativa), buckwheat (Fagopyrum esculentum) and fonio (Digitaria spp.)	0 5	0 0	0 0
Hay or silage from alfalfa	Hay or silage from alfalfa (Medicago sativa)	10 8	10 10	10 10

Feed ingredient	Description	Cattle	Sheep	Goats
Hay or silage from grass and legumes	Hay or silage produced from a mixture of any type of grass and leguminous plants	10 7	10 5	10 5
Molasses	By-product from the sugarcane sugar extraction	0 2	0 0	0 0
Silage from whole grain plants	Silage from whole barley (Hordeum vulgare), oat (Avena sativa), buckwheat (Fagopyrum esculentum) and fonio (Digitaria spp.) plants	10 4	0 0	0 0
Silage from whole maize plant	Silage from whole maize (Zea mays) plant	0 14	0 14	0 14

6.7 Calculation of animal numbers in baseline and scenarios

			Projected[32]	
Item	**Baseline (2022)**	**Reference**	**2025**	**2030**
CATTLE				
Number of cattle in the country	1,883,105	2022 projection by UNIQUE (National stats in 2019: 1680750)	2,085,461	2,422,720
Number of cattle in household systems (50 % of total)	941,553	World Bank (2007)	1,042,731	1,211,360
% of population covered in the project	70 %	RRPCP design report (IFAD, 2019)		
Number of cattle in the project	659,087	70 % of 941553	729,911	847,952
Number of adult females in the project	231,000	GLEAM-*i* calculations	255,500	296,800
Bull to cow ratio	1:25	Stakeholder consultations		
Number of adult males in the project	9,240	0.04 x 231000	10,220	11,872
Number of adult males in the project WP (80 % reduction)	-	Expert opinions	1,848	
Number of cattle (herd) in the project (GLEAM-*i* output)	659,700	GLEAM-*i* calculations	729,668	847,615

32 UNIQUE calculations based on projected GDP agriculture

Item	Baseline (2022)	Reference	Projected 2025	Projected 2030
SHEEP & GOATS				
Number of sheep and goats in the country	7,095,429	2022 projection by UNIQUE (National stats in 2019: 6266739)	7,924,119	9,305,269
Number of sheep in the country (4/5 of total figure)	5,676,343	Calculated from FAOSTAT 2014 figures	6,339,295	7,444,215
% of population covered in the project	70 %	RRPCP design report (IFAD, 2019)		
Number of sheep in the project	3,973,440	70 % of 5676343	4,437,507	5,210,951
Number of adult females in the project	1,422,200	GLEAM-*i* calculations	1,588,100	1,865,000
Male to female ratio	1:25	Stakeholder consultations		
Number of adult males in the project	56,888	0.04 x 1422200	63,524	74,600
Number of sheep (herd) in the project (GLEAM-*i* output)	3,973,567	GLEAM-*i* calculations	4,437,082	5,210,729
Number of goats in the country (1/5 of total figure)	1,419,086	Calculated from FAOSTAT 2014 figures	1,584,824	1,861,054
Number of goats in the project	993,360	70 % of 1419086	1,109,377	1,302,738
Number of adult females in the project	327,000	GLEAM-*i* calculations	365,500	429,000
Male to female ratio	1:25	Stakeholder consultations		

Item	Baseline (2022)	Reference	Projected 2025	2030
SHEEP & GOATS				
Number of adult males in the project	13,080	0.04 x 327000	14,620	17,160
Number of goats (herd) in the project (GLEAM-*i* output)	993,014	GLEAM-*i* calculations	1,109,929	1,302,762

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