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Provision of technical assistance for enhancing climate-resilience and economic sustainability of livestock farming in a rural community in Mongolia

Deliverable 3.2

Report on selection of the most appropriate rangeland and livestock management practices and associated technologies for climate-resilient livestock farming in Bayantümen *soum*

Submitted to:
The United Nations

alinea

About the project

The project will strengthen climate-resilient livestock farming while deriving the economic sustainability for vulnerable herding communities in Bayantümen *soum* and contributing to the Nationally Determined Contributions (NDC) and national climate change adaptation and mitigation priorities for Mongolia. Alinea implements this project with the Alberta Biodiversity Monitoring Institute (ABMI) and the R&D Center for Climate Change and Sustainable Development (CCSD) in Mongolia (www.climatechange.mn).

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Acronyms and Abbreviations

ESD	Ecological Site Description
ESG	Ecological Site Group
FAO	Food and Agriculture Organization
GHG	Greenhouse Gas
MCA	Multi-Criteria Analysis
NAMEM	National Agency for Meteorology and Environmental Monitoring
NAPCC	National Action Program on Climate Change
NCGE	National Committee on Gender Equality
PESTLE	Political, Economic, Social, Technological, Legal, and Environmental
SDC	Swiss Agency for Development and Corporation
SDG	Sustainable Development Goals
STM	State and Transition Models
SU	Sheep Unit
UNDP	United Nations Development Program

Executive Summary

A perfect "climate change storm" is confronting Mongolia's vast rangelands and the livestock industry dependent on the rangelands. From 1940 to 2015, annual mean temperatures have increased by 2.24 C, more than double the global average, while annual precipitation decreased by 7 percent. Ten of the warmest years on record have occurred since 1997, while rainfall has decreased and seasonal weather patterns have shifted. This has exacerbated rangeland degradation, a trend that projections show will intensify in the first half of the 21st century. Twelve percent of rivers and 21 percent of lakes have dried up. Increasing numbers of livestock put additional stress on the land.

Mongolia's livestock sector has seen significant growth in recent decades, but this has mainly been driven by the large increase in livestock numbers. There has been limited improvement in the quality of livestock or livestock products, especially meat. The growth in livestock numbers has been driven by the desire to increase herder household income and was encouraged by subsidies that mainly benefitted large livestock and crop producers. The growth in livestock numbers has also resulted in negative environmental consequences, as it has led to increasing rangeland degradation and rising Greenhouse Gas (GHG) emissions, particularly methane. Over the past ten years, the livestock population in Mongolia has more than doubled from 33.1 million in 2010 to 71.8 million in 2019. Overstocking and overgrazing, along with climate change, have resulted in considerable rangeland degradation. Sixty-five percent of Mongolia's rangeland are degraded to some degree and 7 percent are beyond recovery.[1]

Rangeland degradation has decreased forage yields by 30 percent, from 284 kg/ha in 2011 to 198 kg/ha in 2020.[2] With reduced forage, nutritional status and productivity of livestock have declined. During 1990-2016, the carcass weight of sheep decreased by 13.9 percent, while live cattle weight decreased by 30 kg during 2004-2014. Livestock in poor nutrition and health are more vulnerable to diseases and extreme weather events. The lack of resilience to climate hazards (droughts, *dzuds*, etc.), lack of access to extension services and high-quality inputs (e.g., crop seed/animal breeds with better yields, and resistance to abiotic stress and droughts) remain major constraints. The livestock sector is further constrained by: poor livestock management practices, leading to rangeland degradation; poor animal health and hygiene; outdated slaughtering and meat processing technologies; weak food safety systems; and inefficient cross-border logistics and customs inspections. Lack of access to finance by herders and private sector further inhibits investments to modernize and adopt green technologies for livestock production. As a result, the competitiveness of livestock products, both locally and for exports has declined.

Mongolia's overall development vision, strategy and agricultural and livestock actions plans are aligned with the agricultural challenges and objectives and emphasize the importance of balanced growth and productivity, sustainability and resilience. However, current policy instruments in the agriculture and livestock sectors are not fully aligned to achieve the Government's vision and strategy. Producer subsidies are market distortive and result in negative externalities, worsening rather than improving climate and sustainability outcomes. Subsidies have not been effective in creating incentives to improve productivity

[1] https://ieg.worldbankgroup.org/blog/preserving-rangelands-people-and-climate-lessons-mongolia
[2] World Bank. 2022. Green Transformation of Mongolian Agrifood Systems.

and competitiveness and in the livestock subsector, had the counter effect of incentivizing a huge increase in the number of poor-quality animals. Lack of extension services has further limited capacity of herders to adopt improved production and range management technologies. Despite a knowledge base about the proper management of rangelands, local governments and herders lack the incentive and capacity to adopt more sustainable and climate-resilient practices.[3]

The National Agency for Meteorology and Environmental Monitoring (NAMEM) estimates the winter and spring carrying capacity of Mongolia's rangeland based on annual rainfall, rangeland productivity and the number of livestock and this year determined that annual precipitation was below the ten-year average in 40 percent of the country. Only 40 percent of the rangelands have sufficient carrying capacity for livestock in the coming winter and spring. In 34.4 percent of the country's rangeland, the number of livestock is 1-3 times higher than the carrying capacity. In 7.7 percent of the rangelands, it is 3-5 times higher than carrying capacity and in 18.4 percent of the rangelands the number of livestock exceed the carrying capacity multiple times.[4] This illustrates the dire situation of not enough forage for the number of livestock facing much of the country this coming winter and spring.

The steppes of Eastern Mongolia, which includes Dornod *aimag* and Bayantumen *soum* have long been praised for excellent pastures, fast horses and vast herds of Mongolian gazelle migrating across the grasslands. Like the rest of Mongolia, however, this eastern region of Mongolia has also seen large increases in livestock numbers in recent years with increasing signs of overgrazing. In Bayantumen *soum*, total livestock numbers increased from 158,980 in 2017 to 249,590 in 2021; a 56.9 percent increase in livestock in four years. The number of herder households increased from 470 in 2015 to 757 in 2020; a 61 percent increase in five years. Most of this increase was herders coming into Bayantumen from Central and Western Mongolia. This year, Bayantumen has experienced average and above average rainfall and there has been good grass growth in the rangelands. Because of the lack of rainfall in much of the Central and Western regions there will probably be even more increase in livestock numbers coming into Bayantumen this fall and winter to graze.

Much of the rangeland in Bayantumen *soum*, especially the areas used for winter-spring pastures, are still in good condition. There is considerable potential to create more climate-resilient, sustainable livestock farming systems in Bayantumen *soum*. There are, however, a number of challenges impeding this goal. Increasing livestock numbers raised are now placing increasing grazing pressure on the rangeland, especially in riparian areas (along rivers and streams) which are mainly used as summer pasture. In recent years, there has been an influx of herders from Central and Western Mongolia who have heard of the good pastures in Dornod and have moved in with their livestock, placing additional stress on rangeland resources. There has also been a significant increase in the numbers of horses, often owned by rich, absentee owners who value large herds of racehorses. The number of horses has grown by 53 percent in the four years from 2017 to 2021. In Bayantumen *soum*, horses only make up 15.3 percent of the total livestock numbers (sheep comprise 43.13 percent, goats 29.03 percent and cattle 12.12 percent) but when converted to livestock to Sheep Units (SUs), horses comprise 44.72 percent of the SUs on the land. In other words, almost

[3] World Bank. 2022. Green Transformation of Mongolian Agrifood Systems.
[4] FAO. 2022. Food Security Update Mongolia. 15 September 2022.

half of the total SU equivalents – and related grazing pressure - on the rangeland is from horses. This trend of growing livestock numbers is likely to continue which raises concerns about the sustainability of current pasture and livestock management practices.

There is considerable scientific information available about the ecology of the rangelands in Bayantumen *soum* in terms of vegetation types, Ecological Site Groups and the state of health of the rangelands, forage yield, recommended stocking rates, maps of seasonal pastures and rangeland monitoring. However, little of this information is currently made use of by herders or by local officials in the planning of rangeland and livestock development. Technical advice and extension material that is available is often not provided to herders in a practical, appropriate form for them to readily use.

Growing market demand for quality livestock products from Bayantumen *soum* grasslands in local markets, in Ulaanbaatar and for export offers considerable potential for local economic development and improved livelihoods of herders but is hampered by the ineffective control of livestock diseases. Promoting more climate-resilient, sustainable livestock farming systems will require greater integration between the crop and livestock sectors, especially the growing of forage for winter feed and fattening/finishing of cattle and sheep for meat.

Climate resilient livestock farming systems in Mongolia are influenced by a variety of ecosystem properties that fall into two broad categories, 1) abiotic and 2) biotic[5]. Although important to consider in planning range and livestock management and development, abiotic processes cannot be directly influenced with management. In contrast, biotic properties of the rangeland ecosystem can be influenced by management. The key to robust biotic resilience in rangelands and livestock farming systems will be about maintaining and promoting healthy rangelands.[6] Sustainable production of livestock and livestock products from the rangelands of Bayantumen *soum* can be socially responsible, environmentally sound and economically viable. This requires awareness of the complex relationships among the three pillars of society/culture, environment and economics. It also requires tackling difficult market and policy issues that hamper the growth of sustainable, climate-resilient livestock farming systems.

A number of rangeland and livestock management practices and technologies have been identified to promote more sustainable, climate-resilient livestock farming systems in Bayantumen *soum*. There are no easy solutions and any efforts need to take a holistic, integrated approach to tackling the issues. Reducing livestock numbers is going to be critical and to do this, restructuring of cattle herds and sheep flocks should be prioritized. Monitoring of rangelands and rangeland planning using the State and Transition Models already developed for Mongolian rangelands will be a key activity in order to start to balance livestock numbers with carrying capacities of the rangeland. Training of local officials and herders and provision of practical, extension material and advice to support herders in the transformation they need to make to more climate-resilient livestock farming systems will also be essential.

[5] Description. Biotic and abiotic factors are what make up ecosystems. Biotic factors are living things within an ecosystem; such as plants, animals, and bacteria, while abiotic are non-living components; such as water, soil and atmosphere.
[6] Concept adapted from: D. Johnson, et.al. 2022. Ratcheting up resilience in the northern Great Basin, Rangelands 44(3): 200-209.

1 Introduction

From August 19 to September 5, 2022, a trip was made to Mongolia to select the most appropriate rangeland management and livestock production practices and associated technologies to promote climate-resilient livestock farming Bayantumen *soum* of Dornod *aimag*. Meetings were held in Ulaanbaatar and a field trip to Bayantumen *soum* was undertaken on August 28-31 to hold discussions with officials in the Dornod *aimag* and in Bayantumen *soum* and with key stakeholders. Discussions were also held with officials in Ulaanbaatar after the field trip. The field visits and discussions enabled the Consultant Team to develop a better understanding of current rangeland and livestock management practices, market conditions, government policies and the opportunities to promote more sustainable, climate-resilient livestock farming systems.

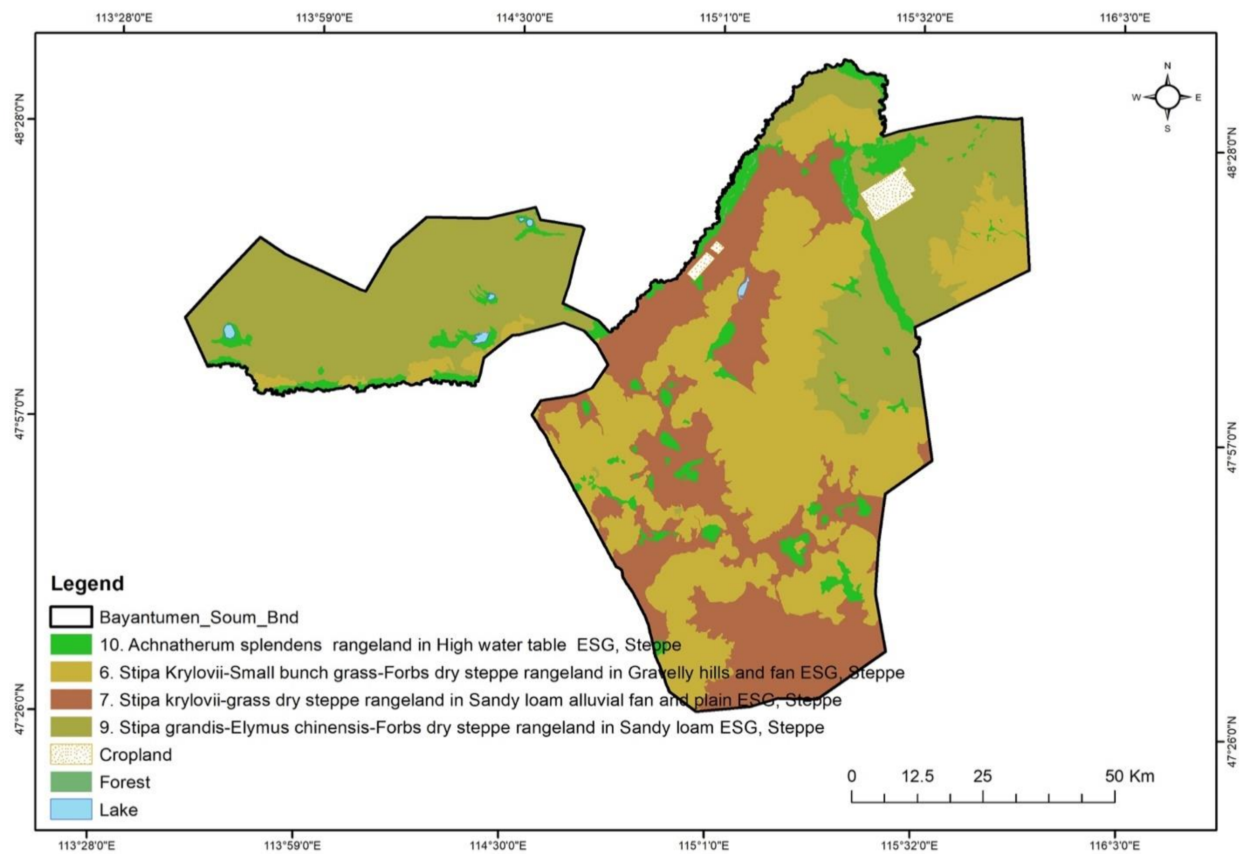
This report provides: 1) an Executive Summary of findings; 2) data on rangelands and livestock in Bayantumen soum; 3) information on carrying capacities of rangelands by Ecological Site Groups; 4) life cycle analysis for cattle and sheep; 5) information on restructured cattle herds and sheep flocks ("with and without project" scenarios); 6) Multi-Criteria Analysis used in identifying activities and technologies to promote more sustainable, climate-resilient livestock farming system; 7) list of recommended rangeland and livestock management practices and technologies and associated costs, impacts and prioritization of implementation; 8) Greenhouse Gas Emission calculations; and 9) gender considerations of livestock farming in Bayantumen soum.

2 Rangelands in Bayantumen *Soum*

2.1 Ecological Site Groups

The rangelands of Bayantumen soum in Dornod aimag are located within one of the largest remaining rangeland ecosystems in the world – the Eastern Steppes of Mongolia. In Bayantumen soum, the rangelands consist of four primary Ecological Site Groups (ESGs) all in the Steppe Zone: 1) *Stipa krylovii*-grass dry steppe rangeland in Sandy loam alluvial fan and plain ESG, 2) *Stipa grandis – Elymus chinensis – forbs dry steppe rangeland* sandy loam alluvial plain and fan, 3) *Achnatherum splendens* rangeland in high water table ESG; and 4) *Stipa Krylovii*-small bunch grass-forbs dry steppe rangeland in Gravelly hills and fan ESG.

Figure 1. Map of Ecological Site Groups of Rangelands in Bayantumen Soum.



Source: NFPUG

2. Rangelands in Bayantumen Soum

Table 1. Area of Ecological Site Groups and other land uses in Bayantumen soum.

Ecological Site	Area (ha)	Area (%)
6. Stipa Krylovii-Small bunch grass-Forbs dry steppe rangeland in Gravelly hills and fan ESG. Steppe	301.950	36.1
9. Stipa grandis-Elymus chinensis-Forbs dry steppe rangeland in Sandy loam ESG. Steppe	275.727	33.0
7. Stipa krylovii-grass dry steppe rangeland in Sandy loam alluvial fan and plain ESG. Steppe	192.157	23.0
10. Achnatherum splendens rangeland in High water table ESG. Steppe	55.779	6.7
Cropland	7.397	0.9
Lake	1.561	0.2
Forest	1.109	0.1
Total	**835.680**	**100.0**

Source: derived from NFPUG data

Ecoregions are subdivided into classes known as ecological site groups, and separate models of ecosystem dynamics are developed for each class. Models are used to characterize ecosystem dynamics occurring at the site (land unit) scale, with an emphasis on natural and semi-natural ecosystems.

Mongolian rangelands are divided into around 22 ecological site groups, based on their productivity and capacity to endure different intensities of use, and to recover and regrow after being used. In general, Mongolian rangelands have considerably high capacity to recover and regrow. Rangeland ecological capacity data is not only an essential tool used in rangeland management, but also can be an instrument for the establishment of appropriate natural resource use, protection and restoration. The rangeland ecological capacity, including rangeland state, transition patterns can be used as a basic document for regulating relationships between rangeland users and lessee parties.[7]

The concept of classifying any area into ecological sites, according to that area's productivity, based on varying soil, climatic and hydrological conditions, and its capacity to endure different intensities of use and to recover from degradation, and of using this classification as a basis of rational use of natural resources is more and more recognized internationally. Since 2009, the Green Gold Project funded by the Swiss Agency for Development and Cooperation (SDC) has been exploring opportunities to develop the Ecological Site Description (ESD) concept for Mongolian rangelands and use it as an essential tool of rangeland management. Based on soil, vegetation and geomorphological data collected from approximately 500 points representing nationwide environmental zones, the the ESD concept was developed for the Mongolian context. According to this concept, Mongolian rangelands are divided into some 22 zones, representing distinct ecological potentials. Based on these plot data and state and transition models a

[7] https://warnercnr.colostate.edu/wp-content/uploads/sites/2/2017/09/2015BuildingResilience_of_MongolianRangelands-ENG1-1Bulgamaa_etal.pdf

preliminary conclusion is made that over 65 percent of Mongolian rangeland has, with varying degrees, altered from its reference state, and 80 percent of this area has potential to recover through changes in rangeland management. The main objective of this Green Gold research was to identify, for each environmental zone, the main factors that determine rangeland ecological potential, to develop the ESD concept and to test the possibility of using it in rangeland management. The novelty of this study, as well as its scientific and practical significance, lie in development and testing of a more detailed classification based on ecological potential within Mongolian ecological zones and geo botanical regions. This approach is significant because the classification may be used as an essential tool for rangeland use planning, implementation and monitoring, as well as for regulating rangeland use agreements.

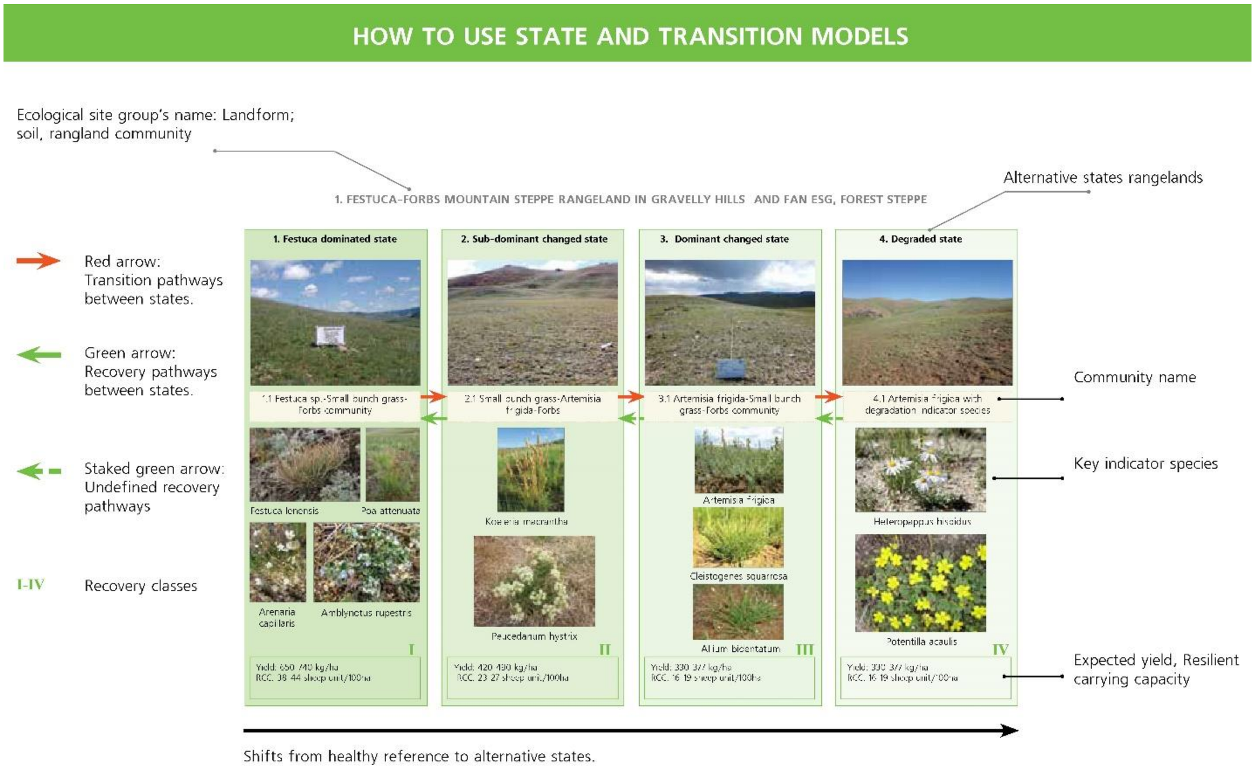
2.2 State and Transition Models to Understand Rangeland Ecosystem Changes and Health of the Rangelands

State and Transition Models (STMs) were developed as a means to organize and communicate information regarding rangeland ecosystem change as a basis for management of rangelands. The value of STMs for rangeland management is in fostering a general understanding of how rangelands function and respond to management actions, thereby leading to more efficient and effective allocation of resources and management efforts. STMs allows land managers to link information about rangeland plant community composition collecting during inventories and monitoring with concepts of ecosystem dynamics to develop management plans aimed at long-term stewardship of the rangelands. STMs can help determine management objectives for rangelands and can serve as a guide to maintain and restore rangeland ecosystem services.[8]

STMs for Mongolian rangelands have been developed that describe the reference (healthy) and alternative states (of degradation from reference or healthy state) for specific types of soils within ecoregions of Mongolia. The “states” represent large changes in rangeland conditions that can be difficult to reverse and “community phases” represent more easily reversed changes in vegetation within states. There are transitions between states and community phases interpreted as degradation and restoration that relate to specific management actions that can be used to prevent or reverse degradation over time. The STMs developed for Mongolia consider key plant indicator species and potential productivity, as well as recommended carrying capacity for livestock (expressed as number of SUs/100 ha). The STMs developed for Mongolia can be used for analysis and interpretation of rangeland health, and for monitoring and assessment. They also provide a scientific basis for planning and implementing of resilience-based rangeland management and rangeland use agreements.

[8] Adapted from Bestelmeyer, et al., 2017. State and Transition Models: Theory, Applications, and Challenges. https://link.springer.com/chapter/10.1007/978-3-319-46709-2_9

Figure 2. How to Use State and Transition Models (taken from State and Transition Models of Mongolian Rangelands 2018)



Source: State and Transition Models for Mongolian Rangelands (2018)

2.3 Carrying Capacity of Rangelands in Bayantumen *Soum*

Carrying capacity and stocking rate are often used interchangeably and incorrectly by herders and range and livestock managers. They are actually two very different measures of how things are at a point in time. Stocking rate is how things are, good, bad or ugly. Carrying capacity is how it should be ideally. Stocking rate is a measure of the livestock grazing (per area, per time period, per unit rainfall), while carrying capacity is the ability of the soil and pasture to provide for grazing by livestock and wild grazing animals.

The number of grazing animals a piece of land can support long term while maintaining or improving the rangeland resources (vegetation, soils, and water) is called carrying capacity. The characteristics of the land, soil, and vegetation and prior grazing use determine the carrying capacity, not the land manager. In Mongolia, carrying capacity is expressed as number of SUs (SUs) per 100 hectares.[9]

Carrying capacities have been determined for each state (health condition) of an ESG (Table 2). In the *Stipa krylovii*-Grass dry steppe rangeland in sandy loam alluvial fan and plain ESG, carrying capacities range from 30-34 SUs/100 ha for rangeland in reference (good) condition to 18-21 SUs/100 for degraded range. In the

[9] In the USA and Canada, Animal Unit Months (AUMs) are frequently used to determine sustainable stocking rates for grazing pasture and rangeland in the west. An AUM is the amount of air-dry forage a 1,000-pound cow and her un-weaned calf will consume (the 'Animal Unit') in one month.

Stipa krylovii-Grass with *Caragana* steppe rangeland in deep sandy alluvial plain ESG, carrying capacity ranges from 59-71 SUs/100 ha in good condition to only 7-9 SUs/100 ha in poor condition. For the *Achnatherum splendens* rangeland in high water table ESG, carrying capacity ranges from 22-24 SUs/100 ha in good condition to 4-7 SUs/100 ha in poor condition. For the *Stipa krylovii*-small bunch grass forbs dry steppe rangeland in gravelly hills and fan ESG, carrying capacity ranges from 57-62 SUs/100 ha in good condition to 18-34 SUs/ha in poor condition.

Table 2. Forage yield and recommended carrying capacities (SUs/100 ha) for different states (health) for the four key ecological site groups (ESGs) found in Bayantumen Soum.

Steppe Zone			
Stipa krylovii – grass dry steppe rangeland in sandy loam alluvial fan and plan ESG			
Reference state	Grass-thinned state	*Artemisia frigida* or *Kochia prostata* dominate	Degraded state
890-1000 kg/ha	550-620 kg/ha	370-425 kg/ha	370-425 kg/ha
30-34 SU/100 ha	30-34 SU/100 ha	18-21 SU/100 ha	18-21 SU/100 ha
Stipa grandis – Elymus chinensis – forbs dry steppe rangeland in sandy loam alluvial plan and fan ESG			
Reference state	Forb decreased state	Stipa grandis decreased	Degraded state
1300-1470 kg/ha	760-800 kg/ha	670-710 kg/ha	350-370 kg/ha
78-86 SU/100 ha	41-44 SU/100 ha	34-36 SU/100 ha	17-18 SUs/100 ha
Achnatherum splendens rangeland in high water table ESG			
Reference state	Grass decreased state		Degraded state
380 - 400 kg/ha	150 - 290 kg/ha		80 -130 kg/ha
22-24 SU/100 ha	8-16 SU/100 ha		4 -7 SU/100 ha
Stipa krylovii-small bunch grass forbs dry steppe rangeland in gravelly hills and fan ESG			
Reference state	Grass-thinned state		Degraded state
970-1030 kg/ha	900-940 kg/ha		362-679 kg/ha
57-62 SU/100 ha	45-52 SU/100 ha		18-34 SU/100 ha

Source: State and Transition Models of Mongolian Rangelands (2018)

3 Livestock in Bayantumen *Soum*

In 2021, there were a total of 249,590 head of livestock in Bayantumen *soum* (Table 3). Forty-three percent of the total number of livestock were sheep; 29 percent goats, 15 percent horses, 12 percent cattle and only 0.35 percent camels. Since 2017, the total number of livestock had increased by 56.9 percent. To really understand the effect of herders' livestock grazing on the rangeland, you cannot just consider total livestock numbers, but need to convert the different livestock species to a standard unit. Mongolia uses a SU where one camel equals 5 SUs, one horse equals 7 SUs, one cow equals 6 SUs, one sheep equals 1 SU and one goat equals 0.9 SU. When you convert all the five different livestock types to SUs, horses made up over 44 percent of the SUs; cattle were almost 29 percent; sheep were 17 percent and goats were only 10 percent. This means that even though horses were only 15 percent of the total animal numbers there make up almost 45 percent of the SUs on the rangeland (e.g., consuming 45 percent of the forage). Table 4 provides information on numbers of livestock and SUs for years 2018-2020 and the total number change and total SU change by year.

Table 3. Livestock Population in Bayantumen Soum 2017 – 2021.

	2017	2018	2019	2020	2021	% of total herd in 2020	SUs 2020	SUs 2021	% in SUs 2020	% Increase SUs 2017 to 2021
horse	25,060	27,840	29,690	34,670	38,400	15.32	242,690	268,800	44.72	
cattle	17,560	21,900	23,640	27,430	30,920	12.12	164,580	185,524	28.97	
camel	680	770	750	800	930	0.35	4,000	4.650	0.70	
sheep	70,070	84,030	90,160	97,660	109,820	43.13	97,660	109,820	17.19	
goat	45,610	56,710	61,400	65,700	69,520	29.03	59,130	62,568	10.41	
total	158,980	191,250	205,640	226,260	249,590		568,060	631,388		59.72

Source: derived from NSO data

Table 4. Livestock Numbers and SU Equivalents for in Bayantumen soum for 2018-2020.

Livestock Type	Total Number (10^3)			# SUs	Total SUs			Total Number Change (%)			Total SUs Change (%)			Average Annual Change (%)
	2018	2019	2020		2018	2019	2020	2018-2019	2019-2020	2018-2020	2018-2019	2019-2020	2018-2020	
Horse	27.8	29.7	34.7	7	194.9	207.8	242.7	6.6	16.8	24.5	12.5	31.5	24.5	12.3
Cattle	21.9	23.6	27.4	6	131.4	141.8	164.6	7.9	16.0	25.3	14.9	30.1	25.3	12.6
Camel	0.8	0.8	0.80	5	3.8	3.8	4.0	-2.6	6.7	3.9	-4.9	12.5	3.9	1.9
Sheep	84.0	90.2	97.7	1	84.0	90.2	97.7	7.3	8.3	16.2	13.7	15.6	16.2	8.1
Goat	56.7	61.4	65.7	0.9	51.0	55.3	59.1	8.3	7.0	15.9	15.5	13.2	15.9	7.9
Total	**191.3**	**205.6**	**226.3**		**465.2**	**498.8**	**568.1**	-	-	-	-	-	-	-

Source: derived from NSO data

3. Livestock in Bayantumen Soum

In 2020, there were 757 herder households in Bayantumen soum. This has been an increase of 61 percent in the five-year period 2015 to 2020 (Table 5). The large increase from 2019 to 2020 was reportedly because of many households moving in from other areas.

Table 5. Number of Herder Households and Herders in Bayantumen Soum.

	2015	2016	2017	2018	2019	2020
# Herder households	470	512	572	622	644	757
# Herdsmen	525	562	682	548	580	835

Source: NSO

Information on average number of livestock by type per herder shows that the number of all types of animals per herder household has decreased (Table 6). Total number of animals per herder household in 2020 was 298; in 2015 it was 338 head.

Table 6. Data on livestock by type per herder household in Bayantumen

	2017	2018	2019	2020
Horse/herder household	53.3	44.8	46.1	45.8
cattle /herder household	37.3	35.2	36.7	36.2
Camel/herder household	1.4	1.2	1.1	1.0
Sheep/herder household	149.1	135.1	140.0	129.0
Goat/herder household	97.0	91.2	95.3	86.8

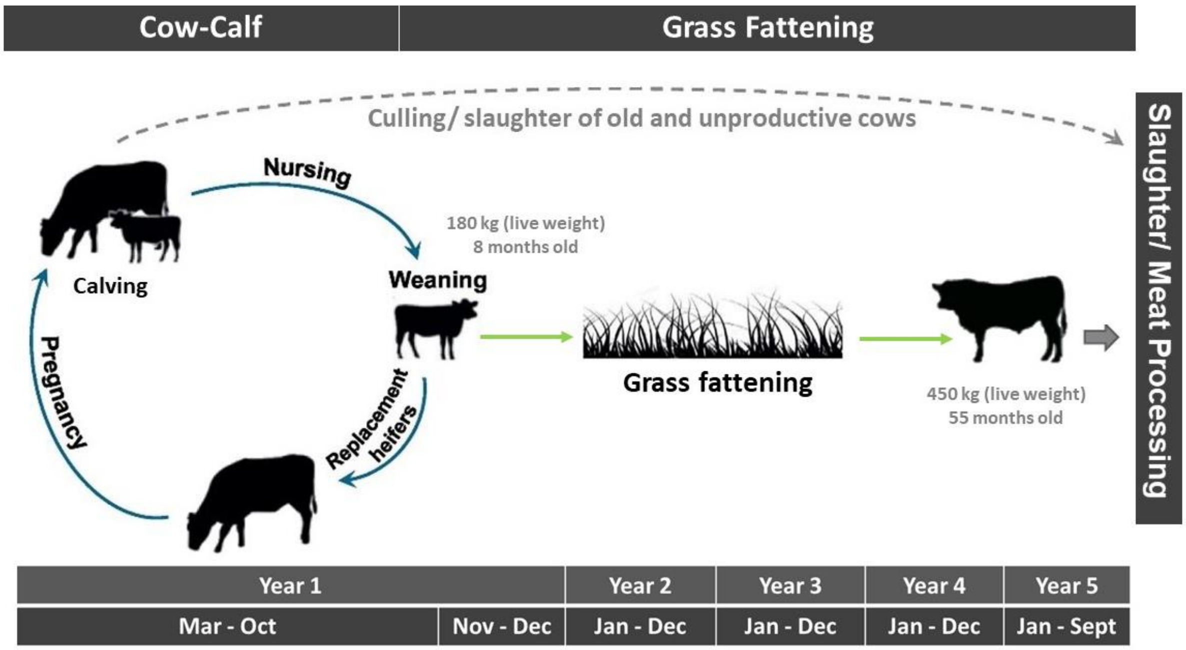
Derived from NSO Data.

4 Life Cycle Analysis for Cattle and Sheep

4.1 Current Cattle Production System

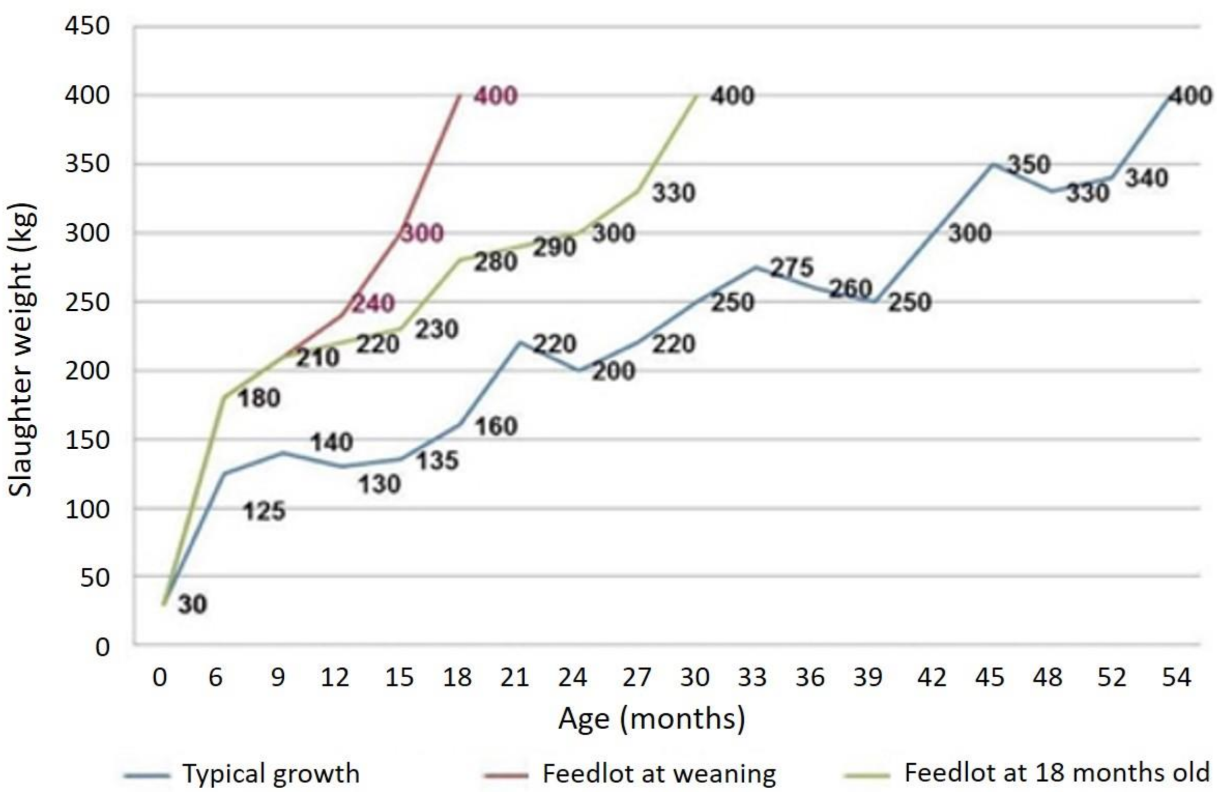
A life cycle analysis enables an easy-to-understand "picture" of the life an animal – cow or sheep. Figure 3 depicts the life cycle for the current cattle production system based on grass fattening. It shows that it takes almost five years for a steer to reach a slaughter weight of 450 kg (see also Figure 4).

Figure 3. Life Cycle for Current Cattle Production



When cattle eat, the food converts to energy. Part of that energy goes to maintaining the animal's bodily functions while another part fuels any extra exertions they need, whether that is running or reacting to stressful situations. The rest goes to growth. Thus, the more you reduce the amount of energy livestock spend on exertion, the bigger the animal grows. Figure 4 illustrates levels of weight gain in cattle over time under three different management systems. It helps explain the why it takes 4-5 years for a steer in Mongolia to reach slaughter weight.

Figure 4. Cattle weight gains under three different management systems.



Source: from data provided by Dan Miller and Jeremy Thiessen

Figure 4 (based on actual data from the Xanadu Razorback LLC feedlot in Hutag-Undur *soum* of Bulgan *aimag.)* depicts the weight of cattle over time and shows the impact of different diets. The blue line (bottom line in the graph) shows what happens when cattle follow the typical Mongolian grazing pattern. In this situation, the calf does not get all the milk from its mother, loses weight in the winter as it fights the cold, and does not get a balanced diet. Under these circumstances, it takes about 4 ½ years before a steer reaches a slaughter weight of 400 kg.

The green line (in the middle) shows what happens when the calf gets all the milk from its mother, receives a balanced diet in its first winter, goes to pasture for the following summer, and then goes into the feedlot at about 18-20 months of age. In this case, the steer reaches a slaughter weight of 400 kg at 24-28 months of age.

The red line (on the top) shows what happens when the calf gets all the milk from its mother, then goes directly to a feedlot after weaning, and eats growth rations and then finishing rations for the last 90-100 days. This approach produces the fastest growing cattle, with steer reaching a slaughter weight of about 400 kg at 18-20 months of age. Using the full feedlot approach can save more than two years in fattening cattle for slaughter compared to traditional methods. That is two years sooner that you can receive money for your cattle.

One of the benefits of putting cattle in feedlots is that you can provide them with special diets and an environment which enables them to grow faster and provide higher quality meat than if they were only grazing on pastures. You can also control the amount of extra exertion they do. The goal of a feedlot is to keep the cost per unit of live weight gain as low as possible. To do this, you need to:

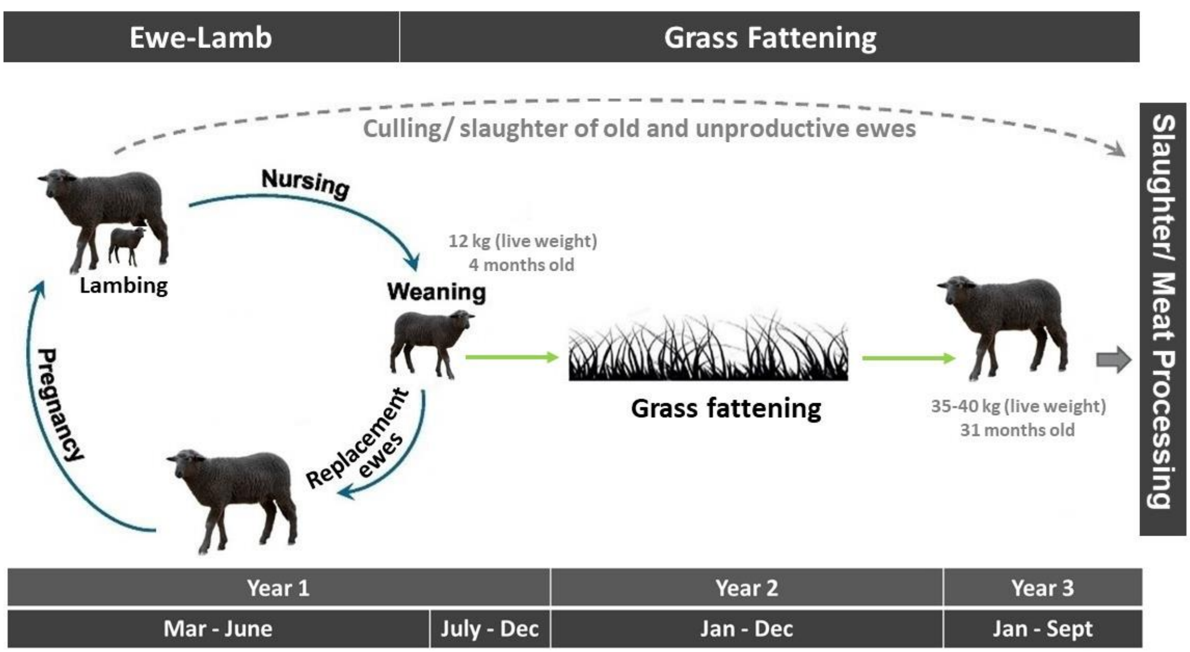
- have a thorough knowledge of the nutritional needs of the cattle
- plan for a consistent supply of all feed ingredients and availability of all nutrients
- be able to continually assess the performance of the cattle in the feedlot.

Good feeding practices are critical to the successful operation of a feedlot. Proper nutrition requires regularly providing feedlot cattle a suitable mix of palatable, digestible, high-quality feed ingredients; clean, fresh water; and adequate mineral supplementation to meet the animals' needs and the feedlot's weight gain goals. Because the animals eat prepared rations and cannot select their own food, it is important to understand the function of the rumen (one of the four stomachs in cattle) and the impact of different types of feed on rumen function and metabolism so that it functions properly.

4.2 Current Sheep Production System

The life cycle for sheep under the current production system is illustrated in Figure 5. Sheep are fattened on grass and are usually not slaughtered until they are 30-31 months old at a live weight of 35-40 kg. Like cattle, sheep also lose weight in the winter because of inadequate nutrition.

Figure 5. Life Cycle for Current Sheep Production



4.3 Life Cycle for Cattle and Sheep Under Improved Management

4. Life Cycle Analysis for Cattle and Sheep

Figure 6 illustrates the life cycle for cattle with improved management by a herder that has adopted restructuring his herd and other recommended practices and technologies. By raising cattle with better genetics (through introduction of good quality Angus or Hereford breeding stock); proper animal health care, and improved nutrition, and with the calf getting all the milk from the cows, calves are weaned in the fall at 8-9 months of age. Castrated male calves (steers) are sent for backgrounding confinement or backgrounding on grazing and supplemental hay and then sent to a feedlot when reach 300 kg live weight for final finishing. In this life cycle, cattle reach slaughter weight of about 450 kg live weight at 18-20 months of age.

Figure 6. Life Cycle for Cattle Under Improved Management

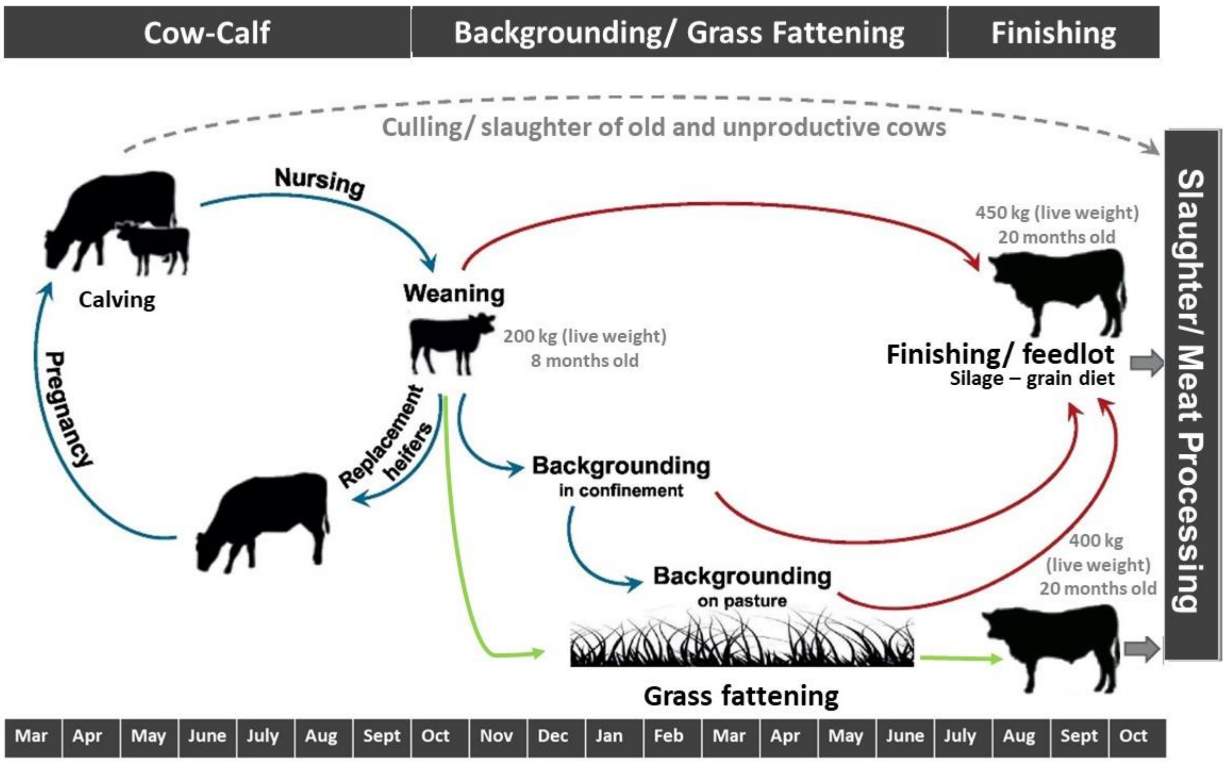
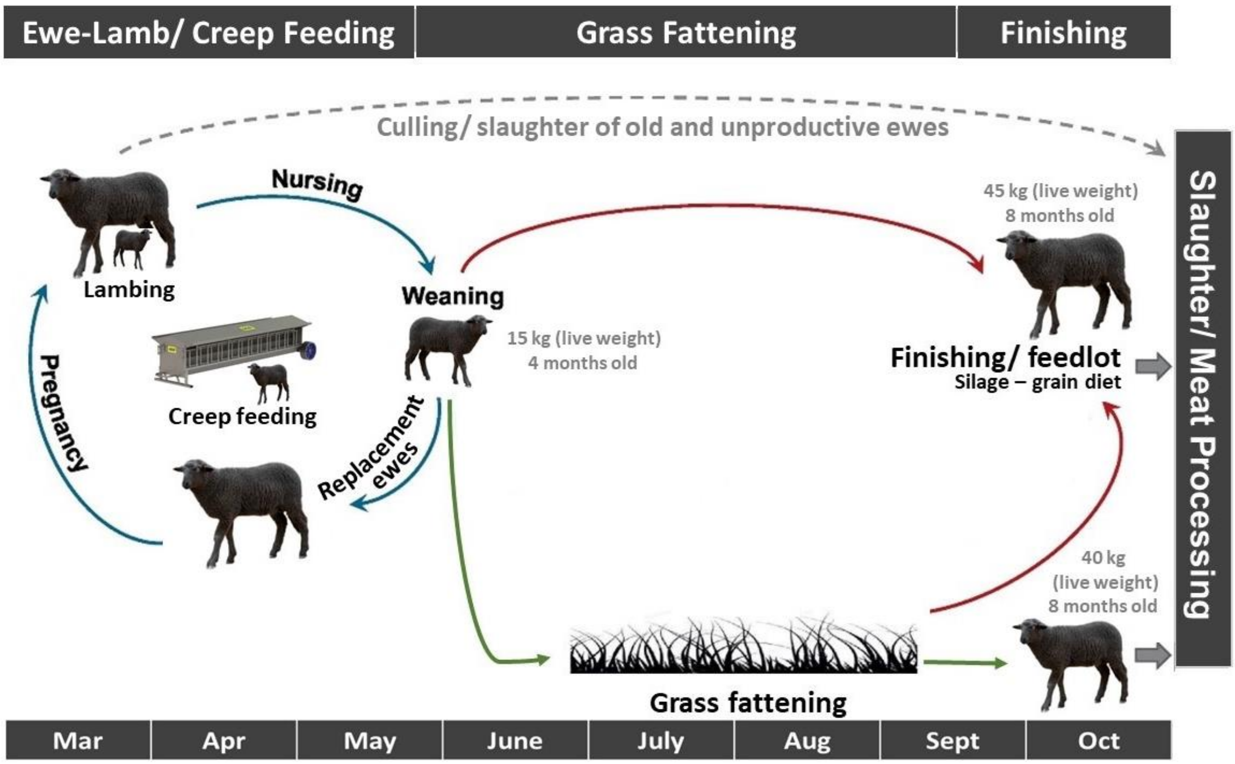


Figure 7 shows the life cycle for sheep under improved management by adopting the recommended practices and technologies (Chapter 8). In this life cycle, improved genetics has resulting in larger lambs and with improved genetics, nutrition and management, ewes are producing more milk, creep feeding of lambs is introduced and lambs are bigger at weaning. After weaning at about four months of age, lambs are grass fattened on pasture until reaching a slaughter weight of 40-45 kg, or they are sent to a feedlot for finishing until reaching a slaughter weight of about 45 kg.

Figure 7. Life Cycle for Sheep Under Improved Management



5 Herd Structures

Knowing the structure of herder's livestock herds is critical to understanding their livestock production system and how to go about improving productivity and efficiency. Table 7 depicts and average herder family with 92 total head of cattle. The herder has 20 adult cows that are being milked to supply milk needs for the family. As outlined in the Life Cycle section, the calf does not get all the nutrition it needs to adequately grow, which is the reason it takes 4-5 years to reach slaughter weight. A typical herder then has cattle of numerous ages in his herd because animals are not being sold for slaughter until they are much older. The herder's main income from raising cattle comes when selling 4–5-year-old steers.

Growing markets for quality beef are creating opportunities for feedlot finishing which require younger cattle to be put on feed, ideally weaned calves in the fall or backgrounded cattle. Table 8 depicts a herd structure for a herder who has adopted the recommended technologies of improved cattle production for beef. Restructuring herds enables herders to reduce total livestock numbers on the rangeland, thus giving the opportunity to implement range management practices and allow ranges to rehabilitate.

Table 7. Current Cattle Structure for Average Herder Household

Cattle types	Current - 20 Adult Cows							
	Total Aug	**Total Dec**	**SUs Aug^**	**SUs Dec^**	**Total Sold**	**Live weight (kg)**	**Price (MNT/kg)**	**Total Value (1000 MNT)**
Adult cows (42 months and older)$	20	17*!	120	102	2	450	3000	2700
Calves (born in spring)	19	18*	38	36	0	-	-	0
Yearlings (16-18 months old)	18	17*	54	51	0	-	-	0
Steers (30 months old)	8	7*	48	42	0	-	-	0
Replacement heifers (30 months old)	8	5ā	48	30	0	-	-	0
Non-pregnant replacement heifers (34 months old)	0	3!	0	21	0	-	-	0
Steers (42 months old)	8	7*	48	42	0	-	-	0
Steers (54 months old)	7	0!	42	0	7	450	3000	9450
Bull for breeding	1	1	6	6	0	-	-	0
Open cows (48 months and older)&	3	2!	18	12	1	450	3000	1350
Total	**92**	**77**	**422**	**333**	**10**	**-**	**-**	**13500**

$ Cows have first calf at 3 years old. Local cows that are being milked for the household needs and therefore calves are not getting proper

& Non pregnant cows kept in the herd.

* Cattle head death loss (approx. 5 % of total herd).

! Sold adult cull cows. steers and open cow to the market for meat.

ā Bred heifers calved adding to the adult cows.

^ One adult cow/ steer/ bull considered as 6 sheep units (SUs). 3 calves considered as one adult cow and 2 yearlings considered as one

Table 8. Cattle Herd Structure for a Herder with Improved Management ("with project")

Cattle types	With Project - 40 Adult Cows							
	Total Aug	Total Dec	SUs Aug^	SUs Dec^	Total Sold	Live weight (kg)	Price (MNT/kg)	Total Value (1000 MNT)
Adult beef cows (42 months and older)$¶	35	30*!	210	180	4	450	3000	5400
Adult milk cows (42 months and older)#	5	5	30	30	0	-	-	0
Calves (born in spring)	40	5£!	80	10	35	200	3000	21000
Replacement heifers (18 months old)£	5	5ǟ	15	15	0	-	-	0
Replacement heifers (30 months old)ǟ	5	4*	30	24	0	-	-	0
Non-pregnant replacement heifers (34 months old)	1	0!	6	0	1	350	3000	1050
Bull for breeding	2	2	12	12	0	-	-	0
Total	**93**	**51**	**383**	**267**	**40**	-	-	**27450**

¶ Beef cows are not being milked. These are Hereford or Angus or crossbred beef cows.

Herders keep 5 good quality milk cows for household milk needs.

* Cattle head death loss (approx. 2-3 % of total herd).

£ Heifer calves kept for replacement. All other calves are sold in the fall after weaning.

$ Cows have first calf at 3 years old.

! Sold adult cull cows and weaned calves to the market for meat for meat.

ǟ Bred heifers calved adding to the adult cows.

^ One adult cow/ steer/ bull considered as 6 sheep units (SUs). 3 calves considered as one adult cow and 2 yearlings considered as one adult cow. The rest of the herd considered as 1 adult cow.

With a restructured cattle herd, the herder can raise 40 cows, sells steers when weaned and has fewer cattle to maintain over the winter. His system is much more efficient and earns more income. Restructuring herds is a way to reduce livestock numbers on the rangelands. With a 40-cow herd, the herder has a total of 267 SUs at the end of the year compared to 333 SUs under the current system. With a restructured herd, a herder can earn 27.4 million MNT by selling weaned calves compared to only earning 13.5 million MNT under traditional management.

A similar analysis is done for traditional raising of sheep and a "with-project" scenario where the herder is selling lambs in the fall when they are 8-9 months of age (Table 9 and Table 10).

Table 9. Current Sheep Flock Structure for a Herder with a 200 ewe flock and a 100 ewe flock.

Sheep types	Total Aug	Total Dec	SUs Aug^	SUs Dec^	Total Sold	Carcass weight (kg)	Price (MNT/kg)	Total Value (1000 MNT)
	Current - 200 Ewe Flock							
Adult ewes (30 months and older)$	200	170*!	200	170	20	20	6000	2400
Lambs born in spring	220ф	210*	73	70	0	-	-	0
Yearling lambs (18 months old)	200	190*	100	95	0	-	-	0
Sheep (30 months old)	180	40*!ā̄	180	40	130	20	6000	15600
Breeding rams (24 months and older)	6	6	6	6	0	-	-	0
Total	**806**	**616**	**559**	**381**	**150**	**-**	**-**	**18000**
Sheep types	**Current - 100 Ewe Flock**							
	Total Aug	**Total Dec**	**SUs Aug^**	**SUs Dec^**	**Total Sold**	**Carcass weight (kg)**	**Price (MNT/kg)**	**Total Value (1000 MNT)**
Adult ewes (30 months and older)$	100	85*!	100	85	10	20	6000	1200
Lambs born in spring	110ф	105*	37	34	0	-	-	0
Yearling lambs (18 months old)	100	95*	50	48	0	-	-	0
Sheep (30 months old)	90	20*!ā̄	90	20	65	20	6000	7800
Breeding rams (24 months and older)	3	3	3	3	0	-	-	0
Total	**403**	**308**	**280**	**190**	**75**	**-**	**-**	**9000**

$ Ewes have first lamb at 3 years old.

ф Assume 10% of the ewes have twins.

* Sheep head death loss (approx. on average 10 % of total herd).

! Sold adult cull ewes and lambs 15-18 months old to the market for meat.

ā̄ Female lambs (~20-21months old) kept for replacement

^ 3 lambs considered as one SU; 2 yearlings considered as 1 SU; the rest of herd considered as 1 SU.

Table 10. Sheep Flock Structure for a Herder with Improved Management ('with project")

Sheep types	With Project - 200 Ewe Flock							
	Total Aug	**Total Dec**	**SUs Aug^**	**SUs Dec^**	**Total Sold**	**Carcass weight (kg)**	**Price (MNT/kg)**	**Total Value (1000 MNT)**
Adult ewes (30 months and older)$	200	170*!	200	170	20	20	6000	2400
Lambs born in spring	220ф	210*	70	70	0	-	-	0
Yearling lambs (18-21 months old)	210	35*!ǎ	105	18	170	20	6000	20400
Breeding rams (24 months and older)	6	6	6	6	0	-	-	0
Total	**636**	**421**	**381**	**264**	**190**	**-**	**-**	**22800**
Sheep types	**With Project - 100 Ewe Flock**							
	Total Aug	**Total Dec**	**Sus Aug^**	**SUs Dec^**	**Total Sold**	**Carcass weight (kg)**	**Price (MNT/kg)**	**Total Value (1000 MNT)**
Adult ewes (30 months and older)$	100	85*!	100	85	10	20	6000	1200
Lambs born in spring	110ф	105*	37	35	0	-	-	0
Yearling lambs (18 months old)	100	20*!ǎ	50	10	75	20	6000	9000
Breeding rams (24 months and older)	3	3	3	3	0	-	-	0
Total	**313**	**213**	**190**	**133**	**85**	**-**	**-**	**10200**

$ Ewes have first lamb at 3 years old.

ф Assume 10% of the ewes have twins.

* Sheep head death loss (approx. on average 5 % of total herd).

! Sold adult cull ewes and lambs 15-18 months old to the market for meat.

ǎ Female lambs (~20-21months old) kept for replacement

^ 3 lambs considered as one SU; 2 yearlings considered as 1 SU; the rest of herd considered as 1 SU.

6 Influence of Livestock on Environmental Goods and Services

Livestock and rangelands of Bayantumen *soum* provide numerous ecosystem services including carbon sequestration, biodiversity, improving forage quality and other benefits that are difficult to quantify. Some of the ecosystem services that are more easily quantified are forage production and livestock production. The value of wildlife and biodiversity and "open space" are more difficult to put economic values on. Table 11 summarizes some of the influences of livestock on environmental goods and services. The text in green in Table 11 indicates a positive influence; text in red indicates a negative influence.

Table 11. Summary of Influences of Livestock Production System on Environmental Goods and Services (Note: The green color indicates positive and red means negative influence).

Environmental goods and services (ESGs)	Influence of current livestock herding	Responsiveness to climate-resilient livestock farming		Opportunity to enhance via climate-resilient livestock farming	
		Grass-finished	Feedlot-finished	Grass-finished	Feedlot-finished
Provisioning services					
Meat production	Moderate	Moderate	High	Low	High
Non-meat products	Moderate	Moderate	High	Low	High
Water supply	Large	High	Low	Moderate	Low
Regulating services					
Water quality regulation	Large	High	Low	Moderate	Low
Air quality regulation	Moderate	Moderate	Low	Low	Low
Disease regulation	Moderate	High	High	Moderate	High
Soil quality regulation	Large	High	Low	High	Low
Climate regulation	Large	Moderate	Low	High	Moderate
Cultural services					
Cultural heritage	Slight	Low	*Not relevant*	Low	*Not relevant*
Recreation and tourism	Slight	High	*Not relevant*	Moderate	*Not relevant*
Biodiversity and habitat					
Biodiversity	Large	High	Low	High	Moderate
Habitat maintenance	Large	High	Low	High	Moderate

Livestock farming systems in Mongolia are influenced by a variety of ecosystem properties that fall into two broad categories, 1) abiotic and 2) biotic[10]. Although important to consider in planning range and livestock management and development, abiotic processes cannot be directly influenced with management. In contrast, biotic properties of the rangeland ecosystem can be influenced by management. The key to robust

[10] Description. Biotic and abiotic factors are **what make up ecosystems**. Biotic factors are living things within an ecosystem; such as plants, animals, and bacteria, while abiotic are non-living components; such as water, soil and atmosphere.

biotic resilience in rangelands and livestock farming systems will be about maintaining and promoting healthy rangelands.[11] Sustainable production of livestock and livestock products from the rangelands of Bayantumen *soum* can be socially responsible, environmentally sound and economically viable. This requires awareness of the complex relationships among the three pillars of society/culture, environment and economics. It also requires tackling difficult market and policy issues that hamper the growth of sustainable, climate-resilient livestock farming systems.

[11] Concept adapted from: D. Johnson, et.al. 2022. Ratcheting up resilience in the northern Great Basin, Rangelands 44(3): 200-209.

7 Multi-Criteria Analysis

A Multi-Criteria Analysis (MCA) was used in assessing recommended pasture and livestock technologies and approaches (Table 12). The MCA used a number of frameworks that included: Political, Economic, Social, Technological, Legal, and Environmental (PESTLE) that has been widely used by UNDP/FAO in recent years. For each framework, there were numerous Criteria and Guiding Questions that were used to determine the appropriateness of each technology/intervention and approach that was being recommended in Chapter 8.

Table 12. Multi-Criteria Analysis Used in Assessing Recommended Practices and Technologies

Framework	Criteria	Guiding Questions
Political	Alignment with Mongolia's Vision 2050 Alignment with Government Action Plan for 2020=2024 for Agriculture, Livestock and Light Industry Alignment with National Livestock Policy Alignment with National Program to Support Intensive Livestock Development Alignment with Atar-4 Campaign for Sustainable Farming Alignment with National Green Development Policy	Is the adaptation intervention in alignment with Mongolia's green economy vision, in terms of aims and objectives? Is the adaptation intervention in alignment with Mongolia's intended development goals, in terms of aims and objectives? Is the adaptation intervention in alignment with the agricultural sector's own climate resilience strategy?
Economic	Cost effectiveness Suitability for resource mobilization Of economic benefit to herders and local communities	How cost-effective is the adaptation intervention, relative to other potential options to reduce the same vulnerability? How strong a candidate is the adaption intervention, in terms of attracting funding from climate adaptation finance sources?
Social	Alignment with Sustainable Development Goals (SDGs) Contribution to food security goals Gender-responsiveness and equity Ability to support sustainable livelihoods and job-creation	To what extent is the adaptation intervention in alignment with or reflective of Mongolia's Program to Support Intensive Livestock Development? To what extent is the adaptation intervention suitable for gender responsiveness and gender mainstreaming in implementation? 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?

7. Multi-Criteria Analysis

Framework	Criteria	Guiding Questions
Legal	Suitability for existing institutional arrangements Feasibility within existing legal and regulatory framework.	To what extent is the adaptation intervention implementable effectively within existing institutional architecture, mandates and mechanisms? How feasible is the adaptation intervention within the current legal and regulatory set-up, without requiring legal or regulatory changes?
Environmental	Ability to reduce vulnerability and build adaptive capacity Environmental co-benefits (biodiversity, water, etc.) Mitigation co-benefits Environmental risks	How effective is the adaptation intervention in terms of targeting the major vulnerabilities of the sector, and building adaptive capacity in the sector? To what extent does the adaptation intervention bring co-benefits for environmental protection, management, resource-efficiency, and conservation? To what extent does the adaptation intervention bring co-benefits in terms of reduce GHG emissions, or carbon sequestration and abatement? How minimal are the environmental risks of implementing the adaptation intervention, in terms of unintended consequences?

8 Recommended Practices and Technologies

A number of rangeland and livestock management practices and technologies have been identified to promote more sustainable, climate-resilient livestock farming systems in Bayantumen *soum*. Each practice and technology being considered was analysed using the MCA (Chapter 7) to determine if it met the various criteria and how well it answered the Guiding Questions. Table 13 also illustrates the cost, impact and priority of implementation of each recommended technology.

There are no easy solutions to developing sustainable, climate-resilient livestock farming systems and any efforts need to take a holistic, integrated approach to tackling the issues. Reducing livestock numbers is going to be critical and to do this, restructuring of cattle herds and sheep flocks should be prioritized. Growing markets for better quality beef and lamb that would come from animals fattened in feedlots and slaughtered at a younger age could provide the incentive for herders to change their herd structures. Monitoring of rangelands and rangeland planning using the State and Transition Models already developed for Mongolian rangelands will be a key activity in order to start to balance livestock numbers with carrying capacities of the rangeland. Training of local officials and herders and provision of practical, extension material and advice to support herders in the transformation they need to make to more climate-resilient livestock farming systems will also be essential.

The most appropriate rangeland and livestock management practices and associated technologies for promoting sustainable, climate-resilient livestock farming include the following (key ones are in **bold**):

<u>Pasture related:</u>

- **Rangeland monitoring, using State and Transition Models developed for Mongolian rangelands.**
- **Rangeland planning to identify areas that need improved management which could include: resting from grazing for a year or more, deferred grazing in the spring, identifying *otor* pastures, areas for reseeding pastures, areas for hay cutting, sites for water development, fencing.**
- Determining carrying capacities and recommended stocking rates for the range.
- Rangeland planning for biodiversity conservation (working with nature reserves in Bayantumen *soum* to manage the rangelands for both livestock and wildlife).
- Forage and fodder development (with annual (i.e. oats, wheat, barley and peas for "green nutrition") and perennial forages (alfalfa, etc.))
- **Training for *aimag* and *sum* officials and herders in rangeland monitoring and planning.**
- **Production of rangeland and forage/fodder-related extension material that is practical for herders.**

<u>Livestock related</u>

- Animal health and disease control.
- Training of veterinarians and provision of supplies and equipment.
- Training of herders in animal health and disease control and proper protocols to follow (with special attention to the role of women).
- Genetic improvement of cattle, sheep, and goats through raising and distribution of breeding stock and artificial insemination (AI).

- **Herd restructuring to reduce numbers of unproductive animals and increase off-take of younger animals.**
- **Promoting raising beef cattle as cow-calf producers and selling weaned calves in the fall.**
- **Herders keep a small number of improved milk cows (i.e., Alatau, Black & White) to provide milk needs for the household.**
- **Sell lambs in the fall at 8-9 months of age or at 15-18 months of age.**
- Improved livestock shelters for winter.
- **Training for herders on livestock production and management, with special consideration to training needs of women and children.**

Market related:

- Strengthen linkages between herders and markets (direct marketing by herders to buyers, which bypass changers).
- Sale barns where weekly or bi-weekly auctions are held in the fall to market cattle and sheep for meat.
- Strengthen all the links in the meat value chains.
- Promotion of grass-raised beef and lamb.
- Promotion of feedlots (intensive livestock raising).
- Promotion of milk-production and small-scale dairying (intensive and semi-intensive livestock raising).

Policy related:

- Analyze current range, livestock, and market policies that are hindering more sustainable, climate-resilient livestock farming systems.
- Provide policy recommendations that are needed to promote sustainable, climate-resilient livestock farming.

Different actions and technologies have different costs and impacts if implemented. Table 13 illustrates whether the recommended actions/technologies have high, medium or low cost and whether their impact is high, medium or low. Most of the actions/technologies should be implemented in the short-term but some could be done later. This prioritization helps in planning development.

Table 13. Priority actions/technologies for climate-resilient livestock systems with the cost, impact and prioritization.

Actions/technologies to promote sustainable, climate-resilient livestock farming system in Bayantumen *soum.*	Cost (High, Medium or Low)	Impact (High, Medium or Low)	Prioritization (Short term or Medium term)
Rangeland and forage/fodder related			
Rangeland monitoring, using State and Transition Models.	M	H	S
Determining carrying capacities for areas used by herders.	H	H	M
Rangeland planning to identify areas for improved management.	L	H	S

8. Recommended Practices and Technologies

Actions/technologies to promote sustainable, climate-resilient livestock farming system in Bayantumen *soum.*	Cost (High, Medium or Low)	Impact (High, Medium or Low)	Prioritization (Short term or Medium term)
Forage and fodder development.	H	H	S
Training for *aimag* and *sum* officials and herders.	M	H	S
Production of rangeland and forage related extension material.	L	H	S
Livestock related			
Animal health and disease control.	H	H	S
Training of veterinarians and provision of supplies and equipment.	H	H	S
Training of herders in animal health and disease control.	L	H	S
Genetic improvement of cattle, sheep, and goats through raising and distribution of breeding stock and artificial insemination (AI).	M	H	S
Herd restructuring to reduce numbers of unproductive animals and increase off-take of younger animals.	L	H	S
Promoting raising beef cattle as cow-calf producers, not milking the cows, and selling weaned calves in the fall to feedlots.	L	H	S
Herders keep a small number of improved milk cows (i.e., Alatau, Black & White) to provide milk needs for the household.	L	H	S
Sell lambs in the fall at 8-9 months old or at 15-18 months old.	L	H	S
Improved livestock shelters for winter.	M	M	M
Training for herders on livestock production and management, with special consideration to training needs of women and children.	L	H	S
Market related			
Strengthen linkages between herders and markets (direct marketing by herders to buyers, which bypass changers).	M	H	S
Establish sale barns where weekly or bi-weekly auctions are held in the fall to market cattle and sheep for meat.	M	H	M
Strengthen all the links in the meat value chains.	M	H	S
Promotion of grass-raised beef and lamb.	L	H	S
Promotion of feedlots (intensive livestock raising).	L	H	S
Promotion of milk-production and small-scale dairying.	L	H	S
Policy related			
Analyze current range, livestock, and market policies that are hindering more sustainable, climate-resilient livestock farming.	L	H	S
Provide policy recommendations that are needed to promote sustainable, climate-resilient livestock farming.	L	H	S

9 Potential GHG Emissions and Carbon Sequestration

9.1 Background and Objective

The climate change vulnerability assessment of the local livestock herding systems revealed that several emerging environmental issues in the Bayantumen Soum had been rooted or intensified due to the recent changes in local and regional climates. These issues included: an increase in livestock population and herd size; change in livestock herd mixture; reduction in livestock movements or herders' immobility across the landscape; and migration of unregistered livestock into the area. As a result, the number of livestock in the *soum* has exceeded the grazing capacity of the pastures by 2.8 times and plant communities in a reference or non-degraded state have decreased and dominated by annual and less desirable plant communities. These changes have negatively affected the livelihood and livestock farming of local herders and raised environmental concerns over the rising rate of greenhouse gas (GHG) emissions from both livestock and rangeland degradation.

The Mongolian traditional livestock herding, which significantly relies on native rangelands and pastures, plays an important role in GHG emission and mitigation. Livestock in traditional herding systems produce GHGs directly through enteric fermentation during their digestive process (mainly methane or CH4) and decomposing dung and urine deposited by them on pastures (both nitrous oxide or N2O and methane). However, indirect soil carbon dioxide (CO2) and nitrous oxide emissions from grazing intensification and haymaking or production of supplementary livestock feed and fodder are considered relatively larger sources of GHG emissions from livestock farming practices. If well managed, the natural grasslands that livestock grazes on have a large capacity to remove or store those GHGs and prevent them from being emitted into the atmosphere. For example, grasslands are well-recognized as natural carbon sinks, sequestering substantial amounts of atmospheric carbon dioxide in the form of organic carbon in their soils. Therefore, in addition to supporting herders' livelihoods, natural grasslands and rangelands play a vital role in mitigating climate change across Mongolia.

In Mongolian traditional herding systems, livestock is raised on pastures year-round and is mainly grass-fed and finished. Grass-fed livestock raised in pastures typically produce more methane in their lifetime than livestock raised in feedlot operations. Ingestion of grass forage and hay naturally emit more methane than high-quality feed provided to livestock in the feedlot. Also, methane emissions from grass-fed and pasture-based livestock happen over a longer time as they typically reach the market weight more slowly than livestock raised in feedlots (see Fig. 4 in Section 4). However, from a carbon footprint standpoint, this comparison may be misleading as net GHG emissions can be potentially much lower in pasture-based livestock production systems that are sustainably managed. Much of the carbon footprint of feedlot livestock is associated with growing grain and high-quality forages and comes from land cultivation and the use of fossil-fuel-based agricultural inputs like fertilizers and pesticides. Conversely, pasture-based livestock herding systems are multifunctional and deliver multiple environmental services (See Table 11 in Section 6), including mitigating GHG emissions through carbon sequestration services.

9. Potential GHG Emissions and Carbon Sequestration

Grazing pressure is frequently mentioned as a driver of land degradation across Mongolia. The widespread overgrazing has raised alarming concerns about the environmental sustainability of current livestock herding practices under a changing climate. High grazing intensity shifts pasture vegetation composition towards less desirable plant communities. This lowers pasture forage availability and quality, reduces livestock productivity and performance, and intensifies GHG emissions per unit of live weight gain by livestock (e.g., through a lower rate of forage intake and digestibility and a higher rate of energy consumption and livestock disease in degraded pastures). In addition, overgrazing limits potential carbon sequestration in pastures and accelerates carbon loss from soil by increasing erosion and deterioration of soil structure, particularly soil aggregates, that physically protect organic matter accumulation in the soil. Therefore, optimizing the stocking rates (e.g., through herd restructuring and removal of less productive livestock) and distribution of livestock grazing (e.g., rotational grazing) is critical to fully benefit from the GHG mitigation capacity of natural grasslands and traditional livestock herding practices in Mongolia.

Several key steps must be taken to reverse rangeland degradation trends and restore the GHG mitigation capacity of traditional livestock herding in Mongolia. Among the recommended mitigation pathways to decrease GHG emissions along the livestock value chain in Mongolia, the primary livestock and pasture management practices include:

- supporting the stocking rates that are in line with pasture carrying capacity
- restructuring livestock herds and improving feeding practices and herd productivity
- promoting seasonal pasture rotations and traditional four-season nomadic rotational grazing
- rehabilitating vegetation and enhancing soil carbon sequestration and GHG mitigation capacity in degraded rangeland.

A preliminary GHG emissions and carbon sequestration assessment was conducted to demonstrate the identification and potential adaption of the above-mentioned livestock and pasture management measures for promoting climate-resilient livestock herding practices in the Bayantumen Soum, a district of Dornod province. Specifically, direct GHG emissions by livestock were compared between the current or traditional livestock herding practices and livestock production under improved life cycles and herd structures. In addition, indirect GHG removal through carbon sequestration in pasture soils was assessed under grazing and pasture management practices resulting from improved livestock life cycles and herd structures. Details of the examined livestock and pasture management practices and their outcomes for GHG emission and removal are explained below.

9.2 Potential GHG Emissions

A life cycle assessment approach covering livestock production up to where the cattle and sheep meat products leave the farm (i.e., cradle to farmgate) was used to estimate direct GHG emissions from local livestock farming practices in the *soum*. This mainly included GHG emissions from enteric fermentation and livestock waste. Conservatively, rangeland carbon stores were considered static, and no grazing and haymaking-induced carbon equivalent emission and loss from rangeland soils was assumed. A similar assumption was made for cultivated soil as animal feed and fodder production in the *soum* (i.e., mainly oat, barley, and wheat) is supposed to be limited to the existing cultivated lands (I.e., no land conversion) and typically with minimum use of fossil-fuel-based agricultural inputs.

9. Potential GHG Emissions and Carbon Sequestration

Primarily, the effects of the alternative life cycle (as illustrated in section 4) and cattle herd and sheep flock restructuring scenarios for an average herder household (as explained in section 5) were investigated. This assessment was then further extended by considering GHG emission reduction effects from improved grazing and pasture management (i.e., reduced grazing pressure, rotated grazing, and rehabilitated pasture vegetation and soil) and livestock productivity practices (i.e., improved feeding efficiency, breeding and mortality rate, and livestock care management). Horses and goats were excluded from this assessment, as currently, there is no working market for their meat products.

The overall GHG emissions were estimated using the reported emission intensity factors for different livestock types and production practices. Relevant previous studies and existing GHG assessment tools (e.g., GLEAM and LEAP) were reviewed to obtain realistic uncertainty ranges (i.e., min and max) of GHG emission intensity or kg of carbon dioxide equivalents (CO2e) per head of adult livestock per year. This included GHG emission intensities for cattle and sheep meat production under grass-fed or grass-finished (i.e. mainly raised and fattened on pastures) and mixed operation (i.e. raised and fattened on a combination of pastures and creep feeding or feedlots), as well as under improved grazing and pasture, and livestock productivity management (see Table A1 in Appendix).

The information on GHG emission intensity was then integrated with information on cattle herds and sheep flocks for an average herder household. This includes herd composition, total herd size based on adult cows and sheep, final live weight of sold livestock, and slaughter age (see sections 4 & 5). The rate (kgCO2e/kg live weight) and total annual CO2e emissions (tCO2e/yr) from the current herd and under the proposed cattle and sheep herd restructuring scenarios were then estimated and compared (Table 14). All estimates were obtained by assuming an average climate and livestock-marketing year and based on the best available data from open-access studies and datasets.

Table 14. GHG emissions from current and alternative cattle herd structure and operation scenarios (Note: The green color indicates GHG removal and red means additional GHG emissions).

Cattle Herd Management*	Operation*	GHG Emission							
		Total (tCO2e/yr)		Rate (kgCO2e/kg live weight)		Change in Total (tCO2e/yr)		Change in Rate (kgCO2e/kg live weight)	
		Min	Max	Min	Max	Min	Max	Min	Max
Current (20 adult cows)	Traditional	122	169	27	38	-	-	-	-
Restructured (40 adult cows)	Cow-calf	109	151	12	17	-13	-18	-15	-21
	Grass-finished	161	223	13	18	39	54	-14	-20
	Feedlot-finished	145	201	8	11	23	32	-19	-26
	Cow-calf	76	139	8	15	-46	-30	-19	-22
	Grass-finished	113	205	9	16	-9	36	-18	-21

Cattle Herd Management*	Operation*	GHG Emission							
		Total (tCO2e/yr)		Rate (kgCO2e/kg live weight)		Change in Total (tCO2e/yr)		Change in Rate (kgCO2e/kg live weight)	
		Min	Max	Min	Max	Min	Max	Min	Max
Restructured & grazing/pasture	Feedlot-finished	101	184	6	11	-21	15	-21	-26
Restructured & livestock productivity improved	Cow-calf	94	137	10	15	-28	-32	-17	-23
	Grass-finished	139	203	11	16	17	34	-16	-22
	Feedlot-finished	101	176	6	10	-21	7	-22	-28

* More information in sections 4 & 5.

The results of GHG emissions for the cattle herd and sheep flock of an average herder household is presented in Table 14 and 15. Overall, a relatively high annual rate (on average, 145 and 143 tCO2e) and per unit live weight of GHG emission (32.3 and 23.1 kgCO2e) were respectively estimated for the traditional cattle and sheep herds. Compared to the current herd structure, the annual rate of GHG emission dropped by 43% for the proposed sheep flock. For the restructured cattle herd, it was almost the same for the across the examined life cycle and herd restructuring scenarios, primarily due to a higher rate of GHG emission and the additional cattle finished in the grass-finished operation compared to the traditional operation.

However, when considering the total live weight of sold livestock (as explained in section 5), the GHG emission rate per unit live weight of both cattle and sheep was remarkably dropped across the examined herd restructuring scenarios (64% and 52%, respectively). In addition, improvement in grazing and pasture management and livestock productivity further reduced the GHG emission rate of the restructured cattle herd and sheep flock, particularly under cow-calf and feedlot-finished operations.

Table 15. GHG emissions from current and alternative sheep flock structure and operation scenarios (Note: The green color indicates GHG removal).

Sheep Flock Management*	Operation*	GHG Emission							
		Total (tCO2e/yr)		Rate (kgCO2e/kg live weight)		Change in Total (tCO2e/yr)		Change in Rate(kgCO2e /kg live weight)	
		Min	Max	Min	Max	Min	Max	Min	Max
Current (100 ewes)	Traditional	118	168	17	25	-	-	-	-
Restructured (100 ewes)	Grass-finished	81	115	11	15	-37	-53	-7	-10
	Feedlot-finished	73	104	9	12	-45	-64	-9	-13
Restructured & grazing/pasture improved	Grass-finished	56	106	7	14	-61	-62	-10	-11
	Feedlot-finished	51	98	6	11	-67	-70	-12	-14
Restructured & livestock productivity improved	Grass-finished	63	108	8	14	-55	-60	-9	-11
	Feedlot-finished	51	91	6	11	-67	-77	-12	-14

* More information in sections 4 & 5.

The findings of this assessment support life cycle and herd restructuring as an effective GHG mitigation strategy to protect or even promote herders' livelihoods as they potentially end with more livestock production and with a relatively lower direct GHG emission rate (or higher GHG emission efficiency), in particular when improving feeding practices and herd productivity, and promoting appropriate grazing and pasture management practices.

Rotational grazing is considered an effective way to decrease GHG emissions from herding. Currently, livestock herds in the *soum* are left to graze one area of land continuously, resulting in eating the grass down to the ground, disturbing vegetation and soil carbon stores. If herds are rotated between different areas or seasonal pastures, then carbon stored in the vegetation and soil can remain intact or even enhanced, and further emissions from those sources will be halted. Rotational grazing also drops direct GHG emissions from grazing livestock. The improvements of rangeland vegetation will reflect a reduction in livestock energy use and the proportion of fresh grass in livestock diet due to increased quantity and quality of pasture forage, thus reducing GHG emissions associated with feed and livestock grazing activities.

9.3 Potential Carbon Sequestration

The cattle herd and sheep flock restructuring examples (see section 5) indicated that in the short-term (i.e., 3-5 growing seasons), the number of grazing cattle and sheep for an average herder household in the *soum* could potentially drop by 20% (333 to 267 SUs) and 30% (381 to 264 SUs), respectively under favorable climate conditions. Based on the vegetation plot data and state and transition models (explained in section 2), the majority of vegetation communities within the *soum* area have the potential to recover in the short-term through optimized grazing and pasture management. It was, therefore, assumed that improved grazing management through the livestock life cycle and herd restructuring (i.e., more intensive to less intensive grazing pressure) and promoting seasonal pasture rotations will potentially result in the rehabilitation of vegetation in degraded rangeland and, consequently, enhancement of rangeland soil carbon sequestration and GHG mitigation capacity in the short-term.

The overall carbon sequestration potential of improved rangelands was estimated based on the reported carbon sequestration rates for the relevant vegetation types and grazing or pasture management practices. Relevant studies and reports were reviewed to obtain realistic uncertainty ranges (i.e., min and max) of carbon sequestration rates (tC/ha/yr) for both rangeland vegetation and soil. This included carbon sequestration rates for different levels of vegetation degradation (heavily vs. moderately degraded), grazing pressures (i.e., high vs. moderate) and grazing system (i.e., continues vs. rotational) practices (see Table A2 in Appendix).

Reasonable carbon sequestration uncertainty ranges were then assigned to the four main ESGs that characterize dominant vegetation communities and soil types in the *soum* area (Table 16; More information in section 2). The assignment of carbon sequestration uncertainty ranges was done by considering coarse estimates of the current state of vegetation and soil and rough estimates of the distribution and area proportion of seasonal pasture types across different ESGs. Finally, the area of different ESGs was used to estimate the total annual potential carbon sequestration of *soum*'s rangeland under improved grazing and pasture management in average climate conditions.

The estimated potential carbon sequestration of improved soil and vegetation across the *soum*'s rangelands is presented in Table 16. Overall, applying carbon sequestration coefficients to the major ESGs in the *soum* area led to an annual sequestration estimate of 99.8 to 224.3 thousand tons of carbon or 366.1 to 897.1 thousand tons of CO2e from rangeland vegetation and soil, of which 86.8% to 93% originated from carbon sequestration in rangeland soil and the remains from carbon sequestered in improved rangeland vegetation. Accordingly, the corresponding annual sequestration rate across different ESGs was 0.12 to 0.27 tons carbon per hectare per year or 0.44 to 1.07 tons CO2e per hectare per year.

Considering annual conservative GHG emission rates of 1814 and 234 kg CO2e per head of cattle and sheep respectively (see Table A1 in Appendix), the carbon sequestration potential of improved rangeland can annually mitigate direct GHG emissions from 202 to 495 thousand cattle heads or 1,570 to 3800 thousand sheep heads. Also, considering an annual conservative carbon removal of 20 kg from the air through photosynthesis by a typical young tree, the carbon removal potential of improved rangeland can annually be equal to carbon removal by 18.3 to 44.8 thousand trees.

Table 16. Potential carbon (C) sequestration of different ecological site groups under improved grazing and pasture managements.

Ecological Site (ESGs)*	Area (10^3 ha)	Vegetation C Sequestration				Soil C Sequestration			
		Total C (10^3t/yr)**		Total CO2e (10^3t/yr)!		Total C (10^3t/yr)		Total CO2e (10^3t/yr)	
		Min	Max	Min	Max	Min	Max	Min	Max
6. *Stipa Krylovii*-Small bunch grass-Forbs dry steppe rangeland	302.0	5.7	6.8	20.9	24.8	45.3	102.7	166.1	442.9
9. *Stipa grandis*-*Elymus chinensis*-Forbs dry steppe rangeland	275.7	4.3	5.1	15.9	18.8	13.8	41.4	50.5	151.6
7. *Stipa krylovii*-grass dry steppe rangeland	192.2	2.8	3.3	10.3	11.9	19.2	48.0	70.5	176.1
10. *Achnatherum splendens* rangeland	55.8	0.3	0.4	1.2	1.4	8.4	16.7	30.7	69.5
Total	**835.7**	**13.2**	**15.5**	**48.3**	**56.9**	**86.7**	**208.8**	**317.8**	**840.2**

* More information in section 2; Fig. 1 & Table 1.
** Carbon sequestration rates across ESGs ranged from 0.006 to 0.022 and 0.05 to 0.34 tC/ha/yr for vegetation and soil, respectively (see Table A2 in Appendix).
! A conversion factor of 44/12 or 3.67 was used to calculate the CO2e of the carbon sequestration estimates.

9.4 GHG Emission and Removal Impact

The analysis of the historic livestock population statistics indicated an overall increase of 57% in livestock population size between 2017 and 2021 (Table 17). Considering this historical rate of change, by 2025, the total livestock population in the *soum* can be potentially increased by 143 thousand heads of livestock, which translates to an estimated total of 91.8 thousand tons of extra CO2e emissions from the livestock sector. While, taking livestock population measures such as restructuring cattle herds and sheep flocks and, for example, preventing further increases in the populations of other livestock types (in particular, horses and goats) can lead to a projected livestock population size between the 2017 and 2021 levels. In other words, if appropriate measures are taken to prevent and remove additional livestock heads from the region, by 2025, a total of 113 thousand tons of extra direct CO2e emissions can potentially be removed from the livestock sector, and the overall GHG emission of the sector can potentially decrease to a level below the 2021 level (Table 17).

Table 17. Historical and projected livestock population and GHG emission (Note: The green color indicates GHG removal or no emission and the red mean additional GHG emissions).

Description	Scenario	Year	Livestock Types					
			Horse	Cattle	Camel	Sheep	Goat	Total
Livestock Population (10^3 heads)	Historic	2017	25.1	17.6	0.7	70.1	45.6	159.0
		2021	38.4	30.9	0.9	109.8	69.5	249.6
	Change (%)	2017-2021	53.2	76.1	36.8	56.7	52.4	57.0
	Projected	2025	58.8	54.4	1.3	172.1	106.0	392.6
	Optimized*	2025	38.4	24.7	0.9	76.9	69.5	210.5
GHG intensity (tCO_2e/head/yr)!			0.91	2.06	1.61	0.26	0.23	-
GHG emission ($10^3 tCO_2e$/yr)	Historic	2017	22.7	36.2	1.1	17.9	10.4	88.3
		2021	34.8	63.8	1.5	28.0	15.9	143.9
	Projected	2025	53.3	112.4	2.1	43.9	24.2	235.7
	Optimized	2025	34.8	51.1	1.5	19.6	15.9	122.8
GHG emission change ($10^3 tCO_2e$/yr)	Historic	2017-2021	12.1	27.6	0.4	10.1	5.5	55.6
	Projected	2021-2025	18.5	48.6	0.6	15.9	8.3	91.8
	Historic - Optimized	2021-2025	0.0	-12.8	0.0	-8.4	0.0	-21.2
	Projected - Optimized	2025-2025	-18.5	-61.3	-0.6	-24.3	-8.3	-113.0

* Based on 20% and 30% reductions for cattle and sheep populations, respectively, due to herd restructuring. For other livestock types, the population was kept at the same size as in 2021.
! Values are based on Shi et al., 2022 (Front. Public Health, 11).

These simple estimates of GHG projections for the year 2025 are based on coarse GHG emission intensities for different livestock types and by considering assumptions like no improvement in livestock productivity and management and no major climate event or market condition that drastically alter livestock number in the *soum*. However, when you put these estimates of direct annual GHG emissions in 2025 together with the annual potential carbon sequestration from rangeland, if no adaptive measures are taken to prevent and remove additional livestock from the landscape and rehabilitate soil and vegetation of degraded rangelands in the *soum*, then in the year 2025 alone, an estimated total GHG emission removal opportunity of 479 to 1010 thousand tons of CO2e from the *soum*'s livestock sector will be missed. This would roughly equal annual carbon removal by 23.9 to 50.5 thousand trees (i.e., 20 kg CO2e/yr removal by a single young tree).

These figures demonstrate the large mitigation potential of GHG emissions from the livestock sector, particularly through carbon sequestration in vast rangeland areas of the *soum* and the country. It also demonstrates the importance of developing effective climate-resilient pasture management measures and policies that, while sustaining herders' livelihoods under a changing climate, promote the provision of undervalued environmental goods and services from rangelands (see section 6), including their carbon sequestration and GHG mitigation capacity. Local herders must play a fundamental role in the development process of new policies, as they deeply understand their surrounding landscapes and the environmental good and services essential to their herding livelihood systems.

9.5 Conclusions and Limitations

This preliminary assessment demonstrates the potential GHG emission and removal from the traditional livestock sector in the Bayantumen Soum. It demonstrates how restructuring the existing livestock herds and improvement in grazing and livestock management can potentially increase the GHG emission efficiency of livestock products (i.e., lower CO2e intensity per unit of live weight) while increasing the total production of livestock live weight for an average herder household. Even more remarkably, it demonstrates the considerable opportunity for GHG removal and mitigation through carbon sequestration in the degraded rangeland soil and vegetation that can potentially be restored through improved livestock and grazing practices, as explained in section 8.

Efforts to address livestock related GHG emission risks are likely to require systemic changes in Mongolian livestock management and marketing to sustain herders' incomes over the long term. Community-based rangeland monitoring and management can support local agreement on livestock mobility or seasonal pasture rotation, an adaptive strategy traditionally used by Mongolian herders to prepare for and respond to pasture and climatic conditions. In addition, adaptive measures that reduce livestock mortality and increase livestock productivity are required to minimize the herders’ only offset mechanism or increasing their herd size to compensate for possible livestock losses from harsh climate seasons (i.e., like dzud).

Establishing feedlots for mixed livestock production systems (i.e., feedlot-finished) requires further assessment. On the one hand, feedlots get grazing livestock off the pasture, thus contributing to grazing pressure adjustment while raising more livestock in a shorter period and lowering GHG emissions per kg of livestock product compared to grass-finished production systems. On the other hand, feedlots in mixed systems require special diet composition in different stages (e.g., high fibrous ingredients in the growing stage and high-energy grains during the finishing stage). This can potentially lead to increased CO2e emissions related to feed production, processing and transport. Therefore, decision-making should pay much attention to the source and type of feed that will be fed to the livestock. In addition, the concentration of livestock over small areas can lead to challenges in manure management and, eventually, higher GHG emissions and water pollution issues. Legumes as protein-rich and nutritious feed for the livestock can enrich soils with nitrogen, increase forage production, and promote carbon sequestration at a rate that, in some cases, is less achievable through other practices in cultivated lands. Using legume species for livestock feed and fodder production and promoting them in rangeland vegetation composition can be an adaptive measure for mitigating GHG emissions and climate change impacts.

Reports about GHG emissions and carbon sequestration rates are particularly rare for Mongolia. While great care has been taken to ensure that the input data and the results were of the highest quality possible, there remain several limitations in the underlying datasets and therefore projected changes. These results provide a basis for identifying adaptation pasture and livestock management measures that target the mitigation of GHG emissions from the livestock sector. However, they also suggest that more effort needs to be put into a systematic assessment of the sector’s potential GHG emissions and removal. This includes considering the IPCC Guidelines Tier 3 methods that require locally appropriate emission factors for different livestock types and practices that can be obtained though direct measurement of GHG emissions from different aspects and stages of the livestock life cycle.

10 Gender

10.1 Gender and Social Inclusion Considerations

Target groups of promoting gender equality and social inclusion

According to findings of the vulnerability study that was carried out in June 2022, women and young herders, men, single headed-household and households with few livestock are more vulnerable to climate change. Therefore, in terms of provision of gender equally and social inclusive participation we have to consider on the advantages and disadvantages, and opportunity and threats of the above-mentioned target groups (Table 18).

Table 18. Advantages, disadvantages, opportunity and threats of the target groups in relation to pasture degradation

	Households with small # of livestock	Women		Men single headed household	Young herders
		Married women	Women headed household		
Advantage in relation to pasture degradation	Few livestock	Better condition of investment and human resource for improving livestock production; Better education	Few livestock	Few livestock	Few livestock
Disadvantage	With no land ownership; Low income; Lower owned capital; Lower participation in community decision making	Low income; Lack of participation during school year; Lack of decision-making power; Lower owned capital; Lower participation in community decision making	With no land ownership; Low income; Lower owned capital; Lower participation in community decision making	With no land ownership; Low income; Lower owned capital; Lower participation in community decision making	With no land ownership; Low income; Lower owned capital; Lower participation in community decision making
Risks	Increase number of own and other's livestock	Increase number of own livestock	Increase number of own livestock	Increase number of own and other's livestock	Increase number of own and other's livestock
Opportunity	Increase efficiency of the unit of livestock, Participate in crop farming,	Milk and dairy production; Increase efficiency of the unit of livestock	Increase efficiency of the unit of livestock Participate in crop farming,	Increase efficiency of the unit of livestock Participate in crop farming,	Increase efficiency of the unit of livestock Participate in crop farming,

10. Gender

	Households with small # of livestock	Women		Men single headed household	Young herders
		Married women	Women headed household		
	feeding and slaughtering	Participate in crop farming, feeding and slaughtering	feeding and slaughtering	feeding and slaughtering	feeding and slaughtering

A community-based approach is generally equitable, sustainable and legitimized strategies for the pasture management. Although, there are several herders' groups and cooperatives that are attempting to create grassroots community-based groups at the target soum, there are significant differences between the goals of such interventions and the reality of these groups. It is often observed that the groups or cooperatives disappear after the project is completed if a rich or powerful person in the community is selected as the leader; and actual participation of the herders with few animals, women, and young herders' in the group or cooperative is not ensured. Therefore, it is necessary to ensure the active participation of all stakeholders as much as possible when creating a group and defining common goals as a group from the beginning.

A herders' group is possible to exist sustainable if all members are able to participate equally in all stages to solve their problems including describing their problems, determining problem solving options, implementing measures, and monitoring and evaluation. Therefore, a key strategy to promote equal participation is provision of gender equality and social inclusion.

In order to ensure gender equality and social inclusion in the selected pasture management methods, it is necessary to pay attention to create a structure that can effectively ensure target groups' real participation. According to the existing statistical information, target groups in Bayantumen *soum* and 4th *bagh* have very limited opportunities to express their voice in the decision-making processes, and it is difficult to benefit equally from the public policies and measures for them (Table 19). One of the reasons of no concerted effort by authorities to support reducing livestock numbers is lacking opportunities of the herders with few livestock to influence on decision making process.

Table 19. Men and women's participation at the decision-making level of the target soum and bagh

	Man	Woman	Total
Chairman of *soum*'s Citizens' Representatives' Khural (CRK)	1		1
Representative of *soum*'s CRK	16	5	21
Herder representative of *soum*'s CRK	3 (1 is from 4th bagh)	1 (with higher education certificate)	4
Soum Governor		1	1
Council of *soum* governor	5	8	13
4th bagh Governor	1	1	
Citizens' council of *bagh*	5	2	7

10. Gender

	Man	Woman	Total
	Rich herder	Middle	Lower
Herder representative of *soum*'s CRK	2	1	1

The following steps should be taken to create a structure that can effectively ensure target group's real participation:

1. Create sub-groups or councils of women, young people and herders with less than 300 livestock within herders' groups or cooperatives
2. Organize trainings with the aim to develop members' life skills and leadership of the sub councils
3. Update a rule of herders' groups' or cooperatives integrating sub councils' voice
4. Introduce participatory monitoring and evaluation methodology to groups' or cooperatives activity.

It is possible to involve women and young herders in the photo monitoring of the pasture. Young people have better IT and phone skills since they use smart devices, and women are more educated than men of the target *soum.* Therefore, they are able to work on the data analysis by integrating and comparing data and use findings for their pastureland management.

Herder households that used to work in the soum dairy production farm have mainly cattle. A few of them sell milk and dairy products every day in Choibalsan city. Transportation is the main challenge for women headed household and women who have few cattle. If they are engaged and organized as a group, it is possible to solve transportation related problems to sell their products. Thus, group management and trainings to improve financial, business and marketing skills are crucial for them.

We mentioned that officials recognize the need for feed and fodder, and proper animal nutrition through year to meet the meat demand. It requires more use of feed/fodder all year around and crop farmers need to start growing forage/fodder crops in order to improve livestock production in Bayantumen soum. If crop farmers collaborate with the local herders, they need more workers and it is needed to restructure or organize work force of the target *soum* or *bagh* properly.

On the other hand, when households with a large number animals decrease number of their livestock for matching to pasture carrying capacity it is important to feed the animals all year round for create more profit for them. In order to feed animal throughout a year, herders need to re- arrange and organize work force at the target *soum* or *bagh*. If households with many livestock hire herders who have few livestock according to the Labour Law of Mongolia, they will mutually be benefited. If they have same knowledge and information on sustainable pastureland use and labour relations and able to negotiate equally, they would mutually benefit from their cooperation. Therefore, trainings on sustainable pasture management with integration of human rights and labour law regulation that training process provides opportunities for equal participation and learning from each other is essential for all parties. In some cases, herders with few livestock find an alternative income source and increase their income and do not want to herd others' livestock for making money. This would be an option to stop livestock migration to this area.

In addition, reducing the separation of the family during schooling will support female herders' participation in livestock herding. The separation creates a lack of human resource of household farming and increases household cost, as well as women are becoming economically independent from their husband or partner. In order to decrease the separation of the households it is crucial to improve accessibility and service quality of the school dormitory. Totally, 155 students study at the Bayantumen's secondary school and 40 students aged between 6 and 18 stay at the school dormitory equipped with toilets and showers. 4-6 students share a dormitory room. It is observed that households who have close relatives in a soum or aimag center or have their own houses do not prefer to send their children, especially young children aged between 6 and 8 years old, to the dormitory. Most parents are not satisfied with dormitory's condition, safety and child protection service. Therefore, two options to improve dormitory condition and child protection service or to create a bagh school with alternative program of elementary education for herders are both significant.

Youth, especially young women are moving to the urban area of Mongolia. Therefore, preparation of young herders is one of the problems faced by herders. Local authorities do not pay attention on policies and measures to encourage young people, especially young women, to work at the livestock production. Although, secondary schools provide a career counseling service to students, the local authority do not participate in this service and do not concern on this issue. The gender responsive career counseling is essential for preparation to young generation of the herders.

Legislation Framework for Promotion of Gender Equality

The first ever Constitution of Mongolia, adopted in 1924, guaranteed the equal rights for men and women under the concept of "no person may be discriminated on the basis of ethnic origin, sex, or religion" which remained throughout the adoption of the Constitutions in 1940 and 1960.

According to the Constitution of Mongolia (1992), "no one shall be discriminated against because of ethnicity, language, race, age, gender, social origin, or status" along with "equal rights in politics, economics, society, and culture", and everyone has "equal rights in the field of employment, occupation and official position," and "equal rights in education, faith, conscience, conviction, and opinion". Moreover, the adoption of Law on Promotion of Gender Equality (2011) ensured the equal rights for men and women to abolish discrimination on the basis of sex in political, legal, economic, social, cultural and family relations, and regulates its implementation. This law broadly provides the fundamental regulation in political, legal, economic, social, cultural, and family spheres.[12]

Article 19.1.1 of this law mandates of the central and local government agencies to introduce a methodology to incorporate gender considerations in local and sectoral policies, general strategies, programs and projects; to conduct gender analysis of drafts of these documents and review and comment on their reports and to request appropriate funding and budget.

On top of the above-mentioned fundamental laws aligned with gender equality, the following laws guarantees men and women's equal rights as well as providing regulation on discrimination on the basis of

[12] Law on Promotion of Gender Equality, 2011

sex: Labor Law of Mongolia, Law on Combating Domestic Violence, Special Law on Combatting Human Trafficking, Family Law, Criminal Code, and Civil Law.

Conventions and agreements relating to the gender equality Mongolia has ratified and signed

Mongolia has entered into over 200 multilateral agreements and has concluded over 2,000 bi-lateral agreements as of 2015. [13]. On July 10, 1980, Mongolia signed the Convention on the Elimination of All Forms of Discrimination against Women as well as signed its Additional Protocol, which aims to ensure women's rights and gender equality.

Mongolia ratified a number of conventions, including Discrimination (Employment and Occupation, C111), Equal Remuneration Convention (Equal Pay for Equal Work, C100), Convention on the Rights of Persons with Disabilities, Universal Declaration of Human Rights, Convention on the Rights of Children, and Convention on the Political Rights of Women. In case of conflict with national laws, international agreements and conventions must be complied by the member state. By ratifying these international agreements and conventions, Mongolia shows its strong commitment to ensure women's rights and gender equality at all levels of society.

The SDG 2030 are a set of universal goals adopted by the United Nations General Assembly in 2015 to eradicate poverty, protect the planet, and ensure peace and prosperity for all people by 2030. SDGs have become a milestone not only for UN projects, but also for KFW, the World Bank, and the EBRD. Goal No.5 of the SDG 2030 specifically focuses on "gender equality and empowerment of girls and women", and in this context, "care and unpaid domestic work should be recognized and valued through the provision of public services, infrastructure, social services, and infrastructure and social protection policies, and the promotion of shared responsibilities with the household and the family as nationally appropriate".

Inter-sectoral Strategic Plan on Gender Equality

Currently, the National Committee on Gender Equality (NCGE) is developing the Inter-sectoral Strategic Plan on Promotion of Gender Equality in Mongolia (2022-2031). This strategic plan is pursued for satisfactory implementation and continued implementation of the Law on Promotion of Gender Equality, Mongolia’s 2050 Vision-Long term Development Policy and Sustainable Development Goals objectives to introduce gender-responsive policies, planning and budgeting at all levels, and provide equal opportunities for men and women, and girls and boys to participate in social, cultural, economic, political, and family life.

The Strategic Plan consists of five objectives with a total of 20 sub-objectives to ensure adoption of the sectoral gender-responsive policies and strategies. Moreover, the concepts and each objective directly and indirectly relate to herder population. Especially, 5th objective of the strategic plan considered to promote gender equality in climate change adaptation and mitigation and it includes the following sub objectives:

> 3.5.1. gender sensitization in policy planning and implementation on climate change mitigation and adaptation;

[13] The National Legal Institute of Mongolia, 2015

3.5.2. ensure equal gender participation in environment protection, fostering sustainable consumption and increasing green job places;
3.5.3. capacity building of for women, men and social groups to participate in mitigation processes of climate change.

In addition to this, within 1st objective it was considered to improve life condition of rural girls and women. The strategic plan can be used as the policy background for gender mainstreaming in program developing for male and female herders.

Gender related policies and regulations in livestock herding and climate change adaptation and mitigation

The National Action Program on Climate Change (NAPCC) implemented since 2011 with aims to help Mongolia create the capacity to adapt to climate change and establish green economic growth and development. But it was canceled after the approval of Mongolia's 2050 Vision-Long term Development Policy in 2021 within the framework of the implementation of the law on Development Policy, Planning and its Management. Goal 6 of the Mongolia's 2050 Vision-Long term Development Policy considered promoting an environmentally friendly green development and developing climate change mitigation and adaptation capabilities, as well as goal 8.3 focuses on the developing sustainable agriculture that is environmentally friendly, adaptable and resilient to climate change. However, the goals of these policies are not sufficiently integrated with the gender mainstreaming policy.

The Environmental sector Gender Strategy (2014-2030) is one of the gender responsive policy documents at the sectoral level. This policy aims to build capacities to implement gender mainstreaming in policy planning; to implement gender sensitive practice in the environmental sector and its management, and to expand women's and men's participation in green development processes and open up broader avenues for equal access to benefits. Within the framework of third objective of the strategy focuses on ensuring more effective participation of local citizens and groups of communities in the planning, implementation and as well as the evaluation phases of the environmental sectoral policies.

Gender responsive policy in the food, agriculture and light industry sector was approved in 2018. Within the framework of the Objective 2, the following measures for male and female herders will be implemented:

1. Plan and implement socio-economic and culturally comprehensive measures toward providing support to herder-households' development and train future generation herders to keep the continuity of legacy.
2. Encourage agriculture related rational and reasonable skills and practices for female and male herders and crop-farmers based on their differentiated needs and facilitate improving their social responsibilities.
3. Create an accessible network of professional consulting services and business incubators at local areas for women and men engaged in the SMEs and household productions based on their differentiated needs and requirements.

10. Gender

Within the framework of the Objective 3, the following measures for male and female herders will be implemented:

1. Strengthen the capacities towards taking a leadership role in the implementation of the UN Resolution on Achieving Gender Equality and empowering rural women and girls at national and international levels.
2. Strengthen national capacities for encouraging domestic production, sustainable and reasonable consumption, based on differentiated gender roles and responsibilities of users at all levels.
3. Facilitate improving the coherence and efficiency of donor and international organizations' cooperation and coordination towards ensuring gender equality in the food, agriculture and light industry sector.

Evaluation of the findings of the gender responsive policy in the food, agriculture and light industry sector reveals that there are ambitious and a large number of activities were planned the policy and its implementation plan. The policy and its implementation were not introduced to all staffs at the sectoral unit, especially at the soum level and the sectoral sub council does not provide them a detailed guidance to implement the specific activities to achieve its objectives. The coordination within the sector, cross sectors and stakeholders to implement the policy was not satisfied. Some activities had been implemented within the framework of the national and local project with the international, or donor organizations' supports and initiative[14]. Although, clear guidance on the gender mainstreaming in the policy documents is not provided, the projects of international, or donor organizations are supportive to implement this policy.

To conclude, sectoral gender policies have been adopted at the related sectors but their implementation is not sufficient. These policies' objectives and commitments are considered as a gender framework for intended activities of this field, but much more needs to be done to ensure they are actually implemented.

[14] EU, MONES (2022) Evaluation of the Food, Agriculture and Light Industry Sector Gender Responsive Policy. Ulaanbaatar

Annex A: GHG and Carbon Sequestration Calculations

Table A1: Reported emission intensity factors for cattle and sheep under different grazing management and production practices.

Location	Cattle						Sheep						Reference	Remarks
	Baseline		Pasture		Livestock		Baseline		Pasture		Livestock			
	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2e /head)	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2e /head)		
Mongolia	10.8		9.9				15.4		13.1				Asian Development Bank, 2013 (Publication Stock No. RPT136010)	
Argentina	19.6		13.7		17.8								Nieto et al., Sustainability 2018 (10)	Rotational vs Continuous grazing
Scotland								210			163		Moxey & Thomson, 2021, Scottish Government (Sheep Emission Report)	
India							9.5	350						
Mediterranean													Ripoll-Bosch et al., 2013, Agric. Syst. (116)	Zero grazing and pasture grazing : 19.5 and 25.9 kg CO2e per kg of LW
New eland	6.9	####					17	300					Carbon Farming Group, 2021; https://www.carbonfarming.org.nz/	
China													Tang et al., 2019, Science of the Total Environment (654)	methane emission decrease up to 50 % from HG to MG
Western Canada	10.4						13.2						Dyer and Desjardins, 2014, Sustainable Agriculture Research (19)	
Western Australia							8.2				7.7		Black et al. 2021, Animals (11)	livestock productivity improvement of 10% results in 6.5 % decrease in emission.

Table A1 continued

Location	Cattle						Sheep						Reference	Remarks
	Baseline		Pasture		Livestock		Baseline		Pasture		Livestock			
	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2e /head)	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2 e/head)	(kg CO2e /kg LW)	(kg CO2e /head)		
Mongolia	10.8		9.9				15.4		13.1				Asian Development Bank, 2013 (Publication Stock No. RPT136010)	
Argentina	19.6		13.7		17.8								Nieto et al., Sustainability 2018 (10)	Rotational vs Continuous grazing
Scotland								210			163		Moxey & Thomson, 2021, Scottish Government (Sheep Emission Report)	
India							9.5	350						
Mediterranean													Ripoll-Bosch et al., 2013, Agric. Syst. (116)	Zero grazing and pasture grazing : 19.5 and 25.9 kg CO2e per kg of LW
New eland	6.9	####					17	300					Carbon Farming Group, 2021; https://www.carbonfarming.org.nz/	
China													Tang et al., 2019, Science of the Total Environment (654)	methane emission decrease up to 50 % from HG to MG
Western Canada	10.4						13.2						Dyer and Desjardins, 2014, Sustainable Agriculture Research (19)	
Western Australia							8.2				7.7		Black et al. 2021, Animals (11)	livestock productivity improvement of 10% results in 6.5 % decrease in emission.

Table A2: Reported carbon sequestration rates under different grazing management and production practices.

Vegetation Type	Soil depth (cm)	SOC (tC/ha)	Baseline		Pasture/ grazing		Reference	Remarks
			Rate (tC/ha/yr)	Rate (t CO2e/ha/yr)	Rate (t SOC/ha/yr)	Rate (t CO2e/ha/yr)		
Downstream wetland	0-100	65.0					Liu et al., 2022; Ecological Indicators 139 (2022) 108945	
Semi-arid grassland					0.10	0.35	Asian Development Bank, 2013 (Project No. 47286-001)	
Semi-arid grassland					0.03	0.12	Asian Development Bank, 2013 (Publication Stock No. RPT136010)	Improved grassland management; Conservatively assumed no soil carbon emission in baseline
Semi-arid grassland							Byrnes et al. 2018, J. Environ. Qual.(47)	Heavy grazing decrease soc by 14%
Semi-arid grassland							Byrnes et al. 2018, J. Environ. Qual.(47)	Rotational vs. contineous grazing increase soc by 29%
Mountain steppe - heavily degraded	0-20		0.26	0.95			Chang et al. 2015, Agriculture, Ecosystem and Environment (212)	
Mountain steppe - heavily degraded	0-20	10.9					Chang et al. 2015, Agriculture, Ecosystem and Environment (212)	
Mountain steppe - lightly degraded	0-20		0.30	1.10			Chang et al. 2015, Agriculture, Ecosystem and Environment (212)	
Mountain steppe - moderately degraded	0-20	31.0					Chang et al. 2015, Agriculture, Ecosystem and Environment (212)	
Mountain steppe - moderately degraded	0-20		0.35	1.28			Chang et al. 2015, Agriculture, Ecosystem and Environment (212)	
Riparian meadow - heavily degradated	0-20	17.0					Chang et al. 2015, Agriculture, Ecosystem and Environment (212)	
Riparian meadow - moderately degraded	0-20	34.5					Chang et al. 2015, Agriculture, Ecosystem and Environment (212)	
semi-arid grasslands					0.05	0.18	Conant and Paustian, 2017, Ecological Applications (11)	Change from overgrazed to moderately grazed
Meadow steppe	0-20	66.5					Dai et al. 2014	
Typical steppe	0-20	34.1					Dai et al. 2014	
Grassland							Eze et al., 2018, J. Environ. Manage.(223)	Heavy grazing decrease soc by 27%
Grassland							Eze et al., 2018, J. Environ. Manage.(223)	Sowing legumes increase soc by .4 to .9 ton/ha/yr
Grassland			0.27	0.99			Fan et al., 2012, Grassland and Turf (32)	
Typical steppe	0-30	22.7					Feng et al. 2019	
grassland			0.49	1.80	0.39	1.80	Garnett et al., 2017, University of Oxford	Review of literature

Table A2 Continued

Vegetation Type	Soil depth (cm)	SOC (tC/ ha)	Baseline		Pasture/ grazing		Reference	Remarks
			Rate (tC/ha/yr)	Rate (t CO2e/ ha/yr)	Rate (t SOC/ha /yr)	Rate (t CO2e/ha/yr)		
rangeland					0.06	0.23	Henderson et al. 2015, Agriculture, Ecosystem and Environment (207)	Change in grazing pressure; Conservatively assumed no soil carbon emission in baseline
rangeland					0.55	2.00	Henderson et al. 2015, Agriculture, Ecosystem and Environment (207)	Legume sowing add 2 t/co2/ha/yr (compensation for nitrous oxide emission); Conservatively assumed no soil carbon emission in baseline
Semi-arid grassland					0.15	0.55	Henry et al., 2015	Due to vegetation recovery/ improvement; Conservatively assumed no soil carbon emission in baseline
Semi-arid grasslands					0.10	0.36	Lal, R., 2004, Geoderma (123)	Improved grazing practices; Conservatively assumed no soil carbon emission in baseline
Semi-arid grasslands					0.20	0.73	personal communication	
Semi-arid grasslands							Sagar et al. 2019 Journal of Plant Ecology (12)	Conversion of biomass to carbon - 41% for Stipa species
Mountain steppe		26.6					Upton et al., 2015, Plan Vivo Project Design Document	
Mountain steppe					0.03	0.10	Upton et al., 2015, Plan Vivo Project Design Document	Grazing pressure from 80 to 50%
Mountain steppe - summer					0.08	0.12	Upton et al., 2015, Plan Vivo Project Design Document	Grazing pressure from 80 to 50%
Mountain steppe - winter					0.08	0.28	Upton et al., 2015, Plan Vivo Project Design Document	Grazing pressure from 80 to 50%
Riparian meadow		31.7					Upton et al., 2015, Plan Vivo Project Design Document	
Riparian meadow - summer					0.10	0.36	Upton et al., 2015, Plan Vivo Project Design Document	Grazing pressure from 80 to 50%
Riparian meadow -winter					0.05	0.02	Upton et al., 2015, Plan Vivo Project Design Document	Grazing pressure from 80 to 50%
Mountain steppe -Moderately degraded	0-20	33.2					Wang et al., 2013	
Mountain steppe -haveliy degraded	0-20	11.8					Wang et al., 2013	
Riparian meadow - Moderately degraded	0-20	24.1					Wang et al., 2013	
Riparian meadow -haveliy degraded	0-20	16.3					Wang et al., 2013	
Mountain steppe -Moderately degraded	0-20				0.21	0.77	Wang et al., 2013	Between 0.13～ 0.65 t C ha-1yr-1 for degraded pastures under changed grazing (summer grazing)
Mountain steppe -haveliy degraded	0-20				0.34	1.25	Wang et al., 2013	Between 0.13～ 0.65 t C ha-1yr-1 for degraded pastures under changed grazing (summer grazing)
Riparian meadow - Moderately degraded	0-20				0.22	0.81	Wang et al., 2013	Between 0.13～ 0.65 t C ha-1yr-1 for degraded pastures under changed grazing (summer grazing)
Riparian meadow -haveliy degraded	0-20				0.28	1.03	Wang et al., 2013	Between 0.13～ 0.65 t C ha-1yr-1 for degraded pastures under changed grazing (summer grazing)
Typical steppe	0-100	67.0					Yang et al. 2007	
Typical steppe							Zhou et al. 2017, Glob. Chang. Biol.(23)	Heavy grazing decrease soc by 10%