Master’s Thesis

A STUDY ON LIVESTOCK AND LAND MANAGEMENT IN KYRGYZSTAN

ZHUMANOVA MUNAVAR

Graduate School for International Development and Cooperation
Hiroshima University

September 2011

Title of the Master's Thesis	*A Study on Livestock and Land Management in Kyrgyzstan*

Student ID Number ________
Name of the Student Munavar ZHUMANOVA
Main Academic Advisor Professor Keshav Lall MAHARJAN

Abstract

Kyrgyzstan is a mountainous country with the livelihood condition of its population determined by climate, landscape, soil, water resources, biodiversity, as well as social and economic conditions. Most of its population derives a substantial proportion of its income from livestock rearing and farming. Moreover, mountainous pastures, which consist 86% of total agricultural land, favour livestock in Kyrgyzstan. The population of all livestock species has been constantly increasing over the years with decline in productivity at national level. Thus, increase in livestock production is realized by mainly increase in numbers of animals. This study's specific objectives are to study the trends in population and composition of livestock diversity by comparing two types of agro-pastoral systems (mainly livestock-additional crop and mainly crop–additional livestock). It also analyses feed types and feeding systems and derived productivity of livestock. It studies cropland and pastures management by analysing economic cost-benefits from crops, and seeks to measure the condition and botanical composition of pastures by assessing the extent of their utilisation. Moreover, it examines the social and economic context of agro-pastoral systems in terms of income sources. A household survey was conducted by administering semi-structured questionnaires to households and pastoralists. And pasture measurement survey in two Village Governments (VGs) of Ala-Buka district. It was done to understand the factors effecting agro-pastoral systems and mountain pastures.

From the survey and analysis of agro-pastoral systems, it was found that considerable

changes are taking place in livestock population, herd composition, and management systems with different predominance of livestock species. Changes in livestock population are closely associated with land holding, forage and pasture availability. The households' perceptions about the changes in their herd sizes show that the total livestock population is increasing in both VGs. In Torogeldy Baltagulov Village Government is 65% and in 1-May Village Government is 62% respectively. The main reason for the changes in herd composition are income level from livestock and market demand for livestock and its products in general. The most noticeable change is the considerable decline in cattle and goats numbers in BVG, and in sheep numbers in MVG households. The higher number of cows correlates with the major reason of keeping cattle for dairy products; mainly self-consumption and selling extra products in the market, and also using dung as winter fuel. Horse and donkey numbers increased due to the necessity of draft power in the households (HHs).

The increase in the number of horses and donkeys can be an indication of advanced rural poverty as the poor prefer to use livestock in order to avoid extra expenditure for tractor services, such as fuel and rent payments to tractor owners. It can also attributed to insufficient numbers of agricultural machines during land preparation, intercultural operations, harvesting and transporting. On the other hand, the increase in the use of livestock for agricultural purposes decreases the use of agricultural machines; thereby leading to low carbon agriculture. This will be crucial in mitigating the adverse impacts of climate change on human beings and environment through reduced GHG emissions. Forage scarcity is considered the main factor regulating the herd size. Forage scarcity occurs at the end of winter. The main reason of forage scarcity is caused by lack of enough time for hay making during summer. Time shortage for hay-making corresponds with the changing weather condition as climate change causes the depletion of forage species in nearby pasture. Forage availability and scarcity affect milk yield and the shape of lactation curve. On the other hand, lack of breeding technology (artificial insemination) and unplanned calving without considering forage availability decreased the productivity of cows. Thus, lactation curves were very sensitive in winter and autumn calving season in MVG and winter and summer calving season in BVG. Besides, the majority number of cows falls under those calving seasons, which are suffering from ‘low productivity’. As a result, this affects the total milk yield as cows are becoming less productive; thereby decline in productivity. However, the total milk produced in the district as well as at national level is still increasing due to the increase in the number of cattle.

The cropping patterns in the study area vary for self-consumption, forage and cash income. Majority of HHs in BVG used the main land area for wheat (self-consumption) growing, whereas in MVG, maize (forage) was grown in large areas. However, wheat cropland area decreased due to lack of properly working combine harvesters and high costs. Thus, the majority of HHs uses their land for forage and cash crops. It was found that HHs can sell their livestock and buy wheat after harvesting in summer at low price from local markets or imported wheat flour. The costs and benefits from crops are reflected by crop productivity and demand. The greatest benefits were recorded for vegetables produced in kitchen gardens, due to high demand with good price at local and urban markets. Majority of HHs informed that crop yield from 2005 to 2010 decreased and only few HHs had increase in crop yield in both VGs. The low yields for all crops were also attributed to the changes in weather condition, new crop diseases and unfavourable condition for seedlings.

A decline in pasture productivity was also observed in remote pastures, although there was less intensive grazing caused mainly an increase in invasion of semi-arid and steppe grass species, such *Artemisia* and *Stipa* spp. in Chapchyma pastures, bushes such as *Rosaceae* and *Ephedra* spp.in Chanach-Say pastures. It can be concluded that forage grass species are suffering from triple risks; overgrazing (near-village pastures), dominating non-edible plants, and climate change (remote pastures). It was found that in the last decade, *Artemisia* species moved up by 200 m in Chapchyma pastures due to changes in temperature and precipitation patterns. On the other hand it can be attributed to the drying Aral Sea which affects soil quality in mountain pastures. Such conditions also favour the growth of *Artemisia* species, which lead to aridization of mountain pastures in South-Western Tien-Shan.

Acknowledgements

First and foremost, I offer my sincerest gratitude to my academic supervisor, Professor Maharjan Keshav Lall, who has supported me throughout my study with patience and knowledge. He allowed me the room to work in my own way. His encouragement, guidance and support from the initial to the final level enabled me to develop an understanding of the subject. Without him this thesis, would not have been completed.

I thank my sub-advisor, Associate Professor Yuzo Kurokawa, Graduate School of Biosphere Science, Department of Bioresource Science, Hiroshima University, whose patience and kindness, as well as academic experience, has been invaluable, and for giving me the opportunity to visit Hiroshima University farm and to gain practical knowledge related to my research. I am also grateful to my sub-advisor, Associate Professor Kensuke Kawamura. He has very generously prouded broad sub-advisor expertise and deep knowledge of Grassland Ecology and Environmental Science. I also thank him for many insightful suggestions during the development of the ideas of this thesis. Moreover, I would like to express my appreciation to my sub-advisor, Associate Professor Masahiko Togawa, for his valuable suggestions and comments. I also acknowledge suggestions received from Professor Dharma Raj Dangol, Institute of Agriculture and Animal Science, Tribhuvan University, visiting Professor of Hiroshima University, during seminars and discussions.

Very special thanks also goes to Japan International Cooperation Center and Japanese Grant Aid for Human Resource Development Scholarship (JDS) program for giving me the opportunity to study at Hiroshima University and for support in any respect during the time completion of conducting my research, and for the assistance for my studies. The Graduate School for International Development and Cooperation (IDEC) of Hiroshima University offered tremendous advice and support through its staff. I am highly indebted to these institutions.

I also take this opportunity to acknowledge Luni Piya, Niraj P. Joshi, Arija Vaydiya and others seminar colleagues for the comments and suggestions and for the great role they played in the easy adaptation to the new environment. My special thanks go to Boga T. Manatsha for editing my thesis. I offer my regards and blessings to all those who supported me in any respect during my study in Japan. It is not possible to name all of them. In particular, my warm thanks are forwarded to those researchers who are cited in my thesis for providing useful materials and information, and giving me guidelines useful for academic writing.

My special thanks to my colleagues in Ala-Buka District Department of Agrarian Development, Kyrgyzstan, and to Director of the Department, Satylgan A. Akishev for their help in providing valuable time and information. Great respect is also paid to local farmers and other key informants in Ala-Buka district.

Lastly, my immense gratitudes go to the never-ending support, patience and encouragement of my family. I have enjoyed the unfailing support and substantial good humour of all my brothers and sisters. Thanks for all your love and attentions.

With all kinds of support, I have learnt so much through this research. However, all the errors and remaining deficiencies in this study solely remain my own responsibility.

Munavar Zhumanova
September 2011
Graduate School for International Development and Cooperation (IDEC)
Hiroshima University

Table of Contents

List of Tables

List of Figures

List of Pictures

Abbreviations / Acronyms

ADB	Asian Development Bank
AI	Artificial Insemination
APPS	Agro-pastoral Production Systems
BVG	Torogeldi Baltagulov Village Government
CACILM	Central Asian Countries Initiative for Land Management
DA	District Administration
DADD	District Department of Agrarian Development
DCP	Dietary Crude Protein
DE	Digestible Energy
DM	Dry Matter
FAO	United Nations Food and Agriculture Organization
GAO	Gross Agricultural Output
GEF	Global Environmental Facility
Gosregistr	State Agency for the Registration of Rights to Immovable Property under the Government of the Kyrgyz Republic
Giprozem	Kyrgyz State Project Institute on Land Management Kyrgyzgiprozem
GTZ	German Society for Technical Cooperation (Gesellschaft für Technische Zusammenarbeit)
IFAD	International Fund for Agricultural Development

LLM	Livestock and Land Management
ME	Metabolise Energy
MoA (MAWMPI)	Ministry of Agriculture (Ministry of Agriculture, Water Management and Processing Industry
MIG	Management Intensive Grazing
MVG	1-May Village Government
NEAP	National Environmental Action Plan
NSC	National Statistical Committee
PRA	Participatory Rural Appraisal
RAS	Rural Advisory Service
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
VG	Village Government
WFP	World Food Programme
WB	World Bank
WUA	Water Users Association

Chapter I Introduction

1.1 Background of the Study

Throughout history, livestock have been kept for a variety of purposes, with the almost exclusive focus on food use of livestock in modern agricultural systems being a relatively recent development. But, in many developing countries, livestock are still a critical support to the livelihoods of people who live in or near poverty, and it is here that the non-food uses of livestock, such as source of fertiliser (manure), draught power and insurance assets for natural and other emergencies, remain predominant. Livestock, or symbols of them, also play an important role in religious and cultural lives (Steinfeld, 2010). An increase in livestock production comes from increases in animal numbers (in developing countries, small mixed farming systems) and in yields per animal (in industrialized countries). Livestock production is practiced in many different forms. Like agriculture, as a whole, two rather disparate systems exist side by side. In another case, livestock are kept in traditional production systems in support of livelihoods and household food security; other case commercially intensive livestock production and associated food chains support the global food supply system. The latter provides jobs and income to producers and others in the processing, distribution, and marketing chains and in associated support systems. Sere & Steinfeld (1996) distinguish at the highest level the two groups of farming systems: those solely based on animal production, where less than 10% of the total value comes from non-livestock farming activities, and those where livestock rearing is associated with cropping in mixed farming systems, with more than 10 % of total value of production coming from non-livestock farming activities. Livestock productions are determined by the physical (climate, soils, and infrastructure) and the biological environment (plant biomass production and livestock species composition), by economic and social conditions (prices, population pressure and markets, human skills, and access to technology and other services), and by policies (on land tenure, trade and subsidies). These conditions, together, generate the so-called production systems, that is, production units (herds, farms) with similar structure and environments –that can be expected to produce similar production functions (Cees da Haan, 2010).

In Central Asian countries in the past, transhumant stock rearing were the main land use. Nomadic, transhumant and agro-pastoral systems were common. Traditional forms of mobile pastoralism were widely practised in the Soviet Republics of Central Asia until the 1930s. In Kyrgyzstan territory, transhumant grazing of sheep, goats, cattle and horses and, in some areas, yaks and Bactrian camels was practiced (Miller, 2001). Traditionally, horses were the main livestock species, being best suited to long transhumance and foraging in deep snow (Suttie &Reynolds, 2003c). Rangeland use was regulated by tribal councils. However, during the 1930s, mass collectivization took place and the economic system became based on public (state) and collective ownership of productive resources, including the majority of the livestock population. During the collectivization process, nomadic pastoralists were forcibly transferred to permanent settlements, which brought traditional nomadism to an end. Semi-nomadic types of production emerged, under which animals grazed during winter and spring in a fixed location where houses, shelters and water points are provided, while during summer and autumn, animals grazed pastures at more distant locations. The new systems involved the introduction of improved breeds, and specialized commercial production oriented towards exporting livestock and livestock products to Russia (Miller, 2001).

In Central Asia, pasture management has moved from state-managed mobile systems towards *de facto* common property regimes and, more recently, to leasing or privatization. Mobility has contracted due to drops in animal numbers and the collapse of state subsidies for migration and water supply. The sector today is characterized by a large number of small herds used for subsistence, and a much lower number of large commercially viable herds. Broadly, the major barrier to movement amongst small herders is the cost of migration itself, combined with the lack of infrastructure in remote areas (Kerven et al 2004).

However, as livestock numbers recover, the influence of property rights on movement will become increasingly important. In Kyrgyzstan, following the collapse of state farms, pasture continued to be used by those communities that historically exploited them, and common herding systems enabled partial use of remote pastures (Farrington, 2005). Climate conditions and topography of Kyrgyzstan assessed the main role of sheep breeding ‘industry’ in the agriculture sector. The share of sheep products in 70’s was 35 % in total agricultural production, while in mountainous districts was 56.3-86.3 %. Kyrgyzstan was in the third place after Russia and Kazakhstan in wool production and the share of meat production among the Former Soviet Union countries was 12-14 % and inside the country it reached up to 60 % (Balyan, 1978). Livestock still moved between seasonal grazing lands, but many of the summer pastures became intensively grazed. Winter grazing lands were often located hundreds of kilometres away and animals were transported by trucks and trains between seasonal grazing lands (Miller, 2001). Since the transition of the Former Soviet Union countries from a centrally-planned to a free-market economy, the agricultural sector has undergone substantial changes as a result of privatization, land reforms, price liberalization, and decentralization of decision-making. The system of collective livestock production has ceased, and pastoral livestock production has adjusted to the market economy (Suttie & Reynolds, 2003c). Intensive and industrialized livestock production systems were replaced by grazing and mixed–crop livestock or agro-pastoral systems. Livestock were shared among former state-owned farms workers, and thus private herding developed.

Agriculture in Kyrgyzstan has been one of the leading sectors of the economy. In the total GDP of the country, the share of agriculture is significant about 24%. In addition, approximately 65.0% of the population lives in rural areas, the total number of all employed 34,0% or 14% of the total population engaged in agriculture (in developed countries this figure is 1-3%). These data show that agriculture in Kyrgyzstan is not only economic, but also was a great social and political significance (Abdurasulov, 2009). Animal husbandry, the historical tradition of Kyrgyz people as nomadic and pastoralists continues to be crucial. The role and importance of livestock in Kyrgyzstan is due to the presence in the country of large amounts of natural mountain pastures and hay lands which occupy 45% of the entire country (about 200.0 thousand sq. km.) or 87% of all agricultural land (9.6 million hectares). Underdevelopment of other sectors of the economy, especially industry, construction, services and the lack of other employment opportunities, especially in high mountain regions of the country where extensive livestock farming is the only source of income in remote areas, made livestock the mainstay of rural livelihoods. The trends in number of livestock in recent years have tended to increase though a small amount each year. When compared with past planned economy, the number of cattle had reached the Soviet period, the horses exceeded by 100.0 thousand heads, while pigs and sheep exceeded with about 50% (Ajibekov, 2005).Extensive livestock systems (pastoral, agro-pastoral and mixed farming) restored under market-based economy with preserved nomadic traditional knowledge by providing food, employment and income in remote areas. These systems, based on the use of resources available at low or very low cost, are driven by access to feed resources with minimum or noninvestment. Supplemented feed used mainly during winter till mid spring accumulated during summer and partial in autumn.

Mixed farming systems are conducted on a small scale by households and combine various sources of livestock feed: natural pastures, hays from haylands (meadows), crops residues, forage crops, and rare bought feed at markets. These systems became more sustainable and dominate in rural areas. There are many benefits from integrating crop and livestock production; livestock are sources of draught power, fertilizer, and insurance asset. Non-product purpose of livestock continues to give more pressure on pastures; most areas of land are used for cash crops and decrease forage cropland areas.

The grassland-based grazing systems in Kyrgyzstan depend on rainfall, not suitable for cropping. The pastoral systems are predominantly grazing, which depend on the natural productivity of pastures. Mobility is one of its characteristics. In the nomadic systems, people and livestock move according to the growth season of pastures; divided to spring/autumn, summer and winter pastures. These three types of pastures are called intensive, remote and near-village pastures according to geographical location. The agro-pastoral systems, as modernized mix of pastoral and mixed farming systems in general, includes subsistence arable cropping, fruit production, livestock production, and increase income from cash cropping[1].

1.2 Statement of the Problem

Livestock play an important role in Kyrgyzstan economy. Over the past years, considerable changes have taken place in populations of livestock and the composition of livestock holdings, as well as in the management strategies, as a result of population growth

[1] During Soviet times, kolkhozy are cooperatives comprising a number of families which pooled land and equipment together and whose members were paid according to the work undertaken. Members did not receive an annual salary, but a division of the collective income after costs. This variable monthly portion was often in kind. In sovkhozy (state farms), planned and budgeted by the Ministry of Agriculture, every sovkhoznik (worker) received a wage, the same amount with a bonus at the end of the year if the income of the operation was sufficient. Sovkhozy, according to Humphrey (1983) in the case of Soviet Buryatiya, having been considered a 'higher' social economic form than the collective farm (kolkhoz), received large subsidies and other advantages over collective farms.

and land use intensification. There are different social, economic, environmental and political constraints to livestock production systems, which are reflected by livestock productivity, natural and social risks of agro-pastoral systems and natural resources degradation. The absence or weak legal and regulatory framework for agriculture is one of the weaknesses of agrarian policy in Kyrgyzstan. Current policies are based on the former planned economy policy reforms which are not appropriate to market-based economy. These legislations mainly focused on state-owned farms, collective farms and cooperatives, such as development of livestock industry in plain, high populated areas rather than remote, marginalized and small-scale extensive production systems. The adopted laws and other legislations about livestock breeding, pasture utilization and others practically do not work, due to the lack of mechanisms to implement them. After the Land Reform in 90's, people with different backgrounds became farmers. Most of them were not familiar with the basic fundamentals of agricultural production (For instance, former teachers, doctors, engineers and others). Similarly, even people who were experienced in farming and livestock raising are faced with new conditions of production; the changed scale of production industrial relations, economic arrangements, and many more. The lack of institutional development of the sector, in terms of marginalized extensive livestock production systems, is also one of the weaknesses in agrarian policy. The absence of training or underdeveloped training and lack of information services to farmers in remote areas create many difficulties in production-marketing process. During the 20 years of independence, conserved indigenous knowledge about animal husbandry and traditional pasture management are facing serious problems on animal health control, choosing market-oriented and appropriate livestock species, feed shortage during winter time and unpredictable natural hazard in grazing land during other seasons. Limited income and high expenditure of making feed cause difficulties, and the nutrition value of winter feed is also low. Inadequacy of livestock nutrition and insufficient veterinary services increased diseases and parasites affecting livestock productivity. Increased livestock products is due to increase numbers of livestock. At the same time, forage shortage gave pressure to pastures. Large parts of pastures (near-village pastures) have already been overgrazed. A Significant decline in pasture productivity and unbalanced pasture composition with different types of degradation is acute. Conservation and rehabilitation of pastures have been largely ignored. There is a serious imbalance in pasture utilization; remote pastures, which are difficult to access by majority farmers, are underutilised. In other words, degradation of pastures affect biotic and abiotic factors such as increase in temperature and decrease in precipitation, high evaporation rate and wind erosion. Constraints to livestock production systems are interdependent. One's stability or accessibility afford another development while degradation or changes increase others vulnerability. They cannot be solved in isolation or independently or just by providing some projects or policy intervention to one factor. The factors are interdependent, ignoring one of them causes another problems.

1.3 Significance of the Study

Livestock production systems have played the main role in the economy of high altitude areas because the features of pastoral systems here suit the specific characteristics of these mountainous areas. During the Soviet time, ecologically or biophysically driven livestock production systems lost importance as a result of the changing, socio-economically and politically determined circumstances in Kyrgyzstan. Specialized livestock industry-collective systems had influenced rich nomadic traditional knowledge preservation. Other major changes were the shift from local breeds to centre-demand breeds with imported livestock feed from other Soviet countries. The collapse of the Soviet Union gave some opportunities to farmers and created new constraints also. New herd size and free access to pasture resources in some level facilitated the recovery of nomadic pastoral systems with mixture of modern market oriented production systems, the so called agro-pastoral systems. There is considerable increase taking place in livestock population at the district, region and national level. This study tried to identify the process which led to the adoption of livestock species, and herd composition at household level, explore linkages between livestock management, cropland and pastures, and outline the key constraints and strategies for the management of agro-pastoral systems in Kyrgyzstan.

Two main factors contribute towards better results in livestock farming; the quality of the stock and its management. Dependence on livestock keeping and herd size accordingly are based on geographic location of farms and the availability of irrigated cropland areas. Where crop production is practicable, livestock are a crucial element of farming systems. Where extremes of climate and topography make crop production especially difficult, livestock can often live and thrive on available resources and provide livelihood necessities. A Study on interrelationship between crop and livestock, and derived income from them will be helpful to understand the socio-economic context of agro-pastoral systems under a market-based economy.

Easy access to seasonal pastures with rich nutritive and valuable forage plants, enhance livestock population, while market enhances selected composition of them. Productivity of pastures is varied according to geographical zones and climate conditions. Also, it is dynamic, pastoralists' knowledge in grazing management to conserve pasture biodiversity. One of the most important assets of most pastoralists is their rich knowledge of complex ecosystem dynamics, which make them often the best detectors of environmental change. Within this context, it is clear that any minor or major changes to climatic patterns will have significant consequences for many pastoralists, as it increases resource variability, while also reshaping its overall availability (Nori, 2007). The traditional indigenous knowledge of nomadic peoples—regarding seasonal pastures, grazing times, and the composition and quantity of grasses are valuable store of Traditional Ecological Knowledge (TEK). The findings of observations and measurements on pasture quality, in terms of composition, balance of species and climate factors, will be helpful to researchers and academicians for further research.

There are few studies about agro-pastoral production systems in South-Western Kyrgyzstan. Further research is required to find out if the problems are common to small holders across the region and in the other regions of Kyrgyzstan. Certain areas of animal husbandry on the small holdings could be further improved through more in depth research which would be crucial in finding out the feasibility of certain education and co-operative programs for the contribution of livestock to rural livelihoods.

This research tried to find out the common and specific gaps and priorities among production systems across the region and in the other regions of Kyrgyzstan. It can also be a guideline to policy makers and researchers to improve certain areas of animal husbandry smallholdings.

1.4 Research Questions

This research tried to answer the questions below. In general, what are the key factors that affect agro-pastoral systems?

Specific questions:

- What have been the changes in livestock population and composition at household level, in which livestock are the main or additional part of the system?

- What is the relationship between animal nutritional inputs with livestock products output?
- What are the linkages between livestock and crops, with pastures (common property resources) and farm land (private land), and sustainable pasture management with livestock management in market-based agro-pastoral systems?
- Are livestock contributing to an improvement in pastures or to their degradation?

1.5 Objectives of the Study

The general objective of the study is to study the key social, economic and environmental factors affecting agro-pastoral systems in Kyrgyzstan. The specific objectives to meet the general objective are:

- To study the population and composition of livestock diversity by contrasting two types of agro-pastoral systems (mainly livestock - additional crop, mainly crop –additional livestock)
- To analyse feed types and feeding systems and derived productivity of livestock
- To examine land management and cropping patterns with the cost and benefit analysis
- To survey grazing ecology, seeking to measure condition and botanical composition of pastures by assessing the extent of utilisation
- To examine the social and economic context of agro-pastoral systems in terms of income sources

1.6 Conceptual Framework

To address the objectives and research issues identified in the preceding sections a conceptual framework was developed as illustrated in Figure 1.1. It serves as a guide to the study. The conceptual framework for this research on sustainable livestock and land management in agro-pastoral systems draws from transition economy in agrarian sector that explains the changing management systems as a result of changing relative factors. The key outcomes of systems include livestock and crop productivity derived from supplied forage and pastures, household income sources and changes in natural resource conditions; pastures-cropland degradation or improvement. These outcomes also affect households' benefits and opportunities in the future income strategies and livestock- land management; increases in agricultural production and income can facilitate greater investment in different types of capital, whether physical (increase improved herd size or area of rented cropland), financial (cash income), human capital (majority income from livestock used for education payment), and natural capital (soil quality improvement, reseeding in pastures) and non-returned capital (self-investment by building house, shelters, and forage storage space). These changes in agro-pastoral 'range' may promote enough potential and appropriate factors for development. Various constraints in different levels can cause opposite changes in the systems; low productivity, low income, poverty and cropland and pasture degradation, loss of biodiversity and high vulnerability to outside factors as marginalised system. They are related to each other. There is another factor not included to system, but it can be one of the key factors affecting whole system that is the climate change. The study tried to examine the on-going climate related changes inside and outside agro-pastoral systems.

Changes in livestock population and composition depend on access to market, infrastructure and the amount of other income sources. Income strategies influence land management and labour intensity. Mixed crop–livestock producers are more likely to apply manure to their crops and use of animals as draught power. The impact of livestock on land degradation may be mixed, and depends on the type of degradation as well as on interactions between crops and livestock.

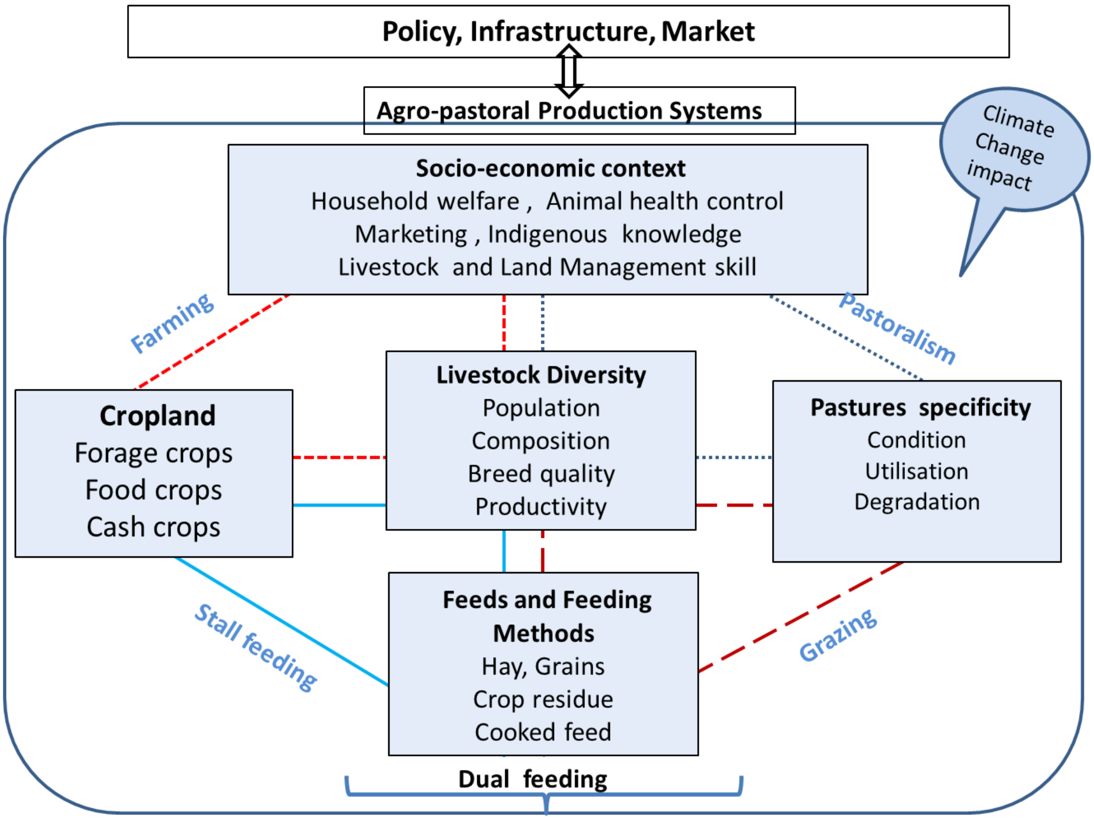


Figure 1.1 Frameworks for the study on livestock and land management in Kyrgyzstan

On the other hand, households with greater off-farm opportunities may be less prone to crop production or labour-intensive land management practices because their opportunity costs of labour may be higher (Pender, 2006). Decrease in food and forage crops areas cause winter forage scarcity which gives pressure to pastures.

1.7 Limitations of the Study

This study has its own limitations because it was conducted within a given time frame. It covers only one district, with two VGs and two intensive remote pasture areas. The researcher was not able to make chemical analysis of sample (certificated at The State Quarantine Inspection and Protection of Plants of KR) for analysing nutritive quality of forage species due to high risk of Foot and Mouth Disease in Kyrgyzstan. And pastoralists' location on the remote pastures in far distance from each other, and limited time for field visit made the researcher unable to collect more information on pastoralists’ livelihood. The sampling units for the study were chosen randomly, thus, there are possibilities of sampling error in the study. Generalization of the findings outside the study area should be done carefully, taking into considerations the similarities in production systems, socio-economic parameters, ecosystems, pasture biodiversity and topography.

Chapter II Literature Review

2.1 Introduction

A comprehensive literature review was done to encompass most of the literatures available about extensive pastoral and agro-pastoral production systems in the world. The literature review has five main purposes: to review literatures related to livestock and land management; to review studies done in Kyrgyzstan's livestock, natural resource management and agriculture sector, to review researches and literatures done in developing countries; similar terrain and grassland with Kyrgyzstan; to review previous researches and literatures done in developed countries (to observe how they had developed their livestock sector as industrialized, and sustainable management of grassland systems) and to review extension research reports and projects done by international organizations and NGOs in different livestock production systems.

The content of each reviewed literature tried to provide a context of the research, what was done and how it will match with the current study and what are the differences between the previous and the current studies.

The reviewed literatures is arranged into six broad categories: the importance of livestock in countries' economy, livestock research development issues, forage resources and natural resource management, constraints to LPSs, socio-economic issues in LLM and conclusion.

2.1.1 The Importance of Livestock in Countries' Economy

"Livestock development is projected in coming decades to become the world's most important agricultural subsector in terms of value added and land use. Global meat demand is projected to increase from 209 million tons in 1997 to 327 million tons in 2020, while global milk consumption is projected to increase from 422 million tons to 648 million tons over the same period. This increase in demand is expected to exert undue pressure on natural resources worldwide, possibly crowd out the poor, endanger global food security, thwart animal welfare and ensure further degradation of the land and erosion of biodiversity" (World Bank, 2000).

The Livestock sector plays a vital role in the economies of many developing countries. It provides food or more specifically animal protein in human diets, income, employment and possibly foreign exchange. For low income producers, livestock also serve as a store of wealth; provide draught power and organic fertiliser for crop production and a means of transport. Consumption of livestock and livestock products in developing countries, though starting from a low base, is growing rapidly (Sere & Steinfeld, 1996). The way livestock are kept and milk and meat are produced will be key factors in the future health of the planet. Animal agriculture is one of the most important components of global agriculture, and livestock are one of the main users of the natural resource base: livestock use 3.4 billion hectares of grazing land and livestock production from about one-quarter of the world's croplands. In total, livestock make use of more than two-thirds of the world's surface under agriculture, and one-third of the total global land area; livestock raising is the sole source of livelihood for at least 20 million pastoral families, and an important, often the main, source of income for at least 200 million smallholder farmer families in Asia, Africa and Latin America. Livestock provide the power to cultivate at least 320 million hectares of land, or one-quarter of the total global cropped area (FAO, 1994). This would, otherwise, have to be cultivated by hand tools resulting in harsh drudgery, especially for women, or by tractor power with an inevitable drain on foreign exchange. Livestock provide the plant nutrients for large areas of cropland. For example, estimates carried out in Jensen & de Wit's study (1996) shows that, for the tropical irrigated areas, manure provides nutrients of an estimated value of US$ 800 million per year. Finally, livestock are an important asset for investment and insurance for hundreds of millions of rural poor in situations where banks are often too remote and the banking systems too unreliable for safeguarding any savings a smallholder might accumulate.

Livestock play an important role in mountain economies. Overall livestock contribute 36-47 % of the total agriculture income in the mountains and hills of Nepal. In Tibet, they account for more than 50 % of the total gross production value of agriculture (Tashi &Partap, 2000). Livestock play an equally important role in the agricultural economy of the African highlands. In Ethiopia, animals and their products account for 30 % of agricultural GDP and 12 % of the total GDP excluding the value of draught and manure (Sileshi & Tegegne, 2000)

The income–generating functions of livestock vary from livestock being the main cash crop, as in smallholder dairy systems, to the occasional chicken or goat sold to cover sporadic or emergency expenses. The range and the amount of products sold depend on the different systems, but they can vary from meat to manure, eggs to fibre, milk to work. Livestock are critical in maintaining soil fertility. They allow land-use intensification though the concentration of nutrients and the acceleration of nutrient cycling. In the majority of mountain areas, chemical fertilisers are still unavailable or beyond farmers means. In such cases manure serves as the fertiliser, but significant amounts of nutrients are often lost as the result of poor collection and storage methods for manure and exposure of livestock excreta (Tulachan, 2000; Dijkman, 2000).

Hodgson and White (1999) define the importance of pastoral agriculture to the New Zealand economy, and an overview of livestock systems and their distribution, followed by a more detailed appraisal of individual systems. Dairy product sales more, even though dairy cattle account for only 28 % of the total stock units farmed. They described the main pastoral systems as they exist in New Zealand to cover the major historical milestones in their development.

2.1.2 Livestock Research and Development Issues

Agricultural research previously focused on improving animal and crop productivity independently. In the 70s and 80s, it was recognised that crop and livestock interact and must be considered jointly to optimise overall farm performance (Kaufmann & Mohamed Saleem, 2000). Mountain areas are characterised by some specific features that distinguish them from the plains. They include limited accessibility, a high degree of biophysical and social fragility, marginality, and diversity and specific niche opportunities-including human adaptation mechanisms. These mountain specificities and their implications for livestock production systems need to be taken into consideration when addressing livestock issues in mountain areas, in particular the potential for development (Jodha, 2000; Tulachan, 2000). The main challenges to livestock research and development, however, result not from these specificities, but from shortcomings in government policies related to institutional and environmental undertakings to market economic technological changes. Successful development of the livestock sector, particularly market oriented livestock production systems, require that everyone involved is aware of mountain specificities, gender issues and marginality of farms and livestock farming (ibid.).

The complexity and heterogeneity of different agro-ecological zones need to be recognised and taken into consideration when formulating policies. This is the prime obstacle to the transfer of technologies from one region to another. It is also important to recognise that diversified and inter- linked resource- based activities are a key attribute of sustainable production systems in mountain areas that research has an important role to play in ensuring the continued success of such systems (Jodha, 2000). If all these constraints are taken into account during the initial design of research programme, there is considerable potential for increasing the sustainability of crop-livestock productivity and household income (Leon-Velarde & Quiroz, 2000).

Notwithstanding improved accessibility and market links, the dependence of livestock on local resources will continue to be an important factor. Hence conservation and efficient use of these resources, including such things as recycling and reprocessing need to be an integral part of the management of livestock production systems. It can play an important role in ensuring the efficient use of scarce resources, the quality of animals, and the most effective composition of animal holdings (Staal & Jabbar, 2000). Zarate (2000) argues that research and development programs should be directed towards encouraging and empowering local people to retain their unique genetic livestock resources in these ecologically fragile, but globally important mountainous environments.

Sileshi and Tegegne (2000) describe three broad themes important for future research in the African highlands; sustainability of the crop-livestock production system, which include improvement of feed resources, animal traction, nutrient cycling and management, health management at the farm level and options for diversification of animal power; improvement of market–oriented smallholder production, which include development of a feeding package, appropriate breeding schemes and recording systems, efficient processing and handling methods, health management and delivery services, health standards for export of meat and animals, policy adjustment and marketing, and conservation and utilisation of animal and forage genetic resources, which includes characterization and evaluation of genetic resources and selection of animals for resistance to diseases. Singh (2007) explains that the best approach to improving milk production in smallholder dairies is thought to be through reducing the actual numbers of animals whilst improving the quality of the remaining animals and of the feed supply. The major challenge is to increase production whilst avoiding environmental and natural resource degradation. Mixed crop-livestock production systems are means of generating employment.

2.1.3 Trends and Management Strategies in Mixed Livestock-crop Production Systems

Over the past years, considerable changes have taken place in populations of livestock and the composition of livestock holding, as well as in management strategies, as a result of population growth and land-use intensification. In mixed farming systems in mountains, there has been a decline in the populations of goat and sheep and an increase in the populations of cattle and horses, indicating a growing importance of cattle and horses in the livestock economy.

In the mountains, accessibility and development of road networks have played a crucial role in the development of smallholder dairies as an integral part of mountain farming systems. There has been a considerable shift in the management strategies of smallholder dairy farmers; from extensive grazing to intensive stall feeding, from use of public land to use of private land for growing fodder and forage crops, and from feeding crop-residues to increase the use of purchased feeds. There is a growing trend in Himachal Pradesh towards keeping cross-bred cows for milk production-reflecting a shift from low-producing indigenous animals to dairy animals with higher milk yields (Tulachan, 2000). Analysis of the livestock production trends in high –pressure areas across Kenya and Ethiopia indicate that there is an increasing trend towards smallholder crop-livestock production. Smallholder dairies have flourished better in Kenya partly as a result of the differences in the types of animals raised in the two countries. In Kenya, dairy development has been based on the use of cross-bred animals, whereas in Ethiopia the numbers of these animals are negligible (Dijkman, 2000). According to Tashi and Partap (2000), an interesting trend is emerging in livestock production systems in Tibet, especially in the lower altitude areas, with a transition from animal husbandry based on rangelands to a mixed crop-livestock system, from the extensive traditional system to an intensified system. Commercialised livestock production is increasing as a result of both state and private investment.

2.1.4 Technological and Institutional Issues

Before introducing new technologies, it is important to predict the impact on the economy and the environment. Despite an array of scientific innovations, science and technology have had little impact on livestock development or improvement in developing countries. Sound policy backing is crucial for the dissemination of technology. Having policies to promote credit is a key element for adaptation of improvement technologies. Credit must be made available to farmers so that they can make use of new technologies. In Africa, some technologies, like the introduction of cross breeds, have brought households additional income. In Kenya, a recent study shows that farmers with crossbred cows had an additional income of 50 dollars per cow per month without the need for additional labour. There was no significant increase in household milk consumption, however. When evaluating the net benefit of new technologies like this, improved nutrition of the household should be considered (Hugo Li Pun & Victor Mares, 2000)

Zapata (1997) explains two productive technologies aimed at increasing farm production; a conventional and new approach. The conventional technical approach tries to increase milk yields using imported concentrates, improved breeds such as Holstein, and vast amounts of chemical fertilisers. This approach has drawbacks, such as the need for large amounts of capital, dependency on imported inputs, and deterioration of the environment. The new approach is an integrated and environmentally-friendly technology. It uses crossbred cattle and pigs to produce energy and earthworms for composting solid wastes, which combined with the effluent from the bio digesters, to provide organic fertiliser. Some of the numerous advantages of this technology are a feed supply for cattle and pigs, food for humans, pest-free and healthy pastures, natural regeneration of fragile areas, maintenance of soil fertility, a supply of biogas for cooking and the availability of high quality fertiliser. The heterogeneity of mountain regions in terms of factors like altitude, climate, soils, quality and quantity of feed resources, and ethnic background poses a great challenge to the transfer of technologies like this from one region to another.

2.2 Livestock Diversity

Livestock diversity depends on the condition of the area; climate, landscape and forage species. There is insignificant number of specialized beef breed cows in Kyrgyzstan, and the beef industry is based on calves produced by dairy cows. Beef cattle productivity at the farm level is usually measured by some measure of growth, such as average daily weight gain or carcass weight at slaughter. But in Kyrgyzstan, there are 4,435 thousand hectare summer pastures possible to breed beef cattle. A Study on crossbreeding local Ala-Too breed with Aberdeen-angus confirmed this hypothesis; abilities and genetically potential of cross-bred (Nogoev, 2008). Minezawa (2002) focuses on cattle genetic resources in Japan; and explains that the beef cattle can be classified into two categories, indigenous and non-indigenous cattle. The former includes 1,700,000 Japanese beef cattle, named *Wagyu*, and the latter involves 461,000 non-indigenous dairy cattle and 663,000 corresponding crossbred animal. *Wagyu* includes four breeds, Japanese Black (93.9%), Japanese Brown (4.2%), Japanese Poll (trace), and Japanese Shorthorn cattle (1.0%). However, exotic cattle breeds contribute most milk production and more than 99% of the dairy cattle are Holsteins. Production from the two genuine Japanese native cattle is in trace proportions.

Prioritizing livestock breeds for conservation needs to incorporate both genetic and non-genetic aspects important for the survival of the breeds. Gizaw (2008) applied a maximum-utility-strategy to prioritize 14 traditional Ethiopian sheep breeds based on their threat status, contributions to farmer livelihoods (current breed merits) and contributions to genetic diversity. Contributions of the breeds to genetic diversity were quantified using marker-estimated kinship approaches. Non-genetic aspects included threats (*e.g.* low population size, low preferences by farmers) and current merits (economic, ecological and cultural merits). Threat analysis identified eight of the 14 breeds as threatened. The analysis of current merits shows that sub-alpine and arid-lowland breeds contribute most to farmer livelihoods in comparison to other breeds. Their results balanced the trade-offs between conserving breeds as insurance against future uncertainties and current sustainable utilization. The ranking of breeds provided a basis for conservation strategies for Ethiopian sheep and contributes to a regional or global conservation plan.

A study conducted in the Andean Valley, Bolivia, in which breeding groups held under different ecological, socio-economic conditions were compared, show the clear superiority of pure-bred, local animals in harsh environments, crossbreeds in improved environments, and pure-bred exotics under conditions of intensive feeding and husbandry. Crossbred and pure-bred animals are not available to most farmers in mountainous areas, however. The results show that local genetic resources play an important role in producing optimised breeding stock (Zarate, 2000).

Dairy farming is important and has tremendous potential in developing the economy of a country. In developing countries, dairy farming is predominantly a smallholder mixed crop-livestock farming operation. Many Third World countries have taken steps to develop dairy sector under the cooperative system so that rural poor farmers can have access to necessary services for dairy development. Ghosh (2003) focuses on analysing the role of cooperatives in dairy development and its impacts on rural income generation in Bangladesh. His study examines the milk-marketing channel in Bangladesh as a whole, evaluates the economic efficiency of dairy farming under the cooperative and non-cooperative systems, and measures the extent of the income earned by dairy farmers under cooperatives and non-cooperatives in different regions. According to Singh (2007), dairy development could help to generate large amount of income for small and medium farmers who are the most target group in any development program. Dairy contributes significantly in the improvement of rural livelihoods by providing food, income, energy for household purpose, and improved health and sanitation. In mountain areas, smallholder dairy farming has been gaining importance. There is emerging trend towards the introduction of new dairy livestock species for better milk yields. Singh (1999) examines the operation of dairy cooperatives in Himachal Pradesh, and outlines the factors determining their successes and failures. These cooperatives were introduced as a management strategy for milk producers and were intended to act as reliable market outlets for milk producers and as regular suppliers of milk at reasonable prices to consumers. The failures resulted from inefficient management and the problem of vested interests, with people using the cooperatives as a way of gaining power and prestige.

Kenya is one of the few success stories for smallholder dairy development on the African continent. The success mainly resulted from the introduction of exotic and crossbred cattle by Europeans. A profit analysis of the adoption of dairy cattle in the Kenyan highlands indicated those household and local area characteristics, availability of veterinarians, the agro-climate, and formal markets are the important factors affecting the successful adoption of crossbred cattle. The distance by road to an urban centre also has a significant impact (Staal & Jabbar, 2000). Zapata (1999) examines the systems of dairy production practiced in two areas of the Andean region of Colombia; located in the central range of the mountains. Specialised dairy is the common system in Colombia. The most popular breed of cattle is Holstein. Feeding is based on pasture; lactating cows are supplemented with concentrate. This popular system called "pigs-pasture-milk", pigs are penned in a high part of the farm, their manure is used as fertiliser to increase grass production, and the grass is fed to the cattle.

Most dairy producers utilizing Management Intensive Grazing (MIG) were former confinement or non-intensive pasture operations while the others started their operation with MIG. Which farms are candidates for success following a switch? What changes in labour, cost of production, and herd health might be expected? These and other questions were investigated by examining 29 MIG dairy farms in Michigan (Taylor, 2009). These farms experienced similar milk production levels per cow, reduced feed and hired labour cost significantly, reduced the acres of row crops grown, and experienced improved herd health resulting in much lower herd health costs. Those farms did not build farm acres, but rather grew cattle numbers and improved management of pasture forage. Research work remains to be done that will more accurately measure the true economic progress and further find management techniques that prove successful for MIG farms (Taylor, 2009).

2.3 Forage Resources and Natural Resource Management Issues

In the winter months, livestock are fed on stored feed accumulated during the growing season. These feeds include a large component of crop residues as well as green fodders, such as Lucerne that are grown specifically for livestock. A component of winter nutrition also comes from winter pastures and other arid range plants found in winter pasturing areas close to the villages. During the summer, nutritional inputs to livestock are largely derived from summer pastures including temperate alpine pastures made up of grasses, forbs and shrubs. Seasonal measurements of feed use and livestock performance highlight the seasonal dynamics of transhumance system and emphasize the findings of previous studies, which have pointed to a substantial shortage of winter fodder as being important constraint within system. Two fodders are extensively cultivated in Kyrgyzstan, Lucerne (*Medicago sativa)* and Sainfoin *(Onobrychis viciifolia)*. Hay is a very important winter feed. In the absence of concentrates, it is all that is available to many livestock owners. Hay comes from two sources; natural meadows, which are traditionally seen as a community resource, and sown and irrigated forage, which is the property of the individual farm or farmer. Cereal straw is saved for fodder.

2.3.1 Feeds and Feeding Systems

With most feeds eaten by ruminants, the Growth Energy (GE) values reflects that of carbohydrates such as cellulose (17.6 MJ/kg); it increases with increasing concentrations of protein (about 24 MJ/kg) and fat (about 39 MJ/kg), but decreases as its ash content rises which may be due to either a change in the natural mineral content of the feed or to contamination with soil or other extraneous inorganic material. Mitchell (1974) reports that the range of MJ/kg DM for white clover, ryegrass and cocksfoot cut from Tasmanian pastures at various times throughout the year, and values for temperate pastures herbages in New Zealand gave other results; which content of value depends on where the grass grown.

M/D of forages (for fresh temperate grasses and legumes, except lucerne), compound feeding stuffs – in meal or pelleted form, may contain a wide variety of ingredients, including feeds of vegetable, animal or marine origin with high protein and silage can be expected, that will differ from different places and countries in several respects. For example, plant maturation often proceeds more rapidly in Australia making it more difficult to time harvest so that the forage is in a young, highly digestible condition. The DM of European and North American maize silages often contain more than 50 % of cob and there may be up to 50 % grain, but there may be less in the Australian product because of differences in growing conditions and plant cultivars (CSIRO, 1990).

Grains. There is variation in the energy value of Australian oats. It is likely to be low when owing to moisture stress in the plant during growth; the grain has a high proportion of hull which is of very low digestibility. Briggs et al. (1956) give 2.3-2.6 kg /per week of wheat, or maize, or barley, or sorghum to sheep in a drought feeding experiment, and give 3 kg of oats to similar sheep on the assumption, which grain had a lower energy value. After 20 weeks of feeding, the liveweight of the sheep had plateaued and those given oats were 1-3 kg heavier than those given the other grains. This result gives support, that in practical drought feeding of cattle and sheep the ME of all cereal grains is same. When animals are given oats in circumstances other than drought feeding, account should be taken of the variability in its M/D. There appears to be negligible loss of whole grain in the faeces of sheep, but when cattle are fed whole grain, they may excrete substantial amounts. Some may be reingested by coprophagy, which probably accounted for the small difference in performance observed by Southcott and McClymont (1960) among drought-fed cattle given whole wheat and those given crushed wheat, but any excretion, in effect, reduces M/D. The loss appears to be less when cattle are given roughage, which appears to affect a reduction in the time the grain is retained in the rumen. It appears from these results that when rations for cattle containing whole grain are being established, it may be advisable initially to discount their ME value, except with maize, to allow for faecal loss. Cotton seed, milk and milk substitutes, fodder trees and shrubs (browse) feeds are considered particular regionally; they are not common used feeds.

The digestibility *in vivo* of forage is lower when it is ground then when in long or chopped form, but the practical consequences are probably small in animals fed for maintenance. Any reduction in M/D is at least counterbalanced by an increase in the net efficiency of use of the ME for growth and fattening and probably for lactation (Greenhalgh & Wainman, 1972). The digestibility of a feed decreases with increasing level of intake, the greatest effect being found with concentrate feeds and ground forages. Mould et al. (1983b) find that when hay was ground and fed with rolled barley, contributing two-thirds of diet DM, the hay DM digestibility could be reduced. The reduction in hay digestibility was less when it was given in chopped form, and when the barley was whole rather than rolled the reductions were about 0.12 for ground hay and about 0.05 for chopped hay. Poppi et al. (1981) found that conversely cattle digest poorer quality feeds more than do sheep; because cattle retained fibrous material in the rumen for longer period. Goats also appear to digest fibrous to a greater extent than sheep.

Age. Graham (1980) find that feed digestibility appears to increase with age in sheep, but this effect has not been identified with cattle and he concludes that because of energy losses in methane and urine tend to be less earlier ages, so that ME/DE is higher than in adults, ME values of feeds determined in adult sheep can be used to calculate rations for growing ruminants, at least for the same feeding level.

Reproduction. Lamberth (1969) concludes that compared with non-breeding cattle and sheep given the same feed, M/D may be lower in late pregnancy and in early lactation, because of an increased rate of outflow from reduced residence time of digest in the rumen. But no method allowing for such a reduction in M/D can be recommended, but the possibility of its occurrence should be borne in mind when establishing rations for and assessing the performance of breeding stock.

Cold and heat. Digestibility varies with prevailing ambient temperature. From an examination of numerous studies made with cattle and sheep in temperatures ranging from -11^o to 38^{o}C, this effect appeared to be of more importance for forage than for concentrate diets, and it might be advisable to allow for it in computer models particularly for a period following shearing when the thermal insulation of sheep is reduced (NRC, 1981a).

2.3.2 Use of Energy from Liveweight Loss.

Animals will intermittently experience periods of feed shortage, especially in a pastoral system production, when they have to use energy from catabolism of body fat protein for maintenance or survival. The energy from liveweight loss will not be used with 100% efficiency, but there is little information on its use maintenance (Marston, 1948). Calorimetric studies have established the following energy costs of various physical activities by ruminant animals:

Activity	Energy cost per kg W (kJ/day)
Standing	10
Changing body position (double movement of lying down and standing again)	0.26
Walking (horizontal component)	2.6
Walking (vertical component)	28
Eating (prehension and chewing)	2.5
Ruminating	2.0

For animals given feed in stalls, pens, or yards, it can generally be assumed that EGARZE=0 Adam et al. (1984) found that cattle expended less energy for eating 1 kg DM in the form of pelleted feeds 0, 23 kJ/kg, 1.03kJ/kg for eating 1 kg hay or dried grass DM either long or chopped, and 1.43 kJ/kg in eating 1 kg DM (7, 4 kg fresh weight) in chopped turnips. Housed animals would not usually be required to walk so far to feed or milking that there was important effect on their energy requirements. The value of EGRAZE for animals at pasture will vary with grazing conditions including the availability (tones DM/ha) and digestibility of the feed which will affect the rate and amount of intake, and which will effect distances walked as will the distribution of watering points, weather, topography and interactions between these factors. Farrel (1972) found that the unit cost of walking did not differ among sheep of similar skeletal size that were emaciated (27 kg) or in better condition (32 or 47 kg) and for cattle it did not vary with ambient temperature.

When the animal is heat stressed, productivity falls primarily because feed intake is reduced, but its elevated deep-body temperature increases metabolic rate and consequently its maintenance requirement. The lower limit of the zone of the zone of thermo neutrality is termed the lower critical temperature; for an animal varies with its thermal insulation or resistance to heat flow to the environment. Mount & Brown (1982) found that sheep in full wool will be more resistant to cold than a shorn sheep. Sheep experience a sudden major change in their thermal environment when they are shorn. Heat loss by animal is increased during and for some time after rainfall because replacement of air in the pelage by water increases thermal conductivity, because heat energy is used to evaporate the water; and because of induced physical activities by the animal (e.g. shaking). The problem of partial wetting is accommodated, though there remains some difficulty in identifying from daily precipitation the diurnal pattern of wetting and the effects on energy expenditure over 24 hours periods. Hutchinson (1968) found that there may be high mortality during the following one to two weeks after shearing, especially if there is cold wind and rain. Problems of thermoregulation off-shears can be compounded by a reduction in the time spent grazing which probably signifies a lowered feed intake as has been observed in penned sheep immediately after shearing, though after few days intake generally increases and becomes higher than it was before shearing. The first cause of compensatory or ‘catch up’ growth by animals given abundant feed after a period of under nutrition is probably an above-average feed intake though this may not occur immediately with re-alimentation. Increased feed intake will cause substantial increases in gut-fill and liveweight, but there is also evidence of increase in the gross efficiency of conversion of feed to body gain with the result that the proportion of total feed intake available for production will be greater than with animals continuously well fed. Such increases in efficiency are likely to be transitory and it is concluded that the energy content of compensatory gains should be calculated in the same manner as for gains during uninterrupted growth (Tornton et.al, 1979).

Searle et al. (1972) concludes that the composition and energy value of liveweight loss in a sheep of any given type and liveweight is similar to that of its liveweight gain which may also be taken to be valid for cattle. In lactating cows, energy from body tissues is often utilized for milk synthesis, especially during the weeks immediately after calving, but at this time, it is particularly difficult to determine what fraction of an observed liveweight change is actually due to change in gut fill. Several studies have shown that when lactating cows are in positive energy balance the efficiency of conversion of ME to body tissue gain is considerably greater than in non-lactating animals. Moe et al. (1970) report efficiencies in lactating and dry cows, given the same feeds. During the first lactation, skeletal size and weight are likely to be less than those it will eventually attain. In addition, in predicting the animal’s performance, the lactation curve, defining potential milk yield, would be set lower for first lactation than for subsequent lactation (Wood, 1969) allowing that a greater proportion of the feed intake would be available for growth.

2.3.3 Forage Quality, Feeding Value and Animal Performance

It is important for the intensive livestock industries to be able to specify and provide for animals' protein requirements as precisely as possible because protein feeds are generally the most expensive components of their rations. A protein feeding system is also needed for grazing animals to identify effective and economic procedures of supplementary feeding, i.e. lactating cows. Moreover, the low protein content of tropical and subtropical pastures during dry season, Mediterranean-type pastures during summer and native pastures on the Tablelands during the winter, reduces the growth rates of young animals, extends the time to puberty and first pregnancy, and adversely affects reproductive performance and lactation in mature animals (Hennesy, 1983). It appears probable that seasonal change in microbial crude protein (MCP) from forage diets (fresh and dried forages, silage) is associated with the changes in chemical composition that the result in lower net energy values for animal of later compared with spring growth of temperate pastures. Beever et al. (1978) find that MCP yield higher in spring growth ryegrass than autumn growth one. His studies with cattle fed early, midseason and late growth of ryegrass and white clover again, as with the spring and autumn ryegrasses, did not show a clear effect of season on MCP yield. MCP yields may be higher in lactating cows with high feed intakes than in beef cattle and sheep with lower intake. Although realistic allowances have been made for variation in intake between animals varying in type and physiological state, and between pastures which vary immensely in plant species, herbage availability, composition and digestibility, the predicted intakes are inevitability imprecise.

The requirements for minerals, as for other nutrients and energy, are estimated factorially and by the complementary method of feeding experiments; they must then be tested in practical feeding trials. Grazing animals generally do not require supplementary vitamin A, even during drought, because hepatic stores make good a dietary inadequacy (Southcott, 1960). One possible exception is rams, perhaps bulls, required for breeding after some month dry pasture. Supplementation may be desirable for lambs and calves weaned early during drought on to grain and dried forage diets, and recommended allowances in feedlot diets for cattle and sheep are tabulated (NRC, 1980).

Lynch et.al (1972) find that merino ewes in the temperate climate of the Northern Tablelands deprived of drinking water for 12 months or more could survive and breed and have similar productivity to ewes with water; non-breeding cattle may sometimes not drink for long periods. Indeed, extensive areas of pastoral lands have been made usable only by establishing watering points, often supplied by bores into underground sources. Many of these sources contain various salts which are compounded if there is a high salt intake in the feed. Sheep and cattle in small paddocks may drink several times in 24 h but as area served by one watering point increases the time required walking to water from grazing and return becomes longer and drinking frequency will decrease (Squires, 1971). He observed, that lambs will usually walk some distance with their mothers, but when breeding ewes and wethers were provided with salty feed only at a distance of about 4.5 km from water the frequency, decreased to three to two day or once daily, and their feed intakes and productivity decreased. Sheep grazing in semi-arid grassland have been observed to range more 5 km from water, drinking only every third day after even longer intervals in winter, but drinking daily when temperatures exceeded 41^0C. Schmidt (1969) observes the behaviour of Shorthorn cattle in Australia during the dry season where little shade is available. He classifies his cattle as ‘walkers’ and ‘non-walkers’. Both types drank once daily but the non-walkers’ grazed poorer quality pastures close to the watering points while walkers travelled up to 16 km/d in order to graze better quality pastures further away. There were a greater proportion of ‘walker’ cows without calves than ‘non-walkers’.

Forages, either grazed of fed, after conservation, supply at least 75 % of the ME and DCP requirements of ruminant livestock. Many reasons can be advanced, related to forage species, environmental conditions and stage of growth when the forage is ‘harvested’ and the processes of conservation. To optimize utilization of nutrients, it is necessary to recognize the rumen as the principal site of digestion, where extensive fermentation of structural carbohydrates provides energy directly to the microbial population and indirectly, as volatile fatty acids, to the animal. Digestibility of organic matter and crude protein, as indices of forage nutritive value are of little relevance to feeding of ruminants and a more comprehensive assessment of the carbohydrate and protein fraction is essential (Beever et al. 1985)

Grasses, legumes, cereal straws and grains, and forage maize are the principal forages for ruminant livestock. Sheep production relies on most forage being utilized by the grazing animal, whilst supplementary feeding (hay, silage, concentrates) is largely restricted to pregnant ewes. With beef production, both grazed and conserved forage may vary according to the system of production adopted and especially the expected age and body weight of the animal at slaughter. With dairy-cows, high-energy and protein feeds of non-forage origin are fed as milk yields commensurate with the animals’ genetic merit cannot be achieved from forage-only diets. Furthermore, as demand increases for animal products of defined protein and fat contents, forage content of the diet is unlikely to increase. On the other hand, if it can be recognized where current forages fail as adequate feeds for high producing ruminants, it may be possible to reverse this trend by breeding forages with improved characteristics which more closely reflect the animals’ requirements for specific nutrients. It is necessary to analysis the issues relating to forage utilization by ruminants and provide insight to improving the nutritive value of currently available forage.

Poor feed intake or impaired protein supply may compromise the level and composition of animal production which can be achieved forages. Thomson et al. (1984) considered this by grazing dairy cows on pure swards of perennial ryegrass or white clover from lactation week 4 to 18. Overall the milk output from the clover fed cows increased by 300 l, with a small increase in milk protein content and a larger reduction in milk fat content. Post-experimentally, all cows were housed and fed grass silage and fixed amount of concentrates, during which time an extra 600 l of milk were produced by the cows that had previously received white clover, suggesting a substantial residual effect which may have been related to changes in the endocrinological status of the cows as moderated by the different diets. Rinne et al. (1992) find that, indoor feeding and grazing with dairy cows in Finland were compared at two levels of energy and protein from concentrates during three growing seasons. Grazed cows produced more milk, and their milk contained more protein and less fat than that of completely indoor fed cows. The number of animals culled due to mastitis was higher for the completely indoor fed cows than for grazed cows. There were several reasons for the higher milk yield of grazed cows. Because of the grazing was efficiently managed, there was plenty of good quality grass available. The long Finnish summer days allowed more time for daily feed intake during grazing than indoor feeding.

Anderson et al. (1966) determined the comparative advantages of feeding baled hay in three different ways to cattle wintered in the open. One group of cattle was fed hay in a rack daily in an amount equivalent to 2.3 pounds per 100 pounds of body weight. The second group was fed an equivalent amount of hay, but it was spread on the ground at each daily feeding. Hay for the third group of cattle was placed in a rack once each week in an amount which would permit the animals to have all they wanted to eat during the week. These trials were conducted during three winter seasons. The actual beginning and ending of a trial was largely dictated by weather conditions and their effect on grazing. The results of these trials may be summarized as follows:

Weekly Feeding in Rack

1. Requires least time for feeding.
2. Results in greatest feed wastage.
3. Costs involved in removing manure from around rack may offset saving in feeding time.
4. It requires most feed.
5. Cattle gained an average of 25 lbs. during wintering period.

Daily Feeding

1. Requires more time for feeding.
2. Least feed wastage.
3. Major differences between rack and ground feeding were:

a. Cost of removing manure from around rack.

b. Cattle fed on ground lost weight, whereas those fed the same amount of hay from a rack maintained their weight, suggesting less feed wastage with this method.

Sheets et al. (1926) analyses the solution of problems related to winter feed and feeding method with less cost and more effects in 3 a year-study, while in all previous works, the cattle were kept for one year only. They also define relationship between stall feeding and grazing issues under winter feeding methods.

Ration I	Ration II	Ration III
Clover hay	Cottonseed meal	Mixed hay (grain mixture)
Corn silage	Corn silage	Corn silage*
Wheat straw	Wheat straw	Wheat straw*

*- they were given only on the third winter feeding year.

When the cattle graze in the summer (without additional feed) the lots which gain heavily during the previous winter (in the first year Ration III, the second and the third years Ration I and ration II) did not gain so much in the following summer, and the lots gaining less in winter make relatively large summer gains.

Zhang et al. (2008) determine the effect of feeding rice whole crop silage (RWCS, Oryza sativa) with substituting corn silage (CS) diets on milk production, milk fatty acid composition, rumen fermentation and blood metabolism in lactating dairy cows. DM intake, milk yield and milk composition did not differ between RWCS and CS diets. Their study suggested that RWCS could be well utilized as basic roughage as CS for lactating dairy cows.

Put simply, digestion in the rumen is characterized by feed conversion to short chain fatty acid (SCFA), the propionate, which provide the primary energy source for ruminants, which is the major source of protein and finally the gases, mainly CO2 and CH4 which are digestive waste products and obviously of major environmental concern, observed less in RWCS than CS diets.

2.4 Grazing Management

Grasslands and rangelands usually produce the majority of the forage ingested by ruminant animals during the grazing season. Grass, is above all, a healthy food, usually free of residue or toxic substances. Eaten at a sufficiently young stage, they are highly digestible and contain almost as much energy as cereal grains. At this stage, they also have high mineral and protein contents that cover a large part of animals' requirements (Henry et al., 1995). Pastureland is critical to the production of these ruminants and the products they provide. In order to obtain maximum profits from pasture grazing, producers must manage the land for high production per acre and must manage the animals to minimize forage waste and to ensure that they are growing sufficiently. Grazing systems provide high-quality forage and reduce feed and veterinary costs while avoiding manure build-up. Feed costs are reduced because farmers and ranchers do not have to grow or purchase forage and grain year-round, and veterinary costs are reduced because animals on pasture have fewer health problems than those that feed in the barnyard. In addition, pastures require few or no pesticides and allow natural recycling of manure. They also provide a continuous soil cover, thus protecting wildlife habitats and important ecosystems.

The maximum carrying capacity of Kyrgyzstan's grazing-land is estimated at 7 mln sheep equivalents. This includes all ruminant stock (cattle, yaks, sheep and goats) and horses.

Official estimates of sheep equivalents are about 8, 216 thousand units. Though sheep numbers have significantly reduced, the number of 'sheep equivalent' has not when cattle and horses using the pastures and the abandonment of the outlying grazing is taken into account. Previously, large numbers of cattle were managed under intensive conditions, and fewer grazed on natural pasture. The reduction of sheep numbers from 14 mln head in the late 1980s to 3 mln head or less in 1995 should have resulted in a general and gradual improvement of all the pastures. But there has been no policy to bring stock numbers with the carrying capacity of the land. The numbers of grazing horses is probably more than statistics indicate, as ownership is not well recorded. So stock numbers, in 'sheep units' are still higher than the carrying capacity of the grazing, and are excessive on pastures within easy walking distance of settlements. Almost nowhere is controlled grazing management being practised and the privatisation of herds and flocks has only increased this problem (Fitzherbert, 2005). Kyrgyz Pastoralism is much more than simply a mode of livestock production. It is also a consumption system that supports Kyrgyz population, a natural resource management system, key to poverty reduction, development livestock contribution, decreasing external-internal migration and also support of the pastoral livelihood systems. Esengulova (2007) argues, that in Kyrgyzstan, where all pastures belong to the state and there is weak land legislation, the absence of maps of pastures which show boundaries, status of land, lack of knowledge on sustainable practices among land users, inequitable access to resources and not registered rights, maximisation of pasture use is in place, lead to over exploitation of natural resources. She focuses on a case of developing local community association for management of high altitude pastures in Kyrgyzstan; in Tolok community (village) Kok-Jar near fresh water Lake Son-Kol, Kochkor district, Naryn oblast, by comparing pasture condition in pre-Soviet, Soviet, past-Soviet and present period. Further researches are required to find out in other regions of

Kyrgyzstan.

The three most widely used grazing systems are continuous grazing, intensive rotational grazing, and multispecies grazing. The primary grazing system used in Alabama USA, as in many other states, is continuous grazing. In this grazing system, animals graze a specific pasture area freely and uninterruptedly throughout the year or grazing season. Because continuous grazing allows animals to graze selectively, individual animal performance is usually maximal. However, due to the selective grazing nature of animals, some forages are overgrazed while less desirable plants are under grazed, which damages or wastes pastureland. The grazing system that most effectively uses pastureland is the intensive rotational grazing system, which includes short-duration grazing, rapid grazing, cell grazing, and strip grazing. In a rotational grazing system, the pasture is fenced off into subdivisions or paddocks, and animals are rotated according to the forage available and the forage growth rate. Short grazing periods are beneficial because they can increase the carrying capacity of the pasture without plants being damaged. However, research indicates that individual animal weight gains are higher under a continuous grazing system than under an intensive rotational grazing system. Intensive rotational grazing focuses more on animal production per acre than on individual animal performance. Multispecies grazing is a grazing system in which cattle and sheep graze together. Studies in the1950s and 1960s show that cattle, sheep, and goats do well together on shared range because they have different grazing behaviours. Cattle mainly eat grasses, and sheep and goats prefer broad-leafed plants such as forbs and leaves from some small shrubs. Multispecies grazing offers producers the opportunity for complementary pasture use since what one species will not eat, the other will. This significantly maximizes forage utilization, which translates into higher animal production rates per acre, lower costs of production, and better returns for farmers and ranchers. In addition, the cattle's presence protects the sheep and goats from coyotes and wild dogs (Correa, 1999).

Peeters (2004) reports the main characteristics for wild and sown grasses for grasslands in Australia. Grass covers are key components of the landscape and of human culture. In pastoral regions, pastures are major constituents of the landscape and, notably in zones of farmland crest-crossed with hedges and trees, in the hills and in the highlands. The grazing livestock contribute to the attractiveness of the countryside. Grassland landscapes have deeply affected the cultures, the traditions and the lifestyles of the people who live within them. Numerous proverbs and expressions bear witness to the importance of grass and grasslands in the collective psyche. Such landscapes also have a recreational function (tourism) that is reinforced by the region's cultural and aesthetic characteristics in Australia. Despite the fact that many grasses exhibit a great similarity of growth habit, they have very different ecological requirements for many factors (soil moisture, soil texture, nutrient availability, soil pH etc.) and they can also be more or less tolerant of limiting factors (flood, drought, trampling, winter frost, snow periods and late frost in spring). All aspects are influenced by the frequency of defoliation, the stocking rate and grazing system (rotational or continuous).

2.5 Importance of Livestock in the Present and Future and How Climate Change Can Affect It

Globally, livestock contributes 40 % to agricultural GDP, employs more than a billion people and create livelihoods for more than 1 billion poor (Steinfeld et al., 2006). From a nutritional standpoint, livestock contributes about 30 % of the protein in human diets globally, and more than 50 % in developing countries. In many developing countries, livestock is also considered to be the backbone of agriculture, as they provide draught power and farmyard manure, often the sole source of crop nutrition. As outlined in the livestock revolution scenario (Delgado et al., 1999) the consumption of animal products will rise particularly in the so called developing countries in response to urbanization and rising incomes. While the increasing demand for livestock products offers market opportunities and income for small holder producers and even landless, thereby providing pathways out of poverty, livestock production globally faces increasing pressure because of negative environmental implications particularly because of greenhouse gas emissions. Besides greenhouse gases, high water requirement in livestock production systems is a major concern. The relationships between livestock and the environment are complex and appear to be viewed very differently from developed and developing country perspectives (Kristjanson, 2004). The FAO report, Livestock's Long Shadow (2005), focuses on the effects of livestock on the environment. The climate change impacts of livestock production have been widely highlighted, particularly those associated with the rapidly expanding industrial livestock operations in Asia. Yet, in smallholder crop-livestock and agro-pastoral and pastoral livestock systems, livestock are one of a limited number of broad-based options to increase incomes and sustain the livelihoods of an estimated 1 billion people globally, who have limited environmental footprint (Steinfeld et al., 2006).

Livestock are particularly important for increasing the resilience of vulnerable poor people, subject to climatic, market and disease shocks through diversifying risk and increasing assets. The demand for energy supply through biofuels is yet another factor that is putting increased pressure on the natural resource base and balance between different natural resource uses, especially in mixed crop-livestock systems. Blummel et al. (2009) report that in the absence of efficient livestock extension and veterinary services, there has been severe genetic erosion, resulting in low productivity. This compelled small farmers to expand their herd size, resulting in shortage of fodder and feed. As it was not economically viable to feed low productive livestock, farmers facing shortage of fodder let them out for free grazing on common lands and forests which suppressed the productivity further, while accelerating the pressure on the livestock owners either to cull their uneconomic animals or to control their herd size. With the growing threat on food security arising due to global warming, small farmers dependent on rainfed agriculture are likely to be affected more severely, which may compel them to shift over to livestock husbandry for their livelihood. Therefore, there should be development to promote the productivity of livestock, while reducing the population and conserving water and fodder. In relation to climate change, livestock will have to play a dual role: mitigation and adaptation.

2.5.1 Forage and Water

Water scarcity has become globally significant over the last 40 years or so, and is an accelerating condition for 1-2 billion people worldwide (MEA, 2005). The localised impacts of global change on water sources are starting to receive attention, but in the same way as for localised agricultural impacts, there is a great deal of work to be done. The response of increased temperatures on water demand by livestock is well-known. For *Bos indicus*, for example, water intake increases from about 3 kg per kg DM intake at 10 ^{0} ambient temperature, to 5 kg at 30^{0} C, and to about 10 kg at 35^{0} C (NRC, 1981). The impacts of climate change on water supply changes in livestock systems, however, are not well-studied. The key contribution of groundwater to extensive grazing systems will probably become even more important in the future in the face of climate change, although the impacts on recharge rates of the aquifers involved are essentially unknown.

Land use and systems changes

As temperature increases and rainfall increase or decreases (depending on location) and becomes more variable, the niches for different crops and grassland species change. For example, in parts of East Africa, reductions in the length of growing period are likely to lead to maize being substituted by crop species more suited to drier environments such as sorghum and millet (Thornton & Herrero, 2008). These land-use changes can lead to a different composition of animal diets and to a change in the ability of smallholders to manage feed deficits in the dry season. These two effects can have substantial effects on animal productivity and on the maintenance of livestock assets.

Changes in the primary productivity of crops, forages and rangelands

This is probably the most visible effect of climate change on feed resources for ruminants. However, the effects are different depending on location, production system and crop and pasture species. In C4 plant species, increases in temperature up to 30-35^0 C will, in general, increase the productivity of crops, fodders and pastures, as long as the ratio of evaporation to potential evapotranspiration and nutrient availability do not significantly limit plant growth. In C3 plants such as rice and wheat, temperature effects have a similar effect but increases in CO_2 levels will also have a significant (positive) impact on the productivity of these types of crops (IPCC,2007). For food-feed crops, since harvest indexes change with the amount of biomass produced, the end result for livestock production is a change in the quantity of grains and straws and availability of ME for dry season feeding. Higher temperatures increase lignification of plant tissues and, therefore, reduce the digestibility and the rates of degradation of plant species (Minson, 1990). This leads to reduced nutrient availability for animals and ultimately to a reduction in livestock production, which may have impacts on food security and incomes through reductions in the production of milk and meat for smallholders.

2.5.2 Changes in Livestock Species Composition

Species composition in rangelands and some managed grasslands are important determinant of livestock productivity. As temperature and CO2 levels change, the optimal growth ranges for different species also change; species alter their competition dynamics, and the composition of mixed grasslands changes. For example, in the temperate regions and subtropics, where grasslands often contain C3 and C4 species, some species are more prominent than others in the summer, while the balance of the mix reverts in winter. Small changes in temperature alter this balance significantly and often result in changes in livestock productivity. The proportion of browse in rangelands may increase in the future as a result of increased growth and competitive of browse species due to increased CO2 levels (Morgan et al., 2007).

2.5.3 Livestock and Human Health

The major impacts of climate change on livestock and human healh have manifested themselves on diseases that are vector-borne. Increasing temperatures have supported the expansion of vector populations into cooler areas, either into higher altitude systems or into more temperate zones (the spread bluetongue disease in northern Europe). Changes in rainfall pattern can also influence an expansion of vectors during wetter years. This may lead to large outbreaks of disease, such as those seen in East Africa due to Rift Valley Fever virus, which is transmitted by a wide variety of biting insects. Helminthic infections, particularly of small ruminants will be greatly influenced by changes in temperature and humidity. Climate changes could also influence disease distribution indirectly through changes in the distribution of livestock. Areas becoming more arid would only be suitable for camels and small ruminants. If these species are forced to aggregate around water points, the incidence of parasitic disease could increase. “Environment-Friendly” development of livestock production systems demand that the increased production is met by increased efficiency of production and not through increased animal numbers (Leng, 1993). As livestock is, and will remain, an important source of livelihood, it is necessary to find suitable solutions to convert this industry into an economically viable enterprise, while reducing the ill-effects of global warming. In relation to climate change, livestock is part of the problem, but part of the solution where cropping becomes too risky and where livestock will serve as an important tool for risk mitigation and diversification. Increasing the efficiency of livestock production that is harvesting higher productivity from fewer numbers of livestock will play a key role in mitigating environmentally adverse effects from livestock. There are, however, ceilings to this approach mainly defined by feed resources. Feeding of livestock should not lead to competition for human sources and should be based on converting non-human edible feed sources into human edible ones. Some trade-offs between positive and negative effects of livestock have to be accepted (Mendelsohn & Dinar, 2008).

2.6 Constraints to Livestock Production Systems

The inaccessibility and ruggedness of mountain areas are well recognized as physical constraints, but there are other less well-understood constraints. Human disregard for mountain specificities results in a blanket approach providing solutions which does not meet the need to improve farmers’ welfare. One of the characteristics of the mountain region that enriches its diversity but is constraint livestock production systems is its heterogeneity of mountain regions which impedes the transfer of technology from one region to another. Other constraints include lack of methodologies for integrating research results into technological alternatives, inappropriate incorporation of socio-economic aspects into the technology development and transfer process and irrelevance of technological innovations to farmers (Varde, 1999). Shortage of animal feed and the lack of adoption of technologies to improve feed production in monocultures or in association with other crops are seen by some as some of the key constraints in the livestock sector. It is necessary to draw attention to the presence of anti-nutritional factors in highland vegetation as fodder problem. Specific reference is made to the tannins present in many trees that have negative influence on protein digestion; tree fodder is an integral part of feed in many highland mountain areas (Djikman, 1999). The low returns that farmers receive from investments on livestock or another constraint to the development of livestock production can be one of the major constraints of livestock production systems. The low price milk has been seen as a disincentive for smallholder dairy farmers in the mountain areas (Tulachan, 2000).

Broad regional studies and case studies in East Africa show that livestock production is particularly constrained by market and spatial factors. These constraints are likely to become even greater as a result of the high costs of infrastructure and risks of disruption. Selected case studies show that the primary constraints to livestock production in highland and mountain areas are remnants of restrictive policies and regulations, high transaction costs as a result of poor infrastructure and information systems and poorly developed markets for inputs and outputs. These case studies also show the recent reforms have eased some of these constraints with good results for both producers and consumers. Further reform and investment in supporting infrastructure, including farmers' group development, can help provide good growing opportunities for smallholder livestock producers in highland systems. Inadequate veterinary services and health care are general and serious problems for the development of the livestock sector. In the highlands, the withdrawal of subsidised extension and veterinary services has not only affected animal health, but also the adoption of technologies (Staal & Jabbar, 1999).

Kerven (2005) studied other constraints to livestock production in Central Asia. Native goats of Kazakhstan, Kyrgyzstan and Tajikistan produce good quality cashmere that is recently being bought by international processors. Central Asian producers are not equipped to take full advantage of these new marketing opportunities. Lacking prior experience, Central Asian producers are unable to distinguish well cashmere from poor. International markets reward quality with higher prices. Producers and local traders lack global market information on demand and prices. Producers also lack skills in harvesting and sorting cashmere according to international quality standards, and sell individually to traders rather than pooling to gain higher prices. Consequently, Central Asian producers receive much lower prices than Mongolians and Chinese. Strong international demand continues for cashmere. Beauvais (2005) focuses on defining practical, economically viable ways of increasing productivity of Kyrgyz sheep and cattle herds, focussing on animal husbandry. Seven case studies in Karakol in Kyrgyzstan were used as a basis for describing farming methods. A questionnaire was used to find the main problems and diseases associated with the loss of productivity. A number of different problems and diseases were identified. Animal husbandry problems included poor control of nutrition, lack of breeding strategy, poor treatment of disease, poor hygiene and transportation methods. Further research is required to find out if the problems are common to smallholders across the region and in the other regions of Kyrgyzstan. Certain areas of animal husbandry on the smallholdings investigated could be further improved through more in depth research. For example, increasing the lambing rate and milk productivity of cattle through genetics, nutrition control or other methods; enabling a more accurate picture of diseases present through improved diagnostics; finding out the feasibility of certain education and co-operative programs.

2.7 Socio-Economic Issues of Livestock Management

Gender and Livestock - Gender is a vital issue for the sustainable management of livestock in mixed crop-livestock farming systems because of the substantial role women play in livestock management. Men and women have different domains of activity and different knowledge and skills. In some areas, the knowledge and skills of women are considerably greater than those of men, but, in general, this does not receive due recognition (Njiro, 1999). When rural women have access to cash or microcredit, they usually choose to invest in livestock, which provide food, cash, draft power, and fertilizer, and gain value through reproduction. With increasing male outmigration and the feminization of rural poverty, women have a greater need and desire for livestock to improve their food security and income levels.

Livestock and poverty- The fight against poverty starts with rational use of available natural resources. Among those most readily available to the world's poor are farm animals. One-third of the world's 6 billion people depend on animals daily. Of the 1.3 billion people living in absolute poverty, 80% live in rural areas and of these, two-thirds—some 678 million poor—keep livestock (ILRI, 2007). Livestock are a crucial source of financial capital for the rural poor. For many, livestock ownership is the only form of savings available. In fact, for pastoralists and often for poor women, livestock are the most important fungible asset they own. Livestock provide a critical reserve against emergencies and decrease vulnerability to financial shocks from ill health, crop failures, and other risks. They yield direct benefits in the form of food, wool, or hides, and can raise farm productivity by providing manure and draught power. In a comparative study of poor livestock keepers in Bolivia, India, and Kenya, households in all three countries ranked livestock above business and housing as their best investment. In 40% of Kenya’s districts, livestock represent more than a quarter of total household income. In rural Nepal, they contribute 9-14% of production for home consumption, and are even more important as a source of cash income. For Nepal isolated mountain communities, livestock are among the few items exchanged for cash, constituting nearly half of total farm cash income. These studies have found that livestock generally contribute significantly more to the income stream of poor households, particularly the income controlled by women, than to the incomes of those living above the poverty line (Thornton, 2002). The benefits from livestock can even extend to those who do not own livestock, often the poorest members of the community. Non-owners are sometimes able to obtain milk, dung for fuel, or help with ploughing of fields. These may be given free of charge from livestock owners or at greatly reduced prices (Shackleton, 2005). Perhaps not surprisingly, livestock figure prominently in the movement of households into and out of poverty. In a study of household poverty dynamics in 20 communities in Kenya, researchers found that more than 40 %of families that escaped poverty did so by diversifying their farm income, primarily by acquiring livestock (Kristjanson, 2004). When the poor have access to markets, livestock can serve as a source of collateral, giving households access to other forms of capital and opening pathways for further income diversification. The role of livestock in rural communities extends significantly beyond their economic value. Most notably, livestock play a prominent role in social and cultural relationships. Loans and gifts of livestock contribute to family and communities and often play a central role in cultural traditions such as weddings and funerals. Owning livestock can also bring better nutrition to some of the most vulnerable groups, including women and children (IFAD, 2004).

2.8 Conclusion

Academic interest in local-level livelihood studies in rural Kyrgyzstan is growing.

Existing case studies illustrate the variety of coping strategies employed by rural households, depending on their socio-economic background. To some extent, however, most of these studies neglect the importance of the institutional context, most probably because it is highly demanding and time-consuming to capture other more complex institutional aspects in a survey. Most surveys, therefore, have done with understanding the ways in which institutions contribute to the achievement of collective (community) goals. Similarly, many development projects engaged in institutional strengthening focus on visible, formal organisations only (Mearns & Scoones, 1999). The report on global environmental issues related to livestock herding concludes that there is an urgent need to develop suitable institutional and policy frameworks, at local, national and international levels in order to decrease the often severe environmental impacts caused by the livestock sector (FAO, 2006). Although transition research made a remarkable step from the macro-economic down to the local and household levels, many effects of post-socialist transition upon people's livelihoods remain difficult to grasp. This has to do with certain shortcomings of the often-applied household-surveys. Analyses of household strategies tend to neglect intra-household disparities, i.e. between gender and age groups, which often exceed inter-household disparities. Domestic units are, therefore, best conceptualized as the site of multiple and interlocking sets of processes. These may activate different sub-sets of individuals who constitute appropriate units of analysis (Kandiyoti 1999). This research tried to find out the main socio-economic and environmental factors affecting agro-pastoral systems in two VGs and to analyse how those factors are related to each other.

Chapter III Research Methodology

3.1 Introduction

This chapter includes research designs and methods. This study was conducted at different levels – at individual and household levels for analysing livelihoods; and at local, regional and national level for the analysis of the institutional, socio-economic context of agro-pastoral systems[2]. Another type of agro-pastoral systems practiced in the study area is sedentary transhumance. Pastoralists sometimes rent in some arable land and cultivate crops. The nature of study is cause-effect study – combined qualitative and quantitative data to analyse the interaction between livelihood levels. Additional qualitative methods for studying agro-pastoral systems i.e. analysis of narratives stories, helps in addressing the distinct time component in this study; pre-Soviet time and post-transition (previous 10-15 years) and current-market oriented economy. It is expected that this method will examine how households and pastoralists react to new opportunities with old systems and to new systems with old farming methods and conserved indigenous knowledge. The different components of the study design are below.

3.2 Description of the Research Sites

Ala-Buka district is located in the South part of the Western Tien-Shan, 1600-1800 meters above sea level (average) in north-western Fergana Valley. Seventeen ecosystems can be found from a total 22 ecosystems in the northern temperate part of the district, while in the southern part only three ecosystems are found. The Western part of Zhalal-Abad, including the study district have significant importance in natural resources and biodiversity

[2] -Agro-pastoral production systems are depending on a mix of farming and pastoralism, typically with one or more fixed settlements and pastures to which the animals are sent with some group or household members seasonally.

conservation; three nature reserves (Besh Aral, Sary-Chelek and Padysha-Ata) established to preserve valuable and endemic species in the area. With these points, this research tried to examine the interrelationship between nature and people through livestock and land management issues and the condition of utilization and conservation of natural resources. Ala-Buka district was selected for the study. It is located in the south-west of Zhalal-Abad region, Kyrgyzstan. Within the area of 3 thousand km^2, the district is bounded by Chatkal and Aksy districts of Zhalal-Abad region in East, West and North, and Namangan region of Uzbekistan in the south t (Figure 3.1). Ala-Buka village, that is the centre of district, is located 250 km far from Zhalal-Abad region centre, 700 km far from capital city-Bishkek, and 55 km far from Namangan city, Uzbekistan. Namangan is the nearest market at which most households' economy strongly depends. The main activity in the area is agriculture. There are 21,134 hectares of arable land, including 16718 ha of irrigated and 5416 hectares dry land areas. Most are grown: wheat corn, potatoes, beans, oil plants, tobacco, cotton, melons, vegetables and forage crops. Pastures of district are 129429 ha, including 9,738 ha near-village pastures (by seasonal use called winter pastures-*kyshtoo*), 47616 ha of intensive (spring/autumn pastures– *jazdoo/kuzdoo*) and 72,075 ha remote (summer pastures-*jayloo*) pastures, which create favourable conditions for breeding of cattle, horse and small ruminants. Other land areas such as 400 ha hay land, 1,517 ha orchard and 25,379 ha forests also play major role in district socio-economy. There are 73 agricultural cooperatives, 467 peasant farms, 4,731 private farms and two state owned Kyrgyz fine-wool merino sheep breeding farms (DADD, 2009).

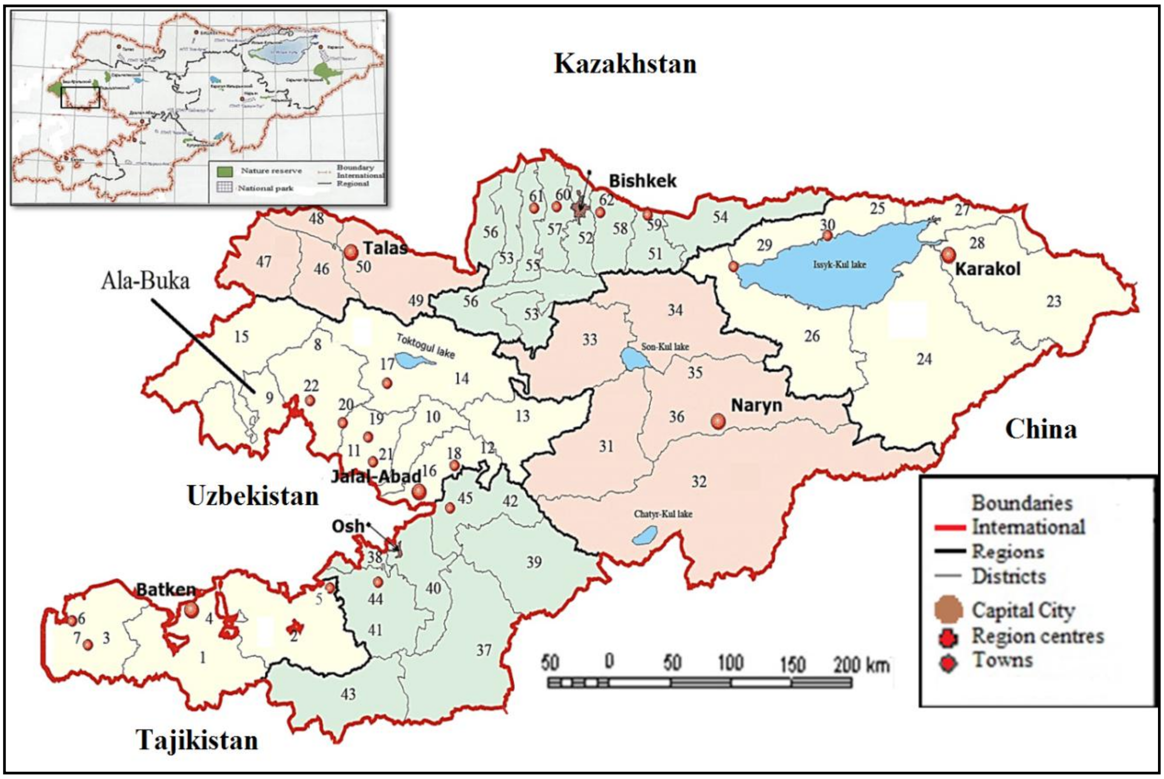


Figure 3.1 Map of Kyrgyzstan showing the study area – Ala-Buka district

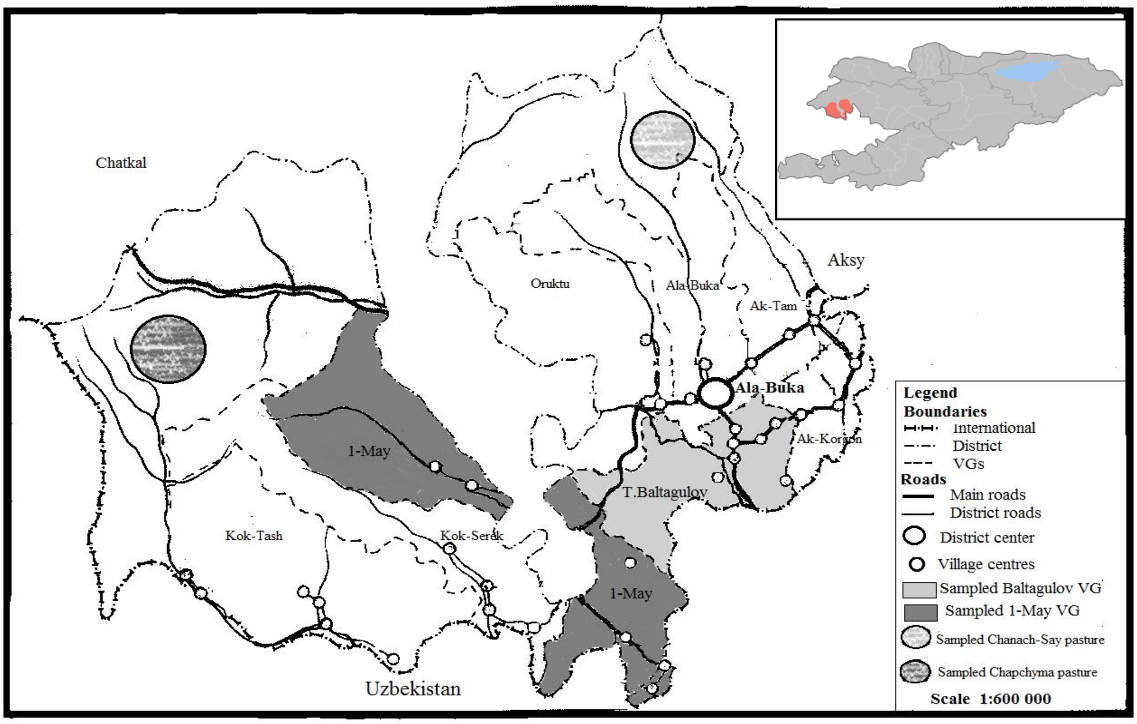


Figure 3.2 Map of Ala-Buka district showing sample VGs and pastures

For the purpose of household surveys, the research was conducted in two VGs, in three agro-pastoral systems: the first mainly livestock with additional cropping, the second mainly farming with additional livestock and for both VGs along livestock holding, shown in Figure 3.2. A single-study design was adopted for all objectives in two VGs: 1-May[3] Village Government (MVG) and Torogeldi Baltagulov Village Governments (BVG). Another reason of choosing two VGs among eight VGs in the district was specialised to different livestock species breeding during Soviet time, due to topography and pasture condition. In the past, MVG and other three neighbouring VGs mainly specialized in Kyrgyz fine-wool merino sheep and cashmere goats breeding, and MVG partially represents other VGs. The same case for BVG represents other three VGs, formerly specialised in Ala-Too meat-dairy direct cattle breed. This background is important in the market based-economy of the district and agro-pastoral systems; gained experiences and new opportunities have had different feedback in both VGs. It is expected that a comparison of the two locations leads to a better understanding of gaps and priorities, and the importance of livestock based livelihood and the ways in which these agro-pastoral systems can be strengthened.

MVG (former 1-May kolkhoz) with total 29,221 ha area is located in the south-western part of Ala-Buka district, 800-3300 m above sea level. The total population is 11,279 people. Ethnic composition is Kyrgyz (96 %), Uzbek (0.3%), Tajiks (3.5%) and others (0.2%). The total arable land area is 2321 ha, including 1668 ha irrigated and 653 ha dry land area. Farmers grow wheat, maize, sunflower, forage crops, cotton, tobacco, beans, watermelon and gourds; double cropping and transitional cropping are common in the south part, while in the north farmers grow only forage crops. During the Soviet time irrigation-drainage systems were strictly controlled and without interruption during the growing season; water was taken

[3] - 1-May reads as *Birinchi May*

by three main pump stations, which after independence were abandoned and created huge difficulties with water to farmers. A total 7865 ha pastures area plays main role in VGs livelihood, with the condition in favour of raising small ruminants.

BVG, former Birlik sovkhoz, is in the south-eastern part located 12 km far from the district centre, neighbouring with Uzbekistan. During the Soviet time, this VG was mainly specialized in breeding Ala-Too breed and there was one of the biggest complexes of pure breed raising in the oblast. The total area of VG is 25549 ha, located between 800-2700 m above sea level in the south-eastern. The total population is 11723 people (2010), ethnic composition consists Kyrgyz (62 %), Uzbek (32%), Tajiks (4.5%) and others (1%). There are 2506 HHs in BVG and 908 HHs of the 37.3% of the total HHs monthly income is up to 175 som[4]. In MVG, it is 810 HHs or 39.9% of the total 2034 of HHs, higher than in BVG. The total arable land area is 2512 ha, including 2155 ha irrigated and 357 ha dry land area. Compared to MVG, irrigated land area is also more than in MVG with ground water sources in four villages. Water availability in the growing season has made farming the main source of income with additional livestock keeping in BVG. In general, farmers grow multiple purpose crops, such as wheat, maize, vegetables, forage crops and cash crops, such as potato and sun flower. The weather condition in BVG is cooler than in MVG; therefore cotton and gourds cannot be grown in BVG. The land size per capita also differs in both VGs, in MVG, 0.12 ha irrigated and 0.06 ha dry land in a total 0.18 ha arable land, while in BVG 0.17 ha irrigated and 0.03 ha dry land with a total of 0.20 ha arable land area per capita[5].

It was observed that lack of land (especially irrigated) and the pressure on resources are

[4] Som is National currency of Kyrgyzstan, 1 USD is equal to 46,45 Som (2010)

[5] Private land ownership in Kyrgyzstan was authorized by a constitutional amendment adopted in 1998, followed in 1999 by the implementing legislation. Land distribution and ownership depended on total arable land area of kolkhozes and sovkhozes, where in BVG was 0.2 ha arable land (0.17 ha irrigated and 0.03 ha dry land) per capita and 0.18 ha arable land (0.12 ha irrigated land and 0.06 ha dry land) per capita.

higher in Ala-Buka district than other neighbouring districts, which increase overgrazing and deforestation, as shown in Figure 3.3.

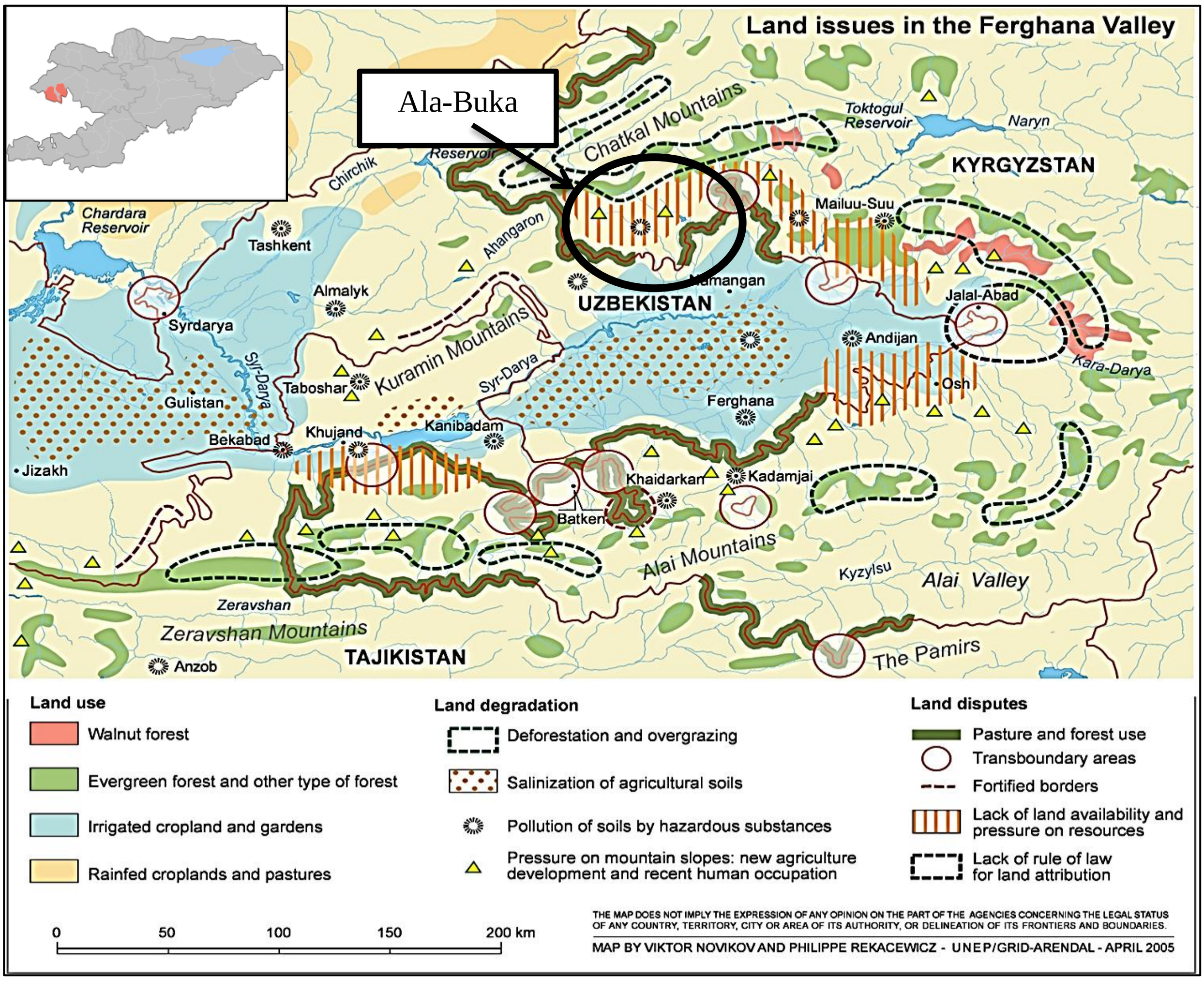


Figure 3.3 Land degradation: overgrazing and pressure on mountain slopes
Source: EnvSecurity, 2005

New agriculture development and recent human occupation gave pressure on mountain slopes. Since this district is located on transboundary zone, pasture and forest usages have political-economic implications. To analyse pasture quality changes (according to temperature and precipitation), plant growth stage, composition and condition, were selected; *Chapchyma* intensive-remote pasture (location $41^0 25^/$N, $70^0 57^/$E, 2500-3000 m altitude, survey area 3.2 ha, 1-May VG) and *Chanach-Say* (*Ak Tash kungoy* (sunny side)) intensive-remote pastures (location $41^0 34^{/}$N, $71^0 29^{/}$E, 1800-2400 m altitude, survey area 3.4 ha, T. Baltagulov VG) located in the south of Western Tien-Shan. Chapchyma pasture, with dryer and hotter climate conditions in summer, its average precipitation is 800 mm a year. It is located near Besh-Aral nature reserve and it favours the grazing of small ruminants and horses. Unlike Chapchyma, Chanach-Say's climate is more humid even in summer; the average precipitation is 1100 mm a year. The biodiversity is almost the same with Padysha-Ata and Sary-Chelek nature reserves. These characteristics necessitate the analysis people-nature interrelationship through livestock and land management and biodiversity conservation issues by comparing the composition, utilisation and degradation levels and factors affecting degradation between two types of pastures. Condition and utilisation of near-village pastures was observed in *Suu Bashy* pasture in Kashkalak village (B VG). This pasture consists of rainfed and irrigated pasture, which can be utilised all year round; in autumn, and in winter, grazing includes cropland.

3.3 Sampling for Household Survey

Following VGs selection, a baseline survey was conducted in different villages to gather basic information on livestock and land holdings, livestock compositions, income resources and other details. Households were then selected for detailed study on the basis of the baseline survey, using stratified, random sampling procedure to ensure that the full range of household sizes was covered. A household survey was conducted both in MVG and BVG to gather basic information on livestock holdings, livestock compositions, income sources, and forage availability, consumption and storage. A total of 240 households, 120 households from each VG, were selected for a detailed study. A household survey used stratified random sampling procedure to ensure that the full ranges of household sizes were covered. Household survey was conducted with semi-structured questionnaire. A total of 80 pastoralists, 40 from each VG, were selected and interviewed in order to gain additional information, including information on pastures and grazing management of the chosen agro-pastoral systems strongly related with them. Information was also collected through interviews with farmers, key informants, discussions with agricultural specialists and government officers of local administration and district.

3.4 Sources of data

Data were collected from both primary and secondary sources. Primary data collection was done in two phases. The first fieldwork was done before starting the research for the study in 2007-2008. Another field survey was done in August-September 2010. Quantitative and qualitative primary data were collected through individual household, village and pasture survey by participant observation, interviews and direct observation at household level. At national level and for supplementing the data from primary sources, various secondary sources were considered such as reports, books, journal articles, and annual statistics reports, and related legislative documents. Many concerned organizations; Ministry of Agriculture and Water Resources and Processing Industry of Kyrgyzstan (MAWRPI, currently Ministry of Agriculture (MoA)), Kyrgyz State Agrarian University, Ala-Buka District Administration (DA), Regional Department of Agrarian Development (DADD), The District Veterinary Department and State Veterinary Laboratory, Rural Advisory Service, Pasture Committees of MVG and BVG were visited. To supplement the data for primary and secondary sources of feeds and feeding methods, additional information from Hiroshima University farm, which was collected during 2009-2011 was used. Some secondary sources were downloaded through the internet.

3.5 Methods of Data Collection

Household and Pastoral survey was conducted by using two types of questionnaires; to generate quantitative data for cause-effect and comparative analysis of data. Questionnaires consisted of three main parts: the first was livestock and land holding with socio-economic issues, second part was about feeds, feeding methods and output from livestock, and, the third part was about access to pastures, pasture management, pastoralists' viewpoints about pasture conditions and socio-economic characteristics of pastoralists and hired shepherds. Questionnaires were designed in three parts to obtain information for meeting all objectives.

The first part of the questionnaire held information on the socio-economic characteristics of HHs, including education, livelihood activities, cropland size, crop species, cropping patterns, income sources, and problems related to livestock and land management issues. The second part was about livestock holding, herd size and composition, changes in herd size and composition in the last five years and reasons for changing. The third part included questions on feeding types, traditional feeding methods, problems with winter shortage and purchasing and selling issues and output from livestock; in terms of milk and milk products. Data on daily milk yield and total milk yield per cow by calving stage, season, length and period were collected in this part. This information was essential for calculating Wood's model; factors affecting lactation curve shape. The forth part was about grazing, transhumance, herding size, payment for herding, income from pasture side, pastures condition and pasture management related gaps and priorities. The Participatory Rural Appraisal (PRA) techniques were used to obtain qualitative information on pasture use and management. The major PRA tools were applied for key informants' interviews and group discussions. Information on some forage species, poisonous plants and the period of poisoning was obtained from pastoralists, some households' members and agricultural specialists. Livestock and crop productivity, fertilisers and fuels supply issues and changes in pasture management and control by Pasture Committee (PC) related information were obtained from the Department of Agrarian Development of District (DADD), Rural Advisory Service (RAS) and Veterinary Department of District (VDD) and Village Governments' specialists by interviewing during field visits. These were supplemented with participant observations and informal discussions with farmers and pastoralists.

3.5.1 Pasture Survey

The second questionnaire was designed about the socio-economic context of pastoralists. This questionnaire mainly focused on pasture management issues; herding, herding cost, income sources and problems of pastoralists. Additional information about daily milk yield and total milk yield of mares were also collected.

To analyse pasture condition and to determine the factors that cause pasture degradation visual survey, according to pasture types, were made. For pasture measurement, *Quadrate method (*the size of square is $1m^2$) was used. Vegetation was measured for a wide range of purposes, such as: description in terms of botanical composition, ground cover, amount of dry matter, quality of dry matter[6], non-edible and edible plant species, height of forage species, and temperature by altitude, biological alters in relation with climate changes, and for determining its capacity to provide feed of livestock. This information were used for assessing pasture degradation level in each pasture side; highlighted main evidences of degradation by species and supplemented with the secondary data. Pasture condition was surveyed in both: utilised and non-utilised intensive and remote pastures.

[6] With purpose of analysing forage quality in Hokkaido University, few collected samples from both Chapchyma and Chanach-Say pastures were brought to Japan. Due to high risk of Foot and Mouth Disease in Kyrgyzstan was not able to analyse the samples.

3.5.2 Traditional Ecological Knowledge

The traditional ecological knowledge (TEK) was used to analyse its role in pasture management, showing how herders ‘knowledge is reflected in pasture use norms and herding practices pre-, during and post-Soviet periods in Kyrgyzstan. Pastoralists are knowledgeable about their environments, topography, climate, and are capable for regulating seasonal resource use among pastoralists, shepherds (themselves and hired). Therefore, examining the role that pastoralists’ ecological knowledge plays in resource management becomes increasingly important in understanding the conditions necessary for the success of traditional resource management. TEK consists of biophysical observations, skills and technologies, as well as social relationships, such as human-environmental interactions. It transferred from one generation to the next, represented cumulative local knowledge and modified as a result of new experiences and observations. This study analyses how TEK acts in common property utilisation among pastoralists. According to Usher (2000), TEK distinguishes four categories:

(A) Factual/ rational knowledge about the environment
(B) Factual knowledge about the past and current use of the environment
(C) Culturally based values about the environment
(D) Knowledge system

This study focused on factual knowledge of modern (hired shepherds, appeared after independence) and traditional pastoralists about the environment, using the category (A), to assess pasture quality and productivity and pasture degradation level, using the category (B) to collect information regarding pasture use and management from modern and traditional pastoralists, PC workers and agricultural specialists, as well as they have different viewpoints about pasture use and herd size management.

3.6 Methods of Data Analysis

The basic mode of data analysis on the livestock diversity, feeds, and outputs from livestock and pasture use and management issues was quantitative with qualitative-descriptive analysis. And these data were complemented with simple statistical tools such as percentages and means used for describing the socio-economic parameters of livestock holdings and pasture measurements. To analyse the socio-economic status of households in terms of the quantity and quality of livestock and land holding, we used household stratification according to herd size in four groups: No livestock-G1, 1-20 livestock-G2, 20-60 livestock-G3 and more than 60 livestock-G4; for land holding: no land, 0-1ha, 1-5ha and more than 5 ha respectively. An economic cost-and benefit analysis for major crops was also analysed using primary data.

Some data related to forage shortage and importance of livestock species were ranked by weighting of answers. T-tests and chi-square tests were done for testing differences among the households and between two study VGs. Factors affecting lactation curves in terms of milk production was analysed by using Wood's gamma model, calculated with STATA software. Data entry was done in Excel and Statistical Package for Social Sciences (SPSS) spread sheets.

Chapter IV Livestock in Production Systems

4.1Introduction

Kyrgyzstan is a mountainous country with livelihood condition of its population determined by climate, landscape, soil, water resources, biodiversity, as well as social and economic conditions. Most of its population derive a substantial proportion of its income from livestock and farming. Moreover mountainous pastures, which consists 86% of total agricultural land, favour livestock rearing in Kyrgyzstan.

The agro-pastoral system includes subsistence farming of main food crops and to an increasing extent, cash crop farming. A key feature of livestock production is the practice of transhumance. Access to common properties, pasture all year round for grazing and supplementary feed from cropping, increased livestock population in general in the country. In other words, an increased demand for livestock and livestock products has resulted in increased number of livestock by species and also by changing its composition. Increased demand for meat and milk production has forced an increase in the number of animals without considering forage availability and pastures' productivity, especially in the case of cattle. This is the main factor that decreases the productivity of livestock species, and can also lead to other constraints of the livestock sector.

The aim of this chapter is to analyse the current condition of two agro-pastoral systems in remote areas; with a focus on livestock-transhumance and additional crop production. In the second section, the basic background information is discussed. The third section is about livestock diversity; trends in livestock population and composition. This section discusses reasons of increasing livestock population and changing composition and how they can contribute to sustainable management of pastures in Kyrgyzstan. The fourth section analysed social and economic issues associated with livestock production. The analysis data was based on households with different herd size categories with mixed livestock species by stratification in four groups. Thus, it discussed the main income sources of these groups to determine the reasons of change in livestock quantity and quality. The fifth section examines livestock feeding by feed types, feeding methods and ratio, and forage deficit by season. The sixth section examines how forage shortage affects output from livestock in terms of milk yield. The calculation of Wood's model about the factors affecting lactation curve based on seasonal forage shortage. The conclusion of this chapter is given in the seventh section.

4.2 Background: Agrarian Sector of Kyrgyzstan: Pre- and Post-independence Periods

Agriculture in Kyrgyzstan has been one of the leading sectors of the economy. In the total GDP of the country, the share of agriculture is significant; about 24%. In addition, approximately 65.0% of the population lives in rural areas. The total number of all employed (34,0%) or 14% of the total population is engaged in agriculture in 2009 (in developed countries this figure is 1-3%). These data show that agriculture in Kyrgyzstan is not only economic, but also has a great social and political significance (Abdurasulov, 2009). When after 1927, the Soviet regime started to force the formerly nomadic Kyrgyz people to settle down and lead a sedentary life, it soon realised that a complete abandonment of livestock migration to summer pastures would hinder further economic development in the Republic. In order to intensify livestock production – mainly sheep production for the Soviet meat and fine wool market – seasonal migration to remote summer pastures was taken up again, yet on a much larger scale than before (Dienes, 1975). The mechanisation of the agricultural sector led to a rapid increase in flock sizes, and overall livestock numbers in the Republic reached about 17.8 million sheep equivalents[7] in 1989 (Farrington, 2005). Semi-nomadic types of

[7] Approximate comparative animal equivalents (AUE) (conversion factors) are taken from Sheep

production emerged, under which animals grazed during winter and spring in a fixed location where houses, shelters and water points are provided, while during summer and autumn, animals grazed pastures at more distant locations. The new systems involved the introduction of improved breeds, and specialized commercial production oriented towards exporting livestock and livestock products to Russia (Miller, 2001).

Climate conditions and topography of Kyrgyzstan assessed the main role of sheep breeding 'industry' in the agriculture sector. The share of sheep products was 35 % in total agricultural production, while in mountainous districts was 56.3-86.3 %. Kyrgyzstan was in the third place after Russia and Kazakhstan in wool production. The share of meat production among Former Soviet Union countries was about 12-14 % and inside the country it reached up to 60 % (Balyan, 1978). Livestock herding was based on transhumant grazing. Most livestock belonged to the state, as property of the collective farms, yet individual herding families could own up to ten sheep, a cow, a horse and one or two goats. Seasonal migration of the collective farms' flocks to summer pastures was organised through kolkhoz herders who, in some cases, together with their families, spent the summer months, or even the whole year, on remote mountain pastures. A highly developed infrastructure was provided to these herders even in the most distant mountain locations, i.e. access to roads, watering points, housing, transport and monthly truck deliveries, and a range of social and cultural services (Fitzherbert 2000; Farrington, 2005). It is estimated that about 75% of all kolkhoz herders operated a transhumant system (van Veen, 1995). The new systems involved the introduction of improved breeds, and specialized commercial production oriented towards exporting livestock and livestock products to Russia (Miller, 2001).

Unit Equivalent (SUE): 1 sheep equals to 1 sheep, 1cow equals to 5 sheep, 1 horse equals to 6 sheep and 1goat equals to 0.7 sheep (MAWRPI, 2007)

After independence, with the transition of the CIS countries from a centrally-planned to a free-market economy, the agricultural sector has undergone substantial changes as a result of privatization, land reforms, price liberalization, and decentralization of decision-making. The system of collective livestock production has ceased, and pastoral livestock production has adjusted to the market economy (Suttie & Reynolds, 2003c). Intensive industrialized livestock production systems were replaced by grazing and mixed–crop livestock or agro-pastoral systems. Depending on the size of the kolkhozes and sovkhozes, every individual (including children, born until 1995) received between 0.18 ha and 0.5 ha of arable land and a few animals, so that thousands of small family farms (depending on family size) with around 0.85 to 4 ha of arable land, a few sheep and goats, one or two cows and one horse to four-or five households[8], were created (Figure 4.1). In 1991, 32.7% of cattle, 42.5% of sheep and goats, and 37.2% of horse were owned by the state, while in 2008, it was 0.2%, 3% and 5% (98% total livestock owned by the private sector) as shown in Figure 4.2 (Nazarkulov, 2009). Collective and state farms had distributed almost all their animals and livestock. Today they are concentrated almost exclusively in household plots and peasant farms. There were considerable differences between state-owned or collective farms, peasant farm and household plots. Extensive livestock systems (pastoral, agro-pastoral and mixed farming) have been restored under market-based economy with preserved nomadic traditional knowledge by providing food, employment and income in remote areas. These systems are based on the use of resources available at low or very low cost, and are driven by access to feed resources with minimum or noninvestment.

[8] - quantity of livestock and species also depended on former kolkhoz and sovkhoz livestock specialization: if it is fine-wool sheep breed specialized, distributed sheep were mainly fall to those breeds, in terms of goats and cattle also distributed similarly. Horses were mainly distributed to peasant farms; one or two horses to one peasant farm, which equaled to one horse to 4-5 households

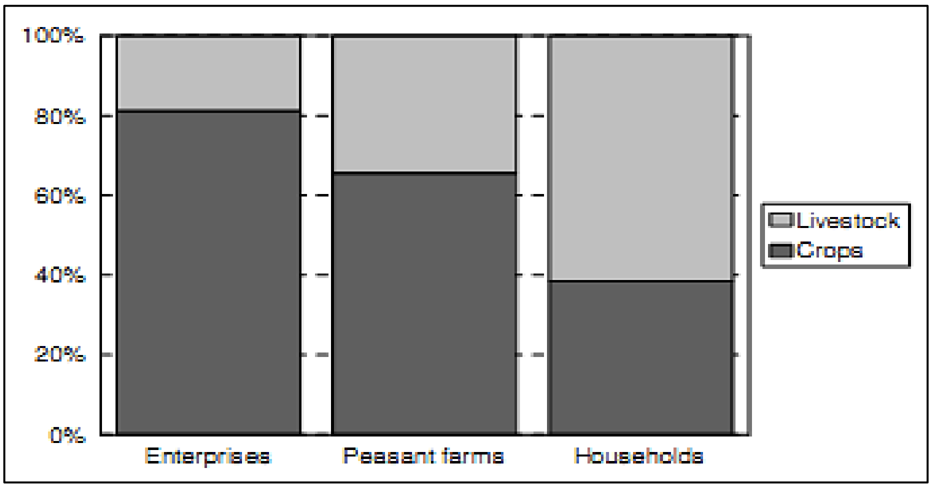


Figure 4.1 The percentage of product mix by farm type from 1998-2007
Source: NSC, 2008 and Lerman et al., 2009

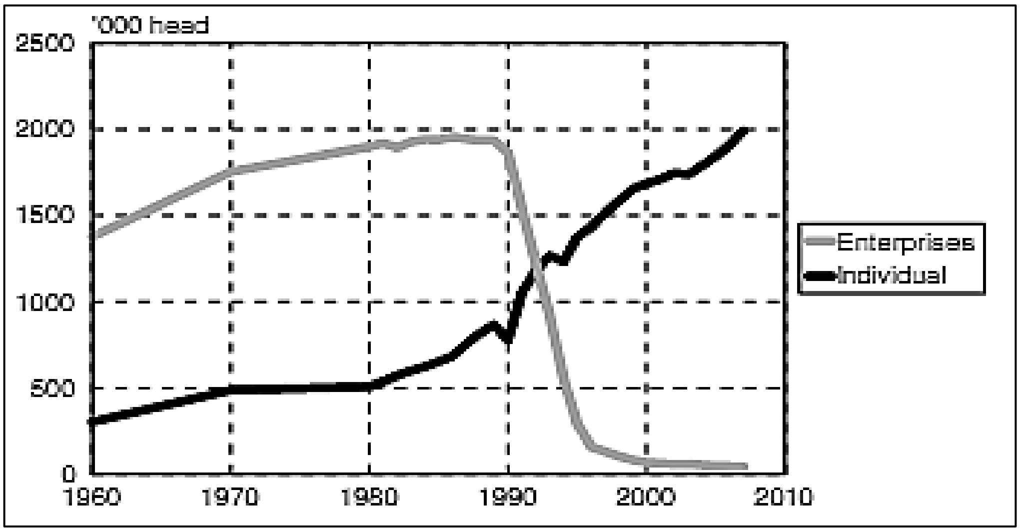


Figure 4.2 Livestock inventories by farm type from 1960-2010 in Kyrgyzstan
Source: Lerman et al., 2009

Supplemented feed used mainly during winter till mid spring accumulated during summer and partially in autumn. Nationally, the product mix since 1999 has fluctuated around 55% crops and 45% livestock. This contrasts with 45% crops and 55% livestock that persisted all through the 1980s and the early 1990s. The switch between the two product mix regimes occurred between 1995 and 1998, at the peak of the individualization process (Lerman et al., 2009). From 2000, crop and livestock shares had drastically changed; increased in crop production with decline in livestock production at national level. Mixed farming systems are conducted on a small scale by households and combine various sources of feed: natural pastures, hays from hay lands (meadows), crops residues, forage crops, and at times feed bought at markets. These systems became more sustainable and dominant in rural areas. There are many benefits from integrating crop and livestock production; livestock are sources of draught power, fertilizer, and insurance asset. On the other hand, non-product purposes of livestock continue to give more pressure to pastures; most areas of land are used for cash crops grow and decrease forage cropland areas. These factors necessitate the examination of the share of crop and livestock at household level and among peasant farms.

4.3 Livestock Diversity: Trends in Population and Composition

Although the livestock sector has experienced phenomenal growth, different regions are responding differently to the increase in livestock population. The livestock sector varies from region to region, between districts and within different parts of the country. Underdevelopment of other sectors of the economy, especially industry, construction, services and the lack of other spheres of employment, especially in high mountain regions of the country where extensive livestock farming is the only source of income in remote areas made livestock the mainstay of rural livelihood. The trends in number of livestock in recent years have tended to increase the system though by a small amount per year. When compared with the past planned economy, the current number of cattle had reached the Soviet period, the horses exceeded by 100.0 thousand heads, and the pigs and sheep by 50% (Ajibekov, 2005). This is attributed mainly to population growth, and income growth. Hence there is need observation the role played by livestock in the rural and national economy, and how it relates to human population dynamics, consumption patterns and indeed, to the availability of natural resources, in particular, land, feed and water. Livestock sector includes total livestock resources, livestock product output and marketing in livestock and livestock products. The animal health situation, as diseases often influence animal productivity and determine the extent to which a country engages in international trade in livestock and livestock products also need to be monitored (Chilonda et al., 2006).

The last decade of independence years, have seen considerable changes taking place in livestock population, composition, and management systems in Kyrgyzstan, with predominance of different livestock species. The number of livestock rapidly declined since 1990 to 2001, and slowly, but significantly increased in all species as shown in Figure 4.3. In 1990, the country had about 10.0 million sheep and goats, 1.2 million cattle, including 75 thousand yaks, 313 thousand horses. Of these, 550.0 thousand sheep and goats, and 55 thousand cattle, 30 thousand horses (or 4.6-9.6% from total number) were considered as pure breeds. Those pure breeds fully met the needs of commercial farms in the high-breeding materials that provide high productivity of livestock in the country. In general, the growth rate is different for various species. Growth rate of goats is higher than other species. Sheep and cattle numbers declined drastically between 1989 and 1995, while horses are almost stable during 1996-2009. The population of all major species of livestock (cattle, sheep and goats and horses) has been constantly increasing over the years.

At the beginning of 2009, in Kyrgyzstan there were 1168.0 thousand heads of cattle, 4.5 million heads of sheep and goats, 355 thousand horses, which 70.8 thousand from total number of sheep and goats, 4,2 thousand horses, and 29,3 thousand head of cattle were purebred. While in 1991, 99% of all animals were purebred and now only 33% of sheep and goats, 24% cattle, and 14% horses' are considered as thoroughbred (Nazarkulov, 2009).

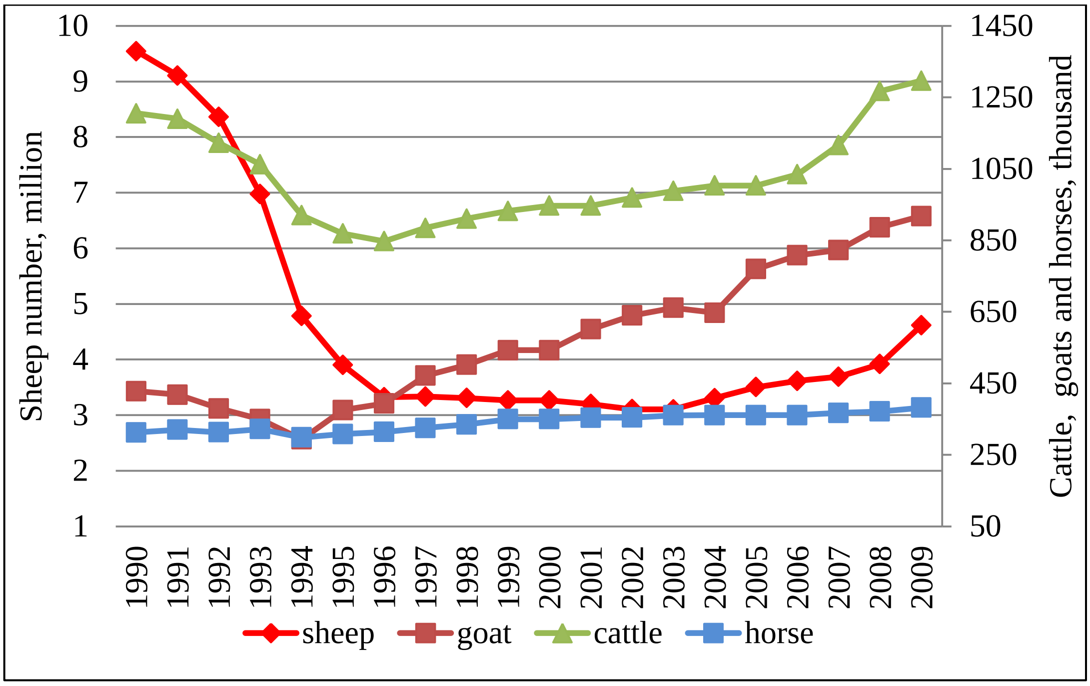


Figure 4.3 Changes in total livestock number (thousand head) in Kyrgyzstan
Source: MoA (MAWRPI), 2010

The socio-economic conditions have brought about a change in livestock preference, away from sheep to goats, cattle and horses. Starting in the 1940s and increasing steadily over the next thirty years, Kyrgyzstan became a wool farm for the Soviet Union. However the pedigree structure of sheep in Kyrgyzstan has changed during the recent last years in connection with transition to a market economy. Thus, in 1990, the share of fine wool production was 87%, semi-fine wool production was 7%, semi-coarse wool production was 3%, and coarse wool fat-tailed production was 3% of the total livestock. In 2003, the share was 31.3% (fine wool), 6.2% (semi-fine), 0.6% (semi-course), and 61.9% (course). The reason of this pedigree ratio was the sharp reduction of the number of fine-fleece and semi-fine-fleece sheep due to the fall of prices and demand for fine and semi-fine wool, and also due to the increase of fat-tailed meat sheep, which has a niche in the domestic mutton market (Ajibekov, 2001).

Cattle in Kyrgyzstan have mainly been kept for dairy production, later for meat; hence the introduction of other breeds. Currently, 97 % of the cattle are bred by farms and personal subsidiary plots. Forty eight per cent of all cattle belong to subsidiary farms which mainly near use village pastures. Main breed are Ala-Too[9]; kept for meat and dairy production and Oluya-Ata for milk production in northern part of Kyrgyzstan. Ala-Too is spread all over Kyrgyzstan (Nogoev, 2008). Improving pathway of local breeds in Kyrgyzstan; territory is shown in Figure 4.4

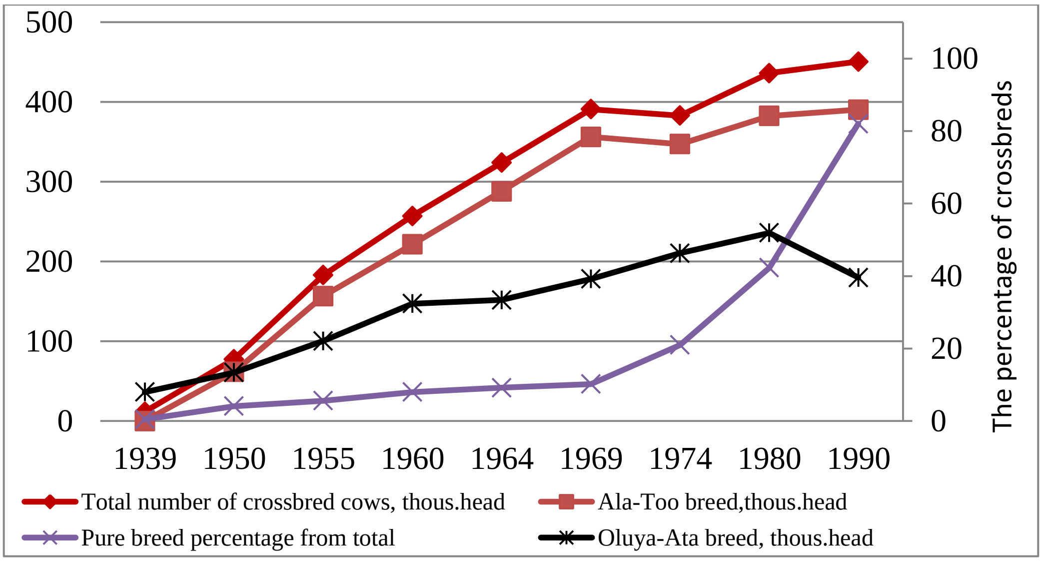


Figure 4.4 Trends in total cattle and improved breeds number in Kyrgyzstan
Source: Nogoev, 2008

Cattle remain the main livestock specie at household level. From 1940 to 2009, total cattle numbers rose from 555 thousand to 1,168 thousand head. In 1990, the percentage of purebred[10] was 85 % of the total cattle number. Introduction of crossbreeding for improved milk-production resulted in increased interest in cattle-raising in the 1980s and 90s. Milk

[9] The Ala – Too (meat-and-dairy) breed of cattle of meat-and-dairy direct has been developed in 1950. It is an improved crossbred of local cattle with Swiss brown and Jersey blood and it makes up about 85% of the total cattle number. Oluya-Ata breed, which make up about 10% of the cattle in the Republic are black and white graded up from Friesian / Holstein imports (Nogoev, 2008;Fitzherbert, 2005)

[10] The Ala – Too breed of cattle of meat-and-dairy direct has been developed in 1950. It is improved crossbred of local cattle with Swiss brown and Jersey blood, and it makes up about 85% of the total cattle number. Oluya-Ata breed which makes up about 10% of the cattle in the republic are black and white graded up from Friesian / Holstein imports (Nogoev, 2008; Fitzherbert, 2005)

yield of cows reached 3208 kg per cow in 1990 (the highest average milk yield). Cows are mainly raised in state–owned farms, while households had 1-2 cows in general among all rural families regardless of ethnic background. Thus, the total number of cattle has remained stable since independence (Figure 4.5). From 1990, there was a sharp decline in number of cattle from 1,219 thousand to 920 thousand heads and also milk yield increased from 3208 kg to 1761 kg till 1995. However, the population of cattle, as well as milk yield, increased till 2005 (2218 kg) and again there was a decline in milk yield. The milk yield of cows decreased from 3208 kg to 2069 kg per head between 1990 and 2009 and increases in livestock production come from increases in animal numbers. There are also other factors responsible for the decline in the yield such as decreasing number of purebred animals, due to lack of control in animal breeding and animal health which affect livestock productivity at regional and national levels (MAWRPI, 2009). At national level, it was considered that the current levels of animal productivity in terms of milk and wool are low – due to poor nutrition, the high incidence of diseases, and poor farm management.

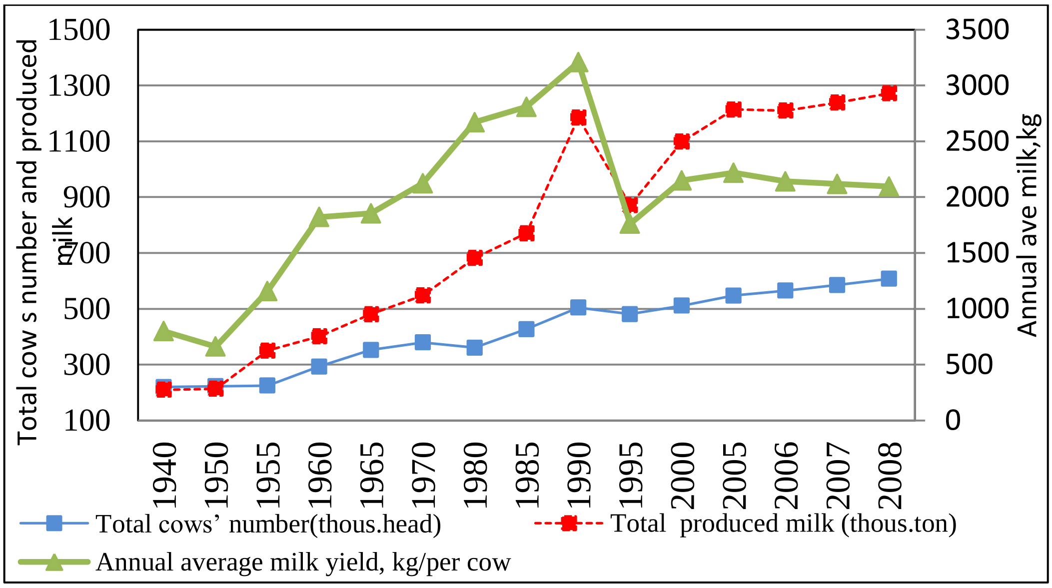


Figure 4.5 Total cows' number and milk yield during 1940-2008 in Kyrgyzstan
Source: Nogoev, 2008

Addressing these constraints rather than increasing animal numbers or changing the genetic composition of the national herd, is the key to raising output from the livestock sector. Lack of good-quality fodder to sustain animals through the long and harsh winter is a critical issue. Many animals lose half of their body weight during winter, and mortality among young animals is very high.   This poor nutritional status is closely linked to the problem of animal diseases. After a long winter with poor nutrition, often having lambed or calved, animals are highly susceptible to infections (World Bank, 2005).Therefore, increase in livestock production is realized mainly by increase in numbers of animals. Similar changes in the population of livestock; their yield of total milk production is observed at district level as well (Figure 4.6 and 4.7). Numbers of goats and sheep have increased significantly, while cattle are almost stable. Horse numbers have changed drastically: it dropped sharply between 2004 and 2006 and increased again.

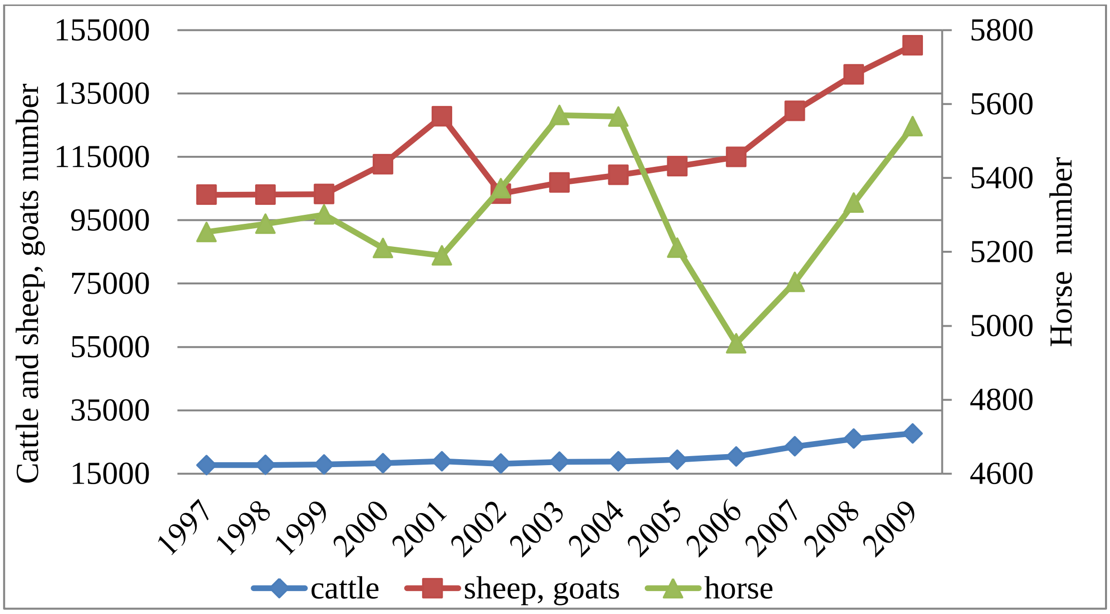


Figure 4.6 Total livestock number by species in Ala-Buka district from 1997-2009
Source: DADD, 2010

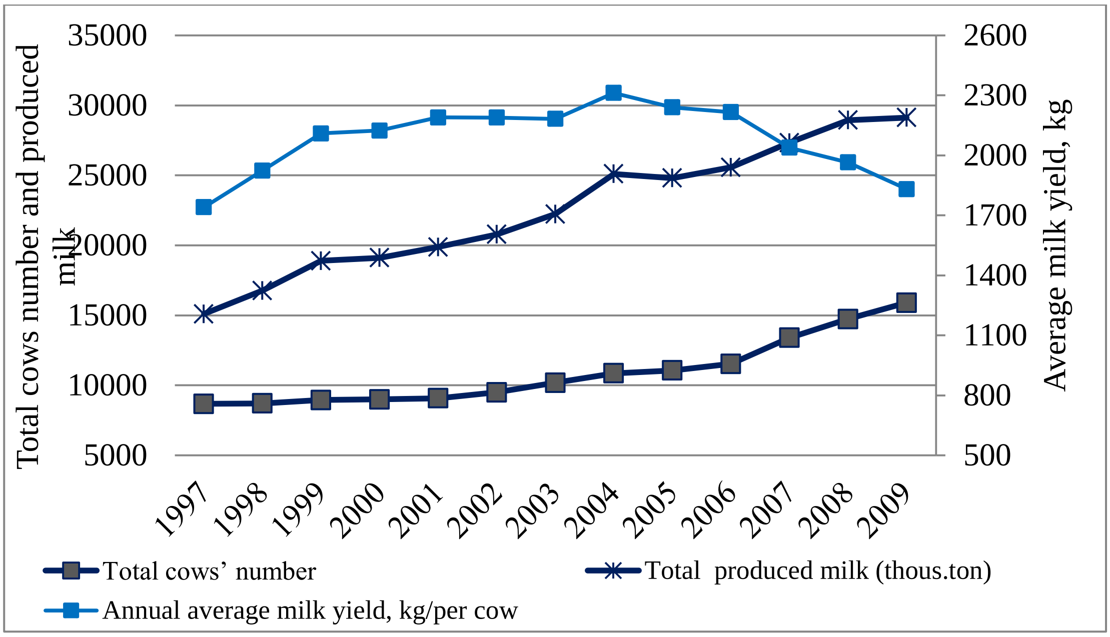


Figure 4.7 Changes in cows number, average milk yield and total milk production in Ala-Buka district from 1997-2009
Source: DADD, 2010

Another reason for the change in number can be development of other sectors of the economy or changes in infrastructure. Another main stimulus for change is inappropriate agricultural policies, services and institutional and community-based rural development. Inappropriate policy mechanisms, lack of services in terms of agro-veterinary services, bad conditions of pasture-village link roads and lack of institutional development activities at district level have led to the decline in both crop-livestock and pasture productivity.

Another reason for the changing numbers can be due to development of other sectors of the economy or changes in the country and district infrastructure. First, the reconstruction of the Bishkek-Osh highway, linking the South to the North, has led to dramatic improvement in communication infrastructure. The road has improved and increased the movement of commodities and people in and out of the region. Imports of external products and transporting produced products to the capital city have both opened markets for internal produce and led to increased competition between production systems and markets. The second main stimulus for change is inappropriate agricultural policies, services and institutional development and community-based rural development. Improved transport infrastructure has increased the opportunity for short-term migration out of the district for employment on a seasonal basis. Another consequence of this recent change has been employment patterns; predominantly economically motivated migration became an important livelihood strategy to diversify the sources of income. But from evidence of research, the livestock and cropping are increasingly financed through remittances, and this leads to the absence of labour at household level. Furthermore, improved trade and market have led to increased opportunities for higher education and off-farm employment in remote areas of the district.

Majority households keep livestock in both VGs. And where crop production is unsustainable livestock are essential component of farming systems. Thus, farming systems with livestock holding establish different types of LPSs with dominating livestock (inside system has dominating different species) or dominating farming activities. The characteristics of typical households in both VGs are presented in Table 4.1.

Table 4.1 Characteristics of a typical household in both VGs*

Species	BVG	MVG
Cattle	2.8	3.2
Sheep	18.8	52.3
Goats	5.8	18.5
Horses	0.7	1
Donkey	0.2	0.8
Land holding**, ha	0.82	0.5
Own land, ha Irrigated land Dry land	0.20 0.17 0.03	0.18 0.12 0.06

Note: * There was no pasture land, as well as it is common property and can be accessed freely in near village pastures, while for intensive and remote pastures required pasture tickets
**Includes rented land areas; renting from the Fund of Land Redistribution (FLD) or from neighbours or purchased land

Source: Field survey, 2010

Livestock play significant multipurpose role in household livelihood and availability of resources in terms of forage is also important for stable herd size. Percentage of households with different numbers of species in their herds in both VGs is presented in Figure 4.8.

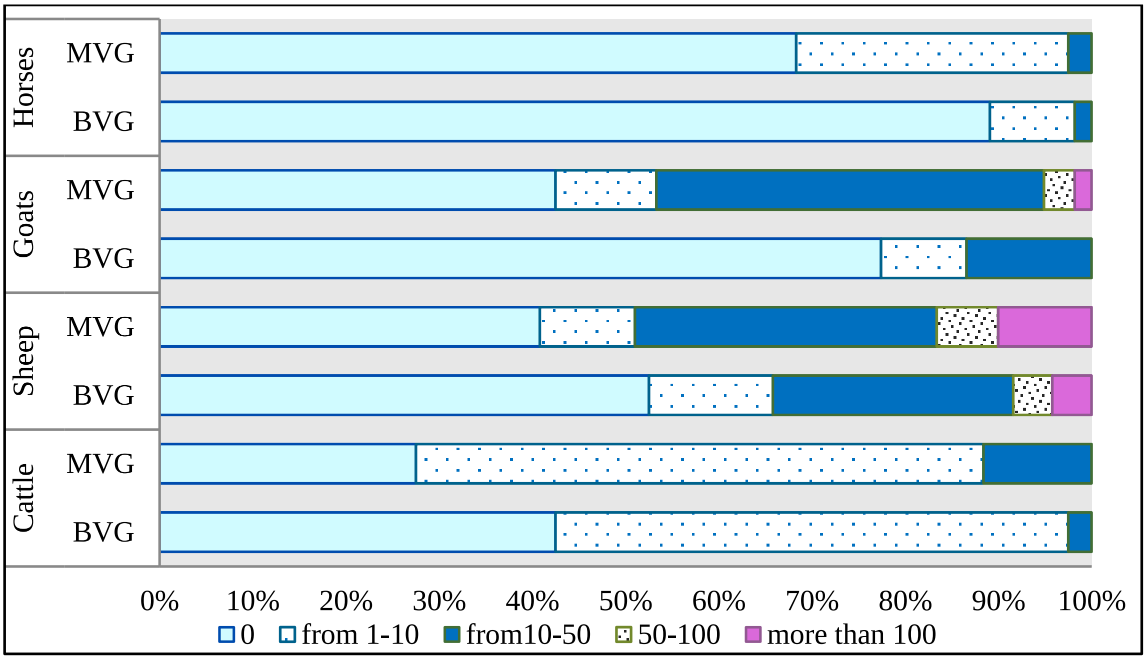


Figure 4.8 Percentage of households with different species number in their herds
Source: Field survey, 2010

According to data, majority households keep 1-10 cattle in both VGs. They consist 60.9% in BVG and 55% in MVG respectively. From this number it can be said that there was at least one lactated cow with calve in each household. In BVG, 42.5% (in MVG 27.5%) of households had no cattle in their herds, where only 2.5% (in MVG 11.6%) of them have 10-50 cattle. The next important livestock specie is sheep; where 25.8% HHs in BVG and 32.4% HHs in MVG had 10-50 sheep in their herd. However, 52.5% HHs in BVG and 40.8% of HHs in MVG had no sheep. In case of goats, 41.6% of HHs in MVG and 77.4% of HHs in BVG did not keep goats in their herd. Horse (and donkeys) numbers were less (89.1% of HHs in BVG and 68.3%of HHs in MVG has no horse) than other species as well as it needs extra labour and care. Livestock holding with different species numbers by physiological condition (age, sex and lactation stage of cows) is given in Table 4.2 and 4.3.

Table4.2 Livestock holding; total cattle number by physiological state and lactation stage							
VGs	Physiological state	Male		Female			Total
		Bulls	Calves	Calves	Heifers	Cows	
BVG	Total number	38	50	46	33	104	265
	Average number per HH, *n*=80[1]	0.4	0.6	0.5	0.4	1.3	3.3
	Ave number per owned HH	1.6	0.9	0.8	1.4	1.8	3.8
MVG	Total number	102	109	74	75	178	537
	Average number per HH, *n*=92	1.1	1.2	0.8	0.8	1.9	5.8
	Ave number per owned HH	2.4	2.1	1.4	1.4	2.3	5.8

Note: [1] These 80HHs in BVG and 92 HHs in MVG are with different species in their herd. HHs in G1 has no any livestock; it was not included to this calculation.

Table 4.3. Livestock holding, total sheep, goats and horse number by physiological state

			Total	Male	Female	Castrated	Age[1] 1	2	3	4<
Sheep	BVG	Total number	1095	227	804	50	328	241	249	264
		%	100	21.4	74.4	4.5	30.9	22	22.7	24.4
		Ave number per HH, *n*=58	18.8	3.9	13.8	0.8	5.6	4.1	4.3	4.5
		Ave number per owned HH	18.8	4.6	14.3	7.1	8.2	7.7	8	11
	MVG	Total number	3559	671	2476	412	1118	646	960	833
		%	100	18.8	69.7	11.5	31.6	18.1	26.9	23.4
		Ave number per HH, *n*=68	52.3	9.8	36.4	6	16.4	9.5	14.1	12.2
		Ave number per owned HH	52.3	11.1	39.3	14.4	21	14	20	21
Goats	BVG	Total number	217	29	183	5	44	36	123	14
		%	100	13.3	84.4	2.3	20.2	16.5	56.9	6.4
		Ave number per HH, *n*=28	10.8	1	6.5	0.1	1.5	1.2	4.3	0.5
		Ave number per owned HH	10.8	2	9.6	4.2	3.3	3.6	12	4.6
	MVG	Total number	2082	511	1373	309	624	444	748	256
		%	100	24.7	60.5	14.8	29.9	21.3	35.9	12.2
		Ave number per HH, *n*=73	28.5	7	18.8	4.2	8.5	6	10.2	3.5
		Ave number per owned HH	28.5	9.1	19.3	8.1	12.4	8.8	14.1	7
Horses	BVG	Total number	27	12	15	-	7	3	10	7
		%	100	44.4	55.6	-	25.9	11.1	37.1	25.9
		Ave number per HH, *n*=12	2.2	1	1.2	-	0.5	0.2	0.8	0.5
		Ave number per owned HH	2.2	1.2	3	-	1.5	3.3	1	1.4
	MVG	Total number	128	60	68	-	29	17	45	37
		%	100	46.8	53.2	-	22.6	13.2	35.3	28.9
		Ave number per HH, *n*=30	3	2	2.2	-	0.9	0.5	1.5	1.2
		Ave number per owned HH	3	2	3.4	-	2	1.7	2	2.7

Source: Field survey, 2010

Age[1] The age group of livestock species 1 – 0-1 year old, 2 – 1-2 years old, 3 – 2-3 years old, 4 – more than 3 years old

The number of animals has altered the relationship of livestock to the overall production systems and to natural resource management. In addition, changes in the natural resources themselves have also had an impact on livestock management practice. Each parameter has its importance in the herd, the differences between age and sex groups explain the importance of livestock on their livelihood based on market demand and products consumption. As shown in Table 4.2 and 4.3, herd compositions of the households indicate that there were more female animals than male. The higher numbers of female cattle reflect with the major reason for keeping cattle, which is milk production for self-consumption, selling in the market and using dung as winter fuel. In case of other species, they have more female in order to increase herd size and to sell live animals to augment household income. There was unclear impression, whether livestock population is increasing or decreasing at household level. For this purpose, the households' own perceptions of changes in their herd sizes during 2005-2010 were studied in both VGs, and this shows a great variation (Table 4.4). The result shows that, in general, the total livestock population increased by 65% BVG and 63% households in BVG and MVG respectively.

Table 4.4 Households' perception in herd-size change during 2005-2010

Change in LS numbers	In general		By species							
			Cattle		Sheep		Goat		Horse	
	BVG	MVG	BVG	MVG	BVG	MVG	BVG	MVG	BVG	MVG
Less	7	14	32	17	9	27	47	3	5	11
Same	24	16	52	25	36	22	9	18	39	28
More	65	63	14	48	55	49	34	62	7	35
No def. answer	4	7	5	10	5	2	10	17	49	26

Source: Field survey, 2010

Majority (62%) of the sampled HHs in MVG perceived that there is increase in goat numbers. Similarly, 48% of sampled HHs experienced increase in cattle in MVG, whereas, in BVG, 55% of sampled HHs experienced increase in sheep holding. It indicates change in importance of livestock species in HH economy overtime, which is discussed in detail in the next section of this chapter. The most noticeable change is the decrease in cattle and goats' numbers 32% and 47 % of HHs' herds in BVG respectively and sheep numbers decreased by 27 % of HHs' herds in MVG. In BVG the majority of households perceived no changes in cattle and horse numbers. During five years, it has remained at the same level of 52 % and 39 % HHs respectively. However, the numbers rapidly changed to 48 % and 35 % of HHs in MVG. Livestock is essential component of farming systems, where crop production is not feasible.

4.3.1 Changes in Livestock Composition

Compared to other species in the herd, the number of sheep is significantly high (16.8 in BVG and 42.3 in MVG) in both VGs' households. During the second decade of independence, in connection with transition to a market economy, the pedigree structure of sheep has changed. Thus, in 1990, the share of fine wool production was 87%, semi-fine wool production was 7%, semi-coarse wool production was 3%, and coarse wool fat-tailed production was 3% of the total sheep wool. In 2003, the share was 31.3% (fine wool), 6.2% (semi-fine wool), 0.6% (semi-course wool), and 61.9% (course wool). The increase of fat-tailed meat sheep has a niche in the domestic mutton market (Ajibekov, 2005). Exotic breeds of sheep like Edilbaev and Gissar fat-tail are becoming more popular among the farmers. Even in remote areas, farmers prefer to raise these breeds. One of the raised Gissar breed in BVG is shown in Picture 1.

Picture 1 Gissar breed ram and lambs in BVG taken by author in August 2010

Gissar breed adapts to mountain conditions well. Lambing usually takes place in a year giving total of 2-3 lamb birth, which in case of earlier breed was 1-2 lamb. Thus, a wide adoption of this breed is one of the reasons for the faster increase in livestock numbers and also higher profit from selling live animals.

Historically, goat breeding has been a traditional sector of the animal husbandry in the country (Alymeev et al., n.d.). Large areas of semi-arid and steppe type of remote natural pastures also promoted goat breeding during the Soviet time, especially in Batken and Zhalal-Abad provinces for producing wool and down. In MVG, Angora, Cashmere and local breeds are common, while in BVG, milking goats and hybrid Saanen (Zaanen) breed are becoming popular (DADD,2010). During the interviews, most households from MVG informed that goats' number is increasing in their herd. Less cropland area and easy access to common property pastures, well-adapted to harsh climate conditions and natural resource based fattened feeding systems make the goats more preferable. Goats are easy to feed, thus require less labour and forage. In addition, they give two kids in a year. Goats, as an asset, can be easily sold in the market at the time of urgent household needs, fertilisers, fuel and veterinary treatments. High number of animals is an additional income source that can help to perform other socio-cultural functions, as well as nomadic people's cultural activities and ceremonies related with livestock.

A goat promotion project organised in Ala-Buka district by district and local administration and two breeding farms initiative in 2001-2005, called "An Iron Goat", is helping to increase the number of goats in the study area, in particular, and, as a whole, in the country. Under the "An Iron Goat" program, 2-3 goats are provided to poor households in VGs through local administrations. After a year, when those goats give birth, kids become their own, goes should be given to other families identified as poor by the program. Less feed requirement and relatively easy rearing practice make goat raising well accepted by poorer HHs. In addition, a higher demand for goat milk makes goat popular among poor. However, there is a growing concern that whether increasing numbers of goats is an indication of increasing rural poverty. Thus, there is future uncertainty that cattle will be replaced by goats in rural areas.

Majority of these HHs retain their cattle in near-village pastures all year round, which leads to overgrazing near-village pastures. Households increase cattle numbers in their herd in order to increase additional cash income through increased production because ability and probability of market participation by farmers will be reduced significantly as the small quantities of milk from local cows are inadequate to save time and labour necessary to reach market. HH sells dairy products to intermediary women buyers of dairy products who significantly increased in BVG because of low price of dairy products in the market. The price paid is almost equal to transportation cost. Besides, it also requires extra labour for handling and is time consuming. Intermediaries buy dairy products from farmers owning 1-2 cows in lower price than market as they have small quantities of milk (daily 5-6 litres milk, excluding self-consumption) or dairy products. In case of MVG, livestock holders and livestock producers are generally scattered in remote rural areas and summer pastures that are often characterised by inadequate access to roads and transportation facilities. HHs increased cattle number due to transhumance movement to summer pastures where dairy products can be increased with sufficient forage. They prefer bulky sell of dairy products not raw milk and without intermediaries. HHs and pastoralists accumulate products during summer and sell in late autumn or winter, when the demand for dairy products and consequently the price is high.

Almost all HHs have at least one donkey in both VGs, while horse is owned by few households. Horse is kept by well-off households. Since it requires more forage and extra care, it cannot be affordable to all households. Horse and donkey provide draft power, which is important in farming activities. The attributes of draft animals are subsidiary for agricultural machines; plugging and threshing the land, transporting the physical products, income-employment gain (services to other farmers) and socio-cultural (nomadic culture, having a horse) and ecological services. Beside these, abandoned or no roads for truck in remote pastures enhanced the use of donkeys and horses as main transport during transhumance. **Is this Rural Poverty or Low Carbon Agriculture? Agricultural machines vs. Livestock**; the reason of increasing number of horses and donkeys can be an indication of advanced rural poverty (to avoid extra expenditure for tractor services, fuel and payments, they prefer to use livestock). On the other hand, the increased use of livestock for agriculture decreased the number of agricultural machines, thereby reducing GHG emissions leading to low carbon agriculture. This will help to mitigate the adverse impact of global warming on human beings as well as environment.

4.4 Social and Economic Issues Associated with Livestock Production

This part of study focuses particularly on households' perceptions of animal husbandry.

However, the interpretation and generalisations of herd sizes must also consider factors other than altitude and accessibility, such as fodder and pasture resources, grazing and management traditions, and off-farm influences (Wright et al., 2005). What is less well recognised is the importance of livestock markets, and also the special constraints that such markets face in remote areas to furthering the contribution of livestock to livelihoods. It can be explained as Von Tunen Model; the distance from the market is the main determinant of what combination of crops or what kind of livestock species a farmer should grow or rear and with what intensity and density (Grigg, 1995). These changes have altered the relationship of livestock to the overall production systems and to natural resource management. In addition, changes in the natural resources themselves have also had an impact on how livestock are managed.

The percentage of households with different herd size categories with mixed livestock species is given in Figure 4.9 by stratifying of households in four groups. Around 33% of HHs in BVG falls in G1 category, where the HHs does not have any livestock, whereas the figure is only 23% in MVG. These HHs' main income sources are farming, wage and off-farm employment. This is one of the reasons of change in livestock numbers, livestock holding increase with decrease in cash crop and via versa. In BVG, a significantly higher proportion (38.3%) of HHs falling under G2 category hold 1-20 mixed livestock numbers compared to MVG with only 5.8%. Usually, HHs in this group keep a 5-10 sheep or goats or 1-2 cattle, or one horse. Majority of animals are kept under stall-feeding during morning and evening providing crop residue and weeds from cropland or HH plot, whereas during day time, they are grazed in near-village pasture. HHs under this category keep livestock mostly for self-consumption of livestock products.

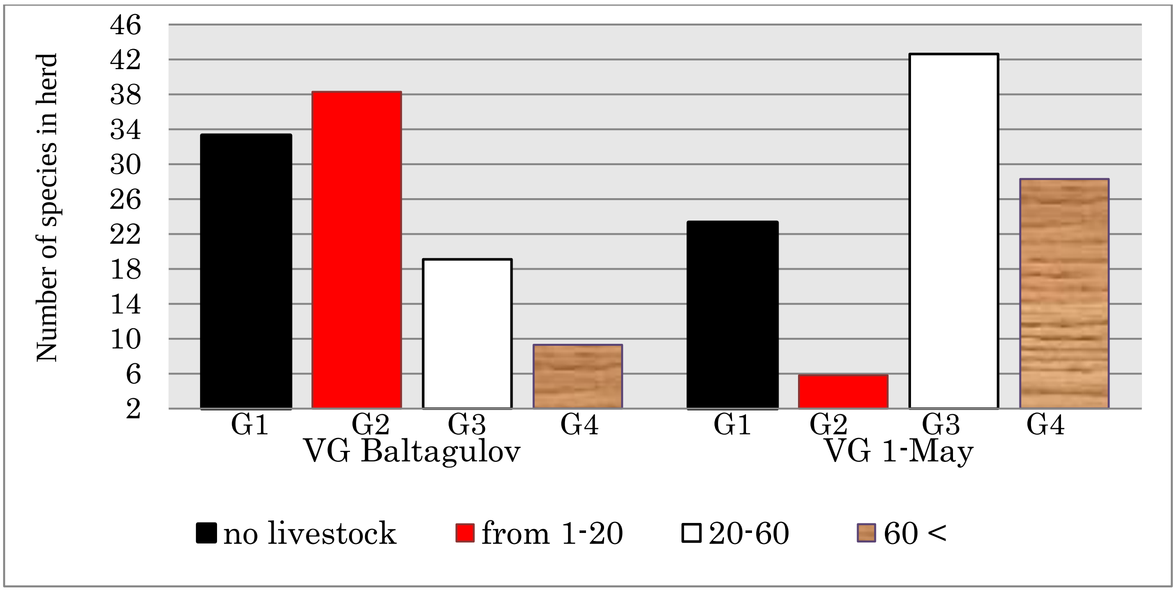


Figure 4.9 Percentage of households in different herd size categories with mixed species
Source: Field survey, 2010

Significantly lower proportion of HH (19.1%) in BVG falls under G3 category in contrast to 42.6% in MVG. The HHs in G3 category hold 20-60 livestock. In case of MVG, main livestock species in their herd are goats and sheep. High altitude, more pastureland, less cropland and harsh climate are important reasons of farmers' preference for sheep and goats in MVG. MVG also has significantly higher proportion (28.3%) of HHs under G4 category, which has more than 60 livestock species, compared to BVG where only 9.3% HH falls under G4 category. For HH under G4 category, the main income is from livestock and its derived products. Households under this category cannot get enough crop from their own land due to lack of water during growing season and bad physics-chemical properties of soil (stony and saline), which force HHs to increase livestock numbers to meet livelihood needs. Thus, increase or decreases are closely interconnected with land size and soil quality. Income from cash crop and farming can affect income from livestock (Figure 4.10). Majority (52.5%) HHs have 0-1 ha of land in MVG, compared to 29.1% in BVG. In contrast, majority (54.1%) HHs in BVG hold 1-5 ha of land, whereas in MVG, only 25.8% of HHs hold 1-5 ha of land.

Around 6 % of HHs in BVG own and rent more than 5 ha of land, whereas, in MVG only one HH has such amount of land. Households generally perceived cows to be the most important animals (Table 4.5). In general, farmers' perception in keeping livestock was tradition and culture related to their nomadic history.

Table 4.5 Farmers' perception of the most important livestock species (% of HHs in which each species important – multiple answer possible)

BVG	Cows	Sheep	Goats	Horses	Donkey
G-2	82	36	-	12	6
G-3	67	48	14	17	12
G-4	51	57	47	24	19
MVG					
G-2	78	35	39	27	16
G-3	59	45	56	35	13
G-4	28	58	66	37	25

Source: Field survey, 2010

Herd composition of the households indicate that there were more female cattle than the male; the average proportions of male to female were about1:16 for adult cattle and 1:4 for calves and heifers. The first proportions were higher in areas closer to district market and in large herds in remote areas. The observed herd structure remarkably typified a smallholder dairy production system. The higher number of cows believed to correlate with the major reason for keeping cattle, which is milk production; G2 (95%), G3(93%) and 87% in G4 in BVG and G2(95%), G3(90%) and 86% in G4 HHs in MVG respectively. The next important reason of keeping livestock was providing dung (mainly fuel for winter and partially manure for cropping), in G2 (91%), G3 (86%) and 93% for G4 in BVG. In MVG, G2 (88%), G3 (89%) and G4 was 92% of HHs are kept livestock for dung. Hired shepherds in near-village pastures can sell dung, accumulated during grazing season. In recent 5 to 6 years, majority of farmers started to use dung as fertilisers in their cropland, due to lack of chemical fertilisers. However, they are not satisfied with only using manure in their cropland. During Soviet time, households adapted to use of the maximum amount of chemical fertilisers which was easy to purchase. Keeping livestock for meat purpose and wool purpose was higher in both VGs. G3 (48%) and 37%, G4 (69%) and 68% in BVG and G3 (35%) and 58%, G4 (40%) and 67% of HHs in MVG responded that they keep mainly small ruminants for self-consumption and for selling in the market under grazing based or stall-fed based fattening feeding methods. Many households depended on animals for transport and for draft power, which is continuing to increase. Lack of mechanisation or shortage of tractors (in the beginning of the growing season and during harvesting season) or high expenditure for using them are making draft animals more important at households.

The share of income from different income sources by income groups show the importance of the livestock sector for different income groups (Figure 4.10). Income sources differ significantly among the groups. Farming and cash crop together constitute the largest share of income among the households falling under G1 category in both VGs; BVG (41%) and MVG (40%). Potato and sun flower are the most important cash crops grown in the study area. HHs under G1 category do not have any income from livestock. Other important sources of income for this group are wage labouring followed by off-farm employment and others. Other sources of income include hay, forage crop (lucerne), wheat straw and maize stover trading, selling honey, non-wood forest products, such as fruits and medicinal plants. For all income groups, maize and wheat are too important crops cultivated under farming. Both of these crops are multipurpose crops used for human consumption (grain) as well as livestock consumption (crop residue and grain as basic and supplementary feed). For HHs falling under G2 group farming (farming and cash crop) is still an important source of income contributing 44% of the total income in BVG. However, for household in MVG, livestock constitute the highest share (41%), followed by crop and cash crop farming.

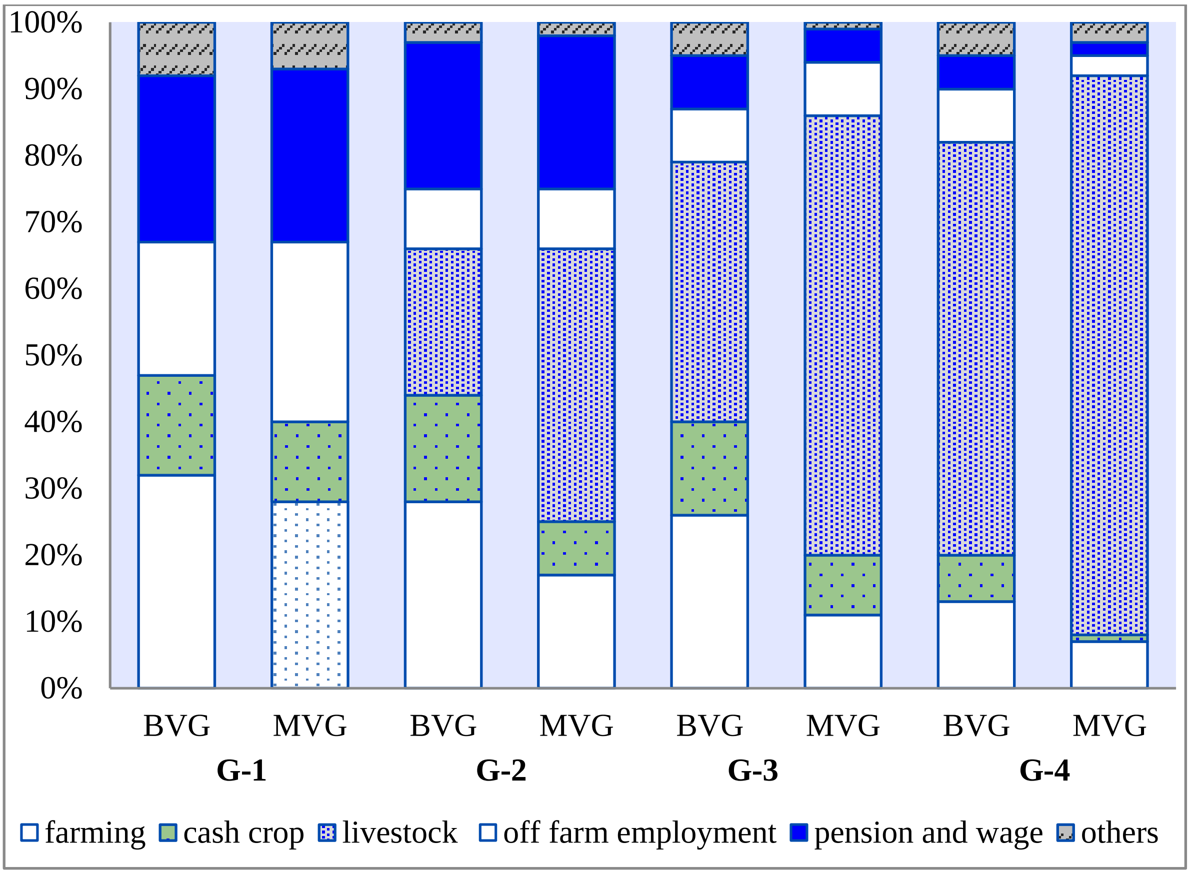


Figure 4.10 The share of income by different sources
Source: Field survey, 2010

Share of income from livestock increase for HHs in G3 and G4 categories. It reaches 84% in the case of HHs under G4 category in MVG. Throughout, the HHs from G2 and G4 share of income from livestock is higher in MVG, which reflects relatively higher importance of livestock in MVG. In both villages, livestock products are mainly raw milk of cattle and horse and traditionally processed dairy products. Livestock can be sold all year round, but the main sale take place in August-October, when livestock return from pastures (cash income). Such cash income is mainly used for the preparation of wheat sowing in autumn as well as growing season in spring. In addition, the cash income is crucial for payment to technical services, purchasing fuel and fertilisers. Another major sale of livestock takes place between February and March, when forage shortage occurs. This takes place as means for survival or subsistence. Thus, farmers are forced to sell bulk of their livestock at lower prices. This increases the poverty. However, at the same time, it also gives new opportunity for "new business", businessmen who send those animals to summer pastures and sell those livestock again in autumn claim higher price. This causes temporary increase in livestock holding among the buyers.

4.5 Factors Affecting Livestock Production Systems

In agro-pastoral systems, social, economic, and environmental constraints cannot be solved in isolation or independently. Increase in livestock population and change in composition of herds depends on household welfare. The major problems of keeping livestock from own experiences of households are given in Figure 4.11. Lack of fodder from the end of winter to mid spring and pasture shortage both of which are related to feeding livestock are perceived as the major problems by almost 50% of HH in both VGs. However, traditional and modern private livestock management strategies have been developed to regulate herd size, according to the available fodder supplies.

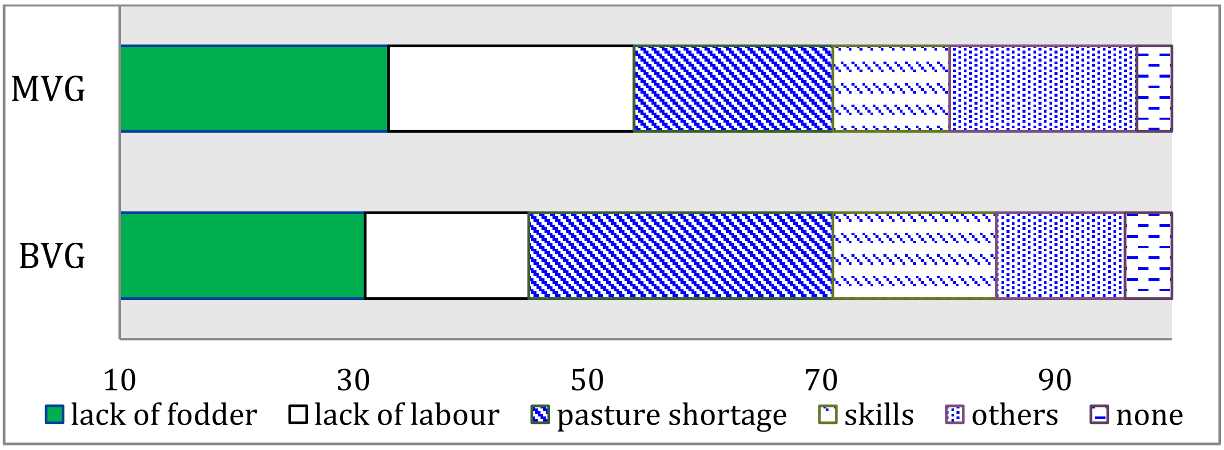


Figure 4.11 HHs' identification of major problems of keeping animals from their own experiences
Source: Field survey, 2010

Forage shortage causes feed scarcity problem at the end of winter, annual feed scarcity by month in the two VGs is given in Figure 4.12. Very serious scarcity occurs from March to

April in MVG, which in case of BVG, it extended till May, but with less intensity of the problem compared to MVG. Lower score in BVG is related to pasture shortage in early spring, which is mainly due to the early movement to pastures when grasses do not grow well.

In the case of MVG, however, forage shortage is related to less crop land areas per household. It is 0.6 ha of irrigated land/HH in MVG compared to 1.0 ha of irrigated land/HH in BVG. Bad condition of drainage systems or lack of water during growing season adversely affect productivity of forage crops and cereals. Hay land is important forage source in MVG. In remote areas, households store only hay for winter feeding which will be fed when heavy snow occur.

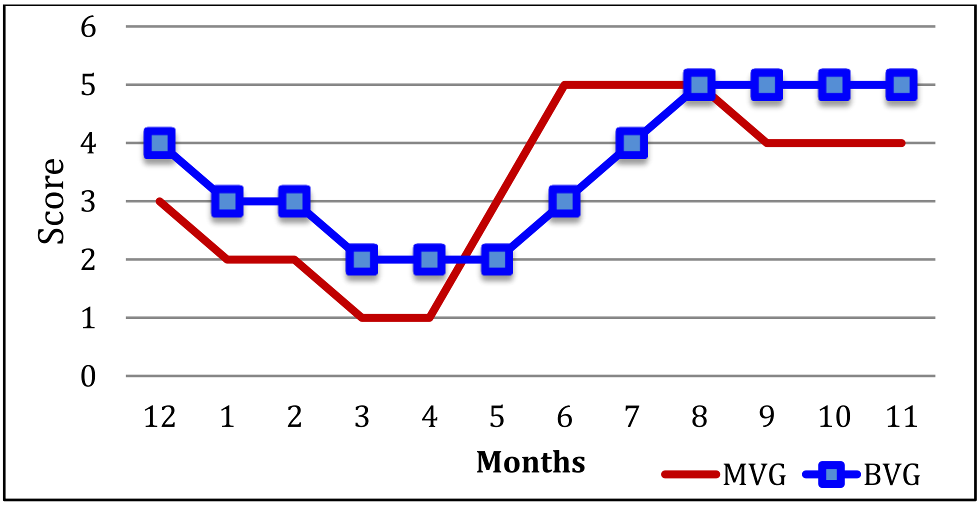
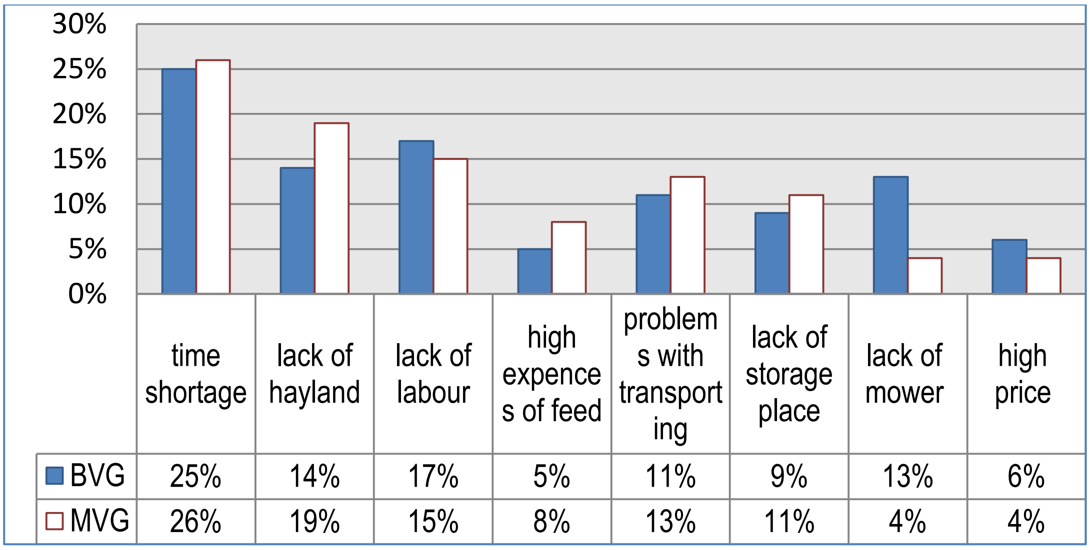


Figure 4.12 The rank of annual feed scarcity problem
Source: Field survey, 2010
Note: *Feed scarcity ranks from 5 “no problem” to 1 “serious feed scarcity”

Other times, animals will be grazed in near-village pastures or even in intensive pastures also. This forage sufficiency mostly took place in near-village–crop land areas, after harvesting wheat (major cereal, which grown in large areas) and continuing till the end of harvesting other crops, side by side. In MVG, forage scarcity occurred in spring, when stored forage was not enough, while in BVG it continued with the permanent keeping of animals near village pastures instead of sending them to summer pasture, and this cause pasture degradation. Forage scarcity increase livestock mortality. During winter, animal will loss liveweight and in early spring they will be weak and less resistant to cold weather. Poisonous grass species cause high mortality in April (mostly in MVG) and in May in BVG, when hungry animals allowed to access in pastures dominated by such poisonous grass species (Annex 3). Poisonous grasses cannot be easily observed when that species grow with other species. In some cases, poisoning can be observed when the thirsty livestock drink water immediately after eating suspected poisonous plants in near-village semi-arid pastures of BVG. During spring, very cloudy weather favours the build-up of nitrates in plants, which cause nitrate-nitrite plant poisoning. In 1996, high mortality of animals was observed in Chapchyma pastures in MVG, when continuous rainfall occurred, for about 41 days. During recent years, April is becoming a rainy month. In addition invasive diseases such as foot and mouth among cattle and brucellosis among sheep and goats increased (DADD, 2010). Helminthic diseases increase among small ruminants with change in temperature and humidity. In recent years, sheep mortality rose after shearing in May and early June because of heavy rain, and the occurrence of snow in intensive pastures. This difficulty is increasing hazard among farmers do not to send animals to intensive and remote pastures and prefer retain near-village pastures.

There are different reasons of forage shortage; lack of land for forage making, or growing only cash crop, which do not have forage residue (such as potato and sunflower) or lack of finance for purchasing it from the market in winter, when the price reaches the higher levels. Beside, two of these factors, there are other factors that cause forage shortage. Time shortage for forage storage is the main problem that leads to forage shortage in both VGs. A quarter of HHs in both VGs found time shortage as the main problem. It is understandable that lack of labour has affected time shortage for storing forage. During interviews with farmers and agricultural specialists it was found that climate change impact on forage storage. Early maturing of hays, forage grasses and forage crops such as Lucerne are caused by increased temperature.



	time shortage	lack of hayland	lack of labour	high expences of feed	problems with transporting	lack of storage place	lack of mower	high price
BVG	25%	14%	17%	5%	11%	9%	13%	6%
MVG	26%	19%	15%	8%	13%	11%	4%	4%

Figure 4.13 Main problems related to forage storage
Source: Field survey, 2010

Farmers told that mowing would be starting 15-20 days earlier than before; grasses are also flowering earlier. In addition, the weather is becoming hotter and dryer. As a result, grasses are maturing quickly, which reduce nutritive value of forage. Farmers had enough time for mowing[11]; collecting and transporting of hay back home, and the quality of the grass was also valuable 7-10 years ago (pers.comm, 2010). Flowering of 'hay mowing is time indicator'[12] *Althaea nudiflora Lindl* started earlier than before and there is significant change in vegetation. Usually, flowering starts from down past of stems to up part of stems, but it can be seen how flowering are mishmash (Picture 2).

[11] During the Soviet time, hay mowing was done by agricultural machines, which in Kyrgyzstan it was well-developed. However, at household level, mowing was done manually and it increased after independence.

[12] One of the local indigenous ethno botanical knowledge about definition of starting time for hay mow; flowering of this grass indicates that hay is 'ready' for mowing.

Picture 2 *Althea nudiflora* Lindl. taken by author in August 2010, BVG

Moreover, these observations show lessen in density and quantity of forage species, increase quantity of poisonous and low nutritive value species and shrink in the height of forage species. During hay mowing, collecting and transporting time, heavy rains, and hailstorms occur or most of the time, the weather is cloudy and it takes more time for hay to dry (Picture3).

Picture 3 *Poacea* dominated hay land and occurred rain during mowing and collecting time Taken by author in August 2010, BVG

According to climate condition and vegetation, hay content is mainly *Poacea* spp; in such kind of weather condition increase nitrate-nitrite poisoning[13] of animals (Annex 3). Mostly,

[13] Nitrates and nitrites are closely linked to the causes of poisoning. When feed containing nitrate is eaten by ruminant animals, nitrate is converted to nitrite, and then to ammonia, by rumen microbes.

hay is stored in open place, which diminishes quality and quantity of forage. Early movement to pastures has negative impact on vegetation period of plants and preliminary degradation of pastures and pasture shortage problem in terms of less availability of palatable species. Such kind of changes in cropland, mainly during wheat harvesting time, cause more problems to farmers; continuously occurring rain increase weeds in matured wheat crop areas and create difficulties for combine-harvesters. Farmers' lost almost half of their crop yield and the quality of cereal worsened due to seeds of weeds which require more labour in cleaning them.

The next most important factors that households identified was lack of labour (21% of HHs in MVG and 14% in BVG) and time for herding animals during transhumance movement. This factor is met by reducing the herd size by keeping more animals permanently near-village pastures. Poor or lack of skills (10% of HHs in MVG and in BVG 14% of HHs) in animal husbandry, especially lack of information in interconnection of producer-consumer chains had caused some problems with inappropriate composition of animals in the herd. Farmers had difficulties with the treatment of suddenly occurred contagious diseases among livestock species, mechanical damages, and the invasion of some helminthic worms and other parasites. About 90%of the farmers practiced uncontrolled breeding of all livestock species; other 10% of farmers use selective natural breeding (Not artificial insemination (AI) at all). The proportion of breeding male stock (bull, ram, and stallion) was low in village herd. Most farmers did not keep breeding male animals. They mainly purchased bull as common village property and at the end of the grazing season (in autumn) it will be sold out and replaced in spring. And in some cases, farmers hired breeding stock from their neighbouring households

---

Non-ruminant animals are unable to do this. Factors which cause nitrate to accumulate in the plant include drought, cloudy or cold weather. Hays made from cereal crops, especially those grown under drought conditions and cut while 'sappy' can develop toxic nitrite levels when they heat up. Oaten hay is particularly risky and becomes poisonous if previously dry hay is dampened by rain or snow some time before feeding out (Sarah Robson, 2007).

to serve their cows. The fact that few farmers or households owned breeding stock implies that these animals increase inbreeding levels of population. Furthermore, most of the breeding stock would be unknown pedigree, without systematic breeding. The skill of farmers in these issues is very important to avoid unfavourable long-term effects of productivity and genetic quality of livestock.   Other reported problems include unfavourable weather, such as sudden snow during spring and summer, heavy rain after shearing of animals and diseases. These problems are of minor importance, but are more relevant during grazing time in summer pastures.

4.6 Livestock Feeds, Feeding Methods and Derived Productivity

Livestock production in Kyrgyzstan is based on transhumance system. During summer, livestock move up to alpine pastures by free grazing. In winter, mainly livestock fed with stored forage during growing season by stall-feeding and partial grazing in near village pastures. Availability of all year round feed is one of the most important factors in the livestock production. During the Soviet time, Lucerne (*Medicago sativa*) and Sainfoin (*Onobrychis viciifolia*) were extensively cultivated in Kyrgyzstan (were mechanically mown and baled, one of the main factories manufacturing hay balers in the USSR was in Kyrgyzstan), and was a major seed producer of Lucerne (Fitzherbert, 2005). Silage making (mainly green maize, but also Lucerne and grasses) was common, associated with the production of dairy and beef cattle. Barley was widely grown as a fodder and cereal crop in the lower valleys, sugar beet in the North was grown for dairy cattle, cotton cake was in the South as supplemented feed for all ruminants. Supplement feed imports amounted to about 1 million tons of feed grain a year (van Veen, 1995). Hay is major winter roughage. It comes from two sources: natural meadows (community source) and sown and irrigated forage (the property of the individual farm or farmer). After independence, forage crops and cereals grown areas declined and were replaced by other cash crops as shown in Figure 4.14. Data comparisons of 1991-1997-2007 show that there are pronounced changes in the structural development of areas under cultivation. Areas planted with forage crops have reduced considerably from 48.5% in 1990 to 18 % in 2006, and areas planted with cotton, potatoes and oil plants crops have markedly increased. Forage crops area declined from 641,427 ha to 248905ha in 1990-2009. Area of cultivated cereals increased from 537,351 ha to 654,532 ha (in 1997 it reached to 683489 ha). Cash crops' area increased from 53,129 ha to 137,205 ha during 1990-2009 (NSC, 2010).

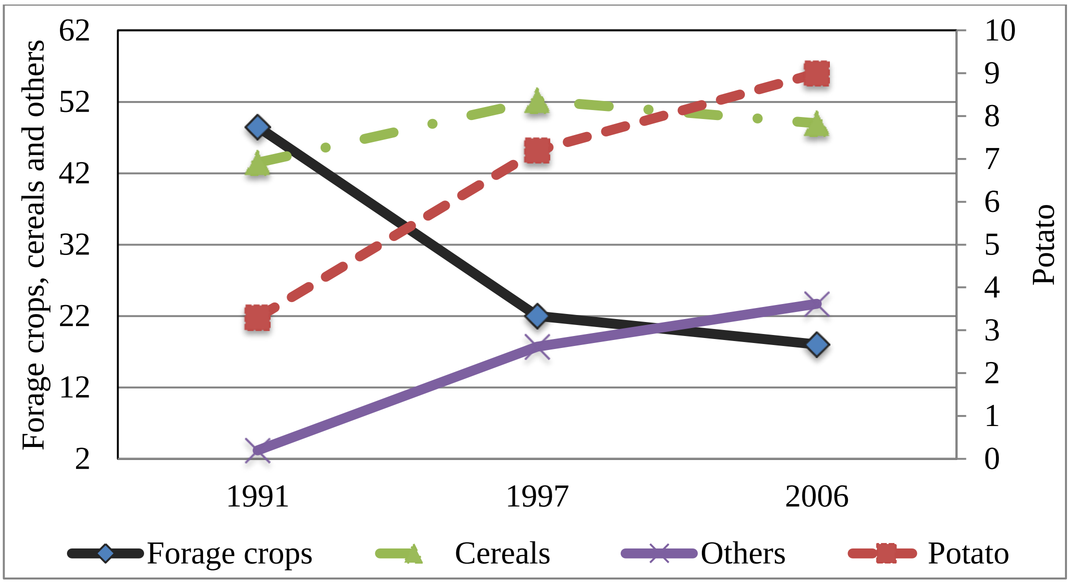


Figure 4.14 Percentage of changes in cultivated area of major crop varieties in 1991, 1997 and 2006 in Kyrgyzstan
Source: MAWRPI, 2007
Note: Others include main cash crop varieties such as cotton, tobacco, oil plants

One of the reasons in increasing cereals (wheat) area is farmers' multipurpose preference in crop species and for self-consumption and crop residues (straw, bran and residue from cleaning of seed) for winter feeding of animals and surplus seed and straw for selling as additional income. Forages, whether grazed or hayed, supply the major source of nutrition for livestock. The stall-feeding and grazing habits of sheep and goats differ from traditional livestock production and they can be incorporated into the grazing systems for cattle and horses (Figure 4.15). Goats tend to browse more while sheep tend to graze. Animals offer an alternative to utilizing forage and vegetation which is otherwise "wasted" (Lemus et al., 2008). These types of habit are very important in mixed herds which are applicable in majority of households. Composition of herd can be preferred by eating habit of animals. Feeding with weeds mainly apply to retained animals (mostly to cattle and sheep) near-village pastures during summer; in the evening, when they return from pastures, animals will be fed with weeds collected from household plot or crop land.

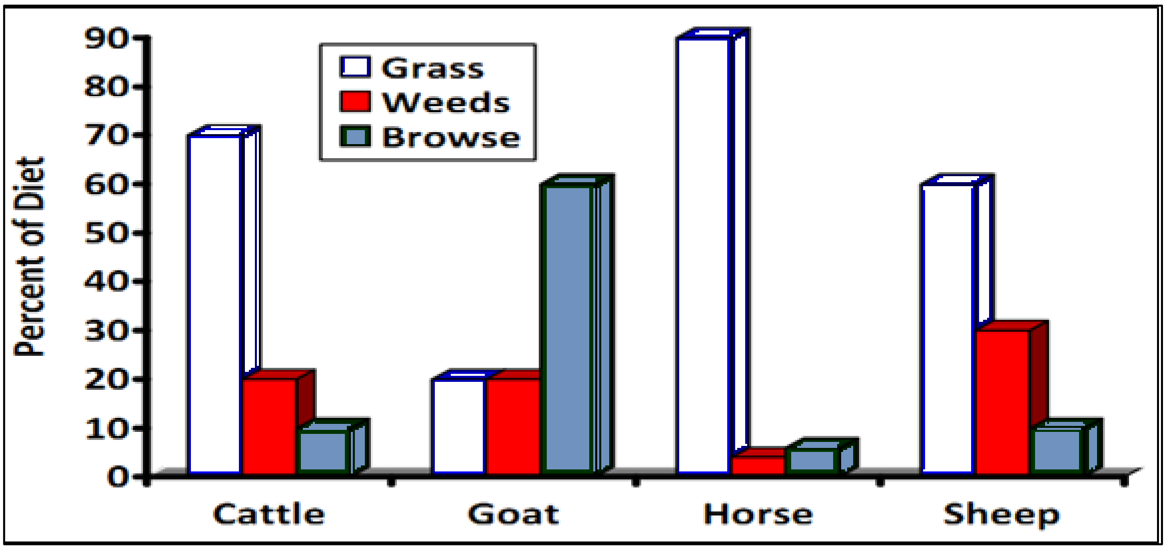


Figure 4.15 Dietary preferences of different livestock species
Source: Lemus et al., 2008

As shown in Figure 4.15, horses prefer more grass, which is suitable for all year round grazing and in winter they also feed on selective roughage and grains. This suggests that all households cannot afford to keep horses in their herd. Donkeys are fed with residue (60% of HHs in MVG and 54% of HHs in BVG) from other animals fodder and some mix roughage.

Presented in Table 4.6 are the feed composition, feeding methods, ratio, surplus and deficit for stored feeds, and classes of animals feed reduced at overwintering time.

Table 4.6 Feed types and availability, feeding methods and ratio and classes of animals feed reduced

Parameters	Parameters	BVG	MVG	Aggregate
Feed composition, Roughage	Wheat straw	38	14	26
	Maize stover	21	26	23.5
	Lucerne	11	29	25.5
	Hay	12	26	19
	Other crops' stalk	18	5	11.5
Grain feed	Maize	25	36	30.5
	Wheat residue *(chary)*	17	9	13
	Wheat bran *(kevek)*	28	9	18.5
	Barley	6	13	10
	Cottonseed	3	15	9
	Oil plant residue	15	13	14
	Concentrate	6	5	5.5
Other supplements	Vitamin, minerals	11	16	13.5
Feeding types	Ground (chopped)	32	34	33
	Whole	48	46	47
Feeding methods	Grazing	23	68	45.5
	Grazing +stall feeding	47.8	26.6	37.2
	Stall feeding	28.2	5.4	16.8
Feeding ratio	Maintenance	60.4	69.7	65
	Production	33.6	27.3	30.4
	Balanced	5	3	4
HHs with surplus and deficit of forage	Surplus	58.7	21.5	40.1
	Barely deficit	28.5	39.6	34
	Deficit	12.7	38.9	51.6
Classes of animals reduced feed during feed scarcity period	Cattle (Heifers)	40(36)	17	28.5 (26.5)
	Sheep and goats	23	53	38
	For all	37	30	33.5

Source: Field survey, 2010

On average, in all HHs, stored roughage at the end of autumn season included wheat straw (26%), maize stover (23.5%), Lucerne (25.5%), hay (19%), and other crop stalks (11.5%). The types of accumulated roughage in both VGs were generally similar. However the proportions differed in case of wheat straw, Lucerne, crop residues and hay. In BVG, HHs stored 24 % and 13 % more wheat straw and other crop residues (such as bean, pea), whereas 18 % and 14% more Lucerne and hay were stored in MVG. According to nutritive value of feeds, Metabolise energy (ME) and crude protein (CP) content play important role in feed composition; whereas in both VGs it was observed a lower percentage of high ME and CP content roughages, such as Lucerne and hay, which suggested low nutritive value of roughage in both VGs. On average stored feed grains, fed as concentrate and mixed grains, included maize (30.5%), wheat residue, locally name *chary*, residue after cleaning of wheat seed (13%), Wheat bran, locally name is *kevek*, residue after milling of wheat flour (18.5%), barley (10%), cottonseed, locally name is *kunjara* (9%), oil plant residue, seed residue after squeezing oil (14%) and concentrate, mixed grain flour (5.5%). Maize (36%) was main grain feed in MVG, whereas in BVG wheat bran (28%) was dominated feed type. In both VGs, observed that main percentage of grains came from wheat, maize and sunflower crop residues, as well as they grown as multipurpose crops. Other supplements, such as vitamins, minerals and salt are purchased and they were given only by 11% HHs in BVG and 16% HHs in BVG, while salt was purchased by all HHs in both VGs. Types of feeding ground (for grain), chopped (for roughage) and whole depends on HHs welfare. Forty eight per cent of HHs in BVG and 46 % HHs in MVG fed whole roughage and grain because this type of feeding requires labour, time and payment.

A vast majority of the HHs in MVG (68%) depended on grazing, which this type of agro-pastoral system characterized by whole year round grazed with low or no inputs to livestock production systems. In BVG, majority of HHs (47.8%) fed their animals under dual feeding: grazing and stall feeding. HHs graze their stock from April to October day time and feed with crop residues or weeds from HH plot and cropland in the evening, after returning from near-village pastures to increase milk production. Feeding in the morning depends on grass availability in the pastures and livestock classes. For example lactated cows usually in summer feeds in the morning and in the evening (because days are longer). On the other hand, stall feeding for all animals is between late November and March due to climate condition. Stall feeding was observed in G2 category HHs, and it is higher in BVG HHs (28.2%), whereas in MVG is 5.4%. With this method, mainly fattened animals such as castrated, male and old animals are sold as additional income and replaced with younger ones. There are also popular many traditional methods of cooking and making supplementary feed *Atala* – boiled feed, consists of a mixture of wheat bran, maize flour, sunflower seed residue, salt and water. Usually prepared during winter feeding time and mostly feeds lactated animals. *Tert* – soaked wheat straw or some woody hays in warm water (20-30 minutes before feeding) or in cold water (7-10 hours) after that mixed with wheat bran or maize flour. Prepared with maize flour contents more nutritive value than with wheat bran; this is also prepared during winter time for lactated animals; cows, ewes, goats and also fed all small size herd (1-20). *Shor tokoch* - salty cake, baked like bread. It is a mixture of wheat, maize flour (sometimes barley flour) with salt and water. Mostly fed fattening animals: castrated (wethers, steers), young ram lambs, old animals.

Majority of HHs in BVG (58.7%) responded that they have enough feed for overwintering of their herd, whereas in MVG, only 21.5% HHs had stored feed surplus. This percentage belongs to HHs of G2 category, where G3 category has barely deficit (in BVG 28.5% and 39.6% in MVG) while G4 HHs suffer from deficit of stored forage shortage. Deficit of feed forced HHs to reduce the amount of feed by classes of animals. Reduction percentage was higher in cattle number in BVG (40%). From this, 36% is for heifers, whereas in MVG 38% was for small ruminants. Decreasing amount of feed for all animal classes was significantly high in both VGs (37% in BVG and 30% in MVG). With these results of feeding in both VGs, the study agrees with Tashi et al, (2000) findings from Tibet. Because of lack of supplementary feed for animals during the winter and spring, most herders suffer a huge loss of animals. And overstocking, combined with fragile rangeland ecosystem, parts of pastoral areas were trapped in a vicious cycle of “weight increase in summer – fattening in autumn –

loss of weight in winter – death in spring". This is also applicable to White et al. (1999) who highlight about the effects of underfeeding on animal production to the condition of the study area, that failure to meet nutrient requirements through underfeeding can adversely affect animal production. At crucial stages of the life cycle, there can be major long-term effects. For young animals, restricted feeding at an early age is unlikely to be compensated by higher levels of feeding at a later stage in life, resulting in small-framed animals. It also affects mating that failure to meet target weights at mating may result in reduced ovulation rates, resulting in a failure to conceive or a lower proportion of multiple births. Poor feeding during pregnancy can result in substantial weight losses by the dam, low birth weights for the offspring and reduced milk yields in the following lactation. Excessive feeding leading to internal fat deposition may cause difficulties during birth. Underfeeding in lactation causes lower milk yields and poorer growth rates in suckling young. Loss of live weight in the dam will be recovered later during lactation at the expense of milk production.

4.7 Forage Shortage Impact to Milk Production and Lactation Curve

Majority of HHs keep local breed Ala-Too meat-milk direct breed cattle. Selling raw milk and milk products by farmers started after independence mainly as additional income source of households. While the majority of them keep cows for self-consumption, some households do not sell milk as they have a belief that "white thing" cannot be sold. Rather they give for free to people who need and request it. Milk productivity was analysed in 98 cows from BVG; 178 cows from MVG's households. They were classified according to calving stage, lactation length and calving season as shown in Table 4.7; 4.8 and 4.9. Lactation length varied from 186-365 days with different stage and breed. Usually, local breed has short lactation period (10.1% in MVG, 6.1 % in BVG) with less amount and high fat content milk (3-5 litres per day).

Table 4.7 Variation in cows' number by lactation length

VGs	Total cows' number	Lactation days						
		186	227	248	279	305	330	365
MVG	178	18(10.1)	24(13.4)	28(15.7)	32(17.9)	49(27.8)	14(7.8)	13(7.3)
BVG	98	6(6.1)	11(11.2)	28(28.6)	27(27.6)	23(23.4)	3(3.1)	-
Total	276	24(8.7)	35(12.6)	56(20.2)	59(21.4)	72(26.3)	17(6.1)	13(4.7)

Source: Field survey, 2010
Note: Figures in the parenthesis indicate percentage

This breed has small body shape and body condition is good fitted for mountain climate. Majority household have meat-milk direct Ala-Too breed cows. Since most of the lactated cows are grazed in near-village, they are bred naturally. Farmers do not care about the quality of bulls in grazing herd. Even if it is high quality bulls; they will be over used in large size herds.

Table 4.8 Variation in number of cows by calving season

VGs	Total cows' number	Parity (calving season)			
		spring	summer	autumn	winter
MVG	178	80(49.7)	23(12.9)	31(17.5)	34(19.7)
BVG	98	26(26.7)	3(3.1)	8(8.1)	55(62.1)
Total	276	106(44.3)	26(9.4)	39(14.1)	89(32.2)

Source: Field survey, 2010
Note: Figures in the parenthesis indicate percentage

Table 4.9 Variation in milk yield by lactation stage

Parity	Average milk yield, kg		Min milk yield, kg		Max milk yield, kg	
	BVG	MVG	BVG	MVG	BVG	MVG
1st	1107	1290	500	680	1810	1830
2nd	1402	1643	540	750	2000	2606
3rd	1255	1396	530	710	2640	2940
4th	1751	2069	1210	960	2650	2911
5th	1205	1955	784	1410	1470	2660
6th	1614	1658	730	685	2760	2650

Source: Field survey, 2010

These issues can be one of the reasons of decreasing milk productivity in the district. Main percentages of lactation length are from 279-305 days in both VGs. In MVG, 13 cows or 7.3% of 178 cows have 365 days of lactation lengths, which can be milked all year round from current calving to the next one. BVG has significantly higher proportion of cattle with lactation length of 248 and 279 days, whereas MVG has significantly higher proportion of cow with lactation length of 305 days. The total average milk yield varies from 1107 kg to 2069 kg by parity (Table 4.9). The lowest milk yield was at 1st parity in both VGs (500kg and 680 kg respectively). The highest milk yield quantified in 4th parity in BVG (2650 kg) and 3rd parity in MVG (2940 kg). The amount of milk yield depends on breed quality, parity and calving season. All these factors effect with feed sufficiency in winter and in summer are shown in Figure 4.16. According to Table 4.8, the number of cows in spring calving season was significantly high in MVG, 80 or 49.7 % of total number, while in BVG it shows high number in winter calving season 55 or 62.1 % of total numbers respectively. This was because of natural breeding; when cows gain enough live weight and have good condition score. For example, if the calf was born in April, insemination was in August, when enough grass is available. On the other hand, farmers usually keep two cows with different calving season to supply milk and milk products all year round. Number of cows in summer and autumn calving is lower in both VGs, even though they have significant positive changes in lactation curves (Figure 4.16). The lactation curves are very sensitive in winter and autumn calving in MVG, in winter and summer in BVG. Higher decrease in milk yield observed in these seasons affects the total milk production at local and district level with assessment in forward to all cows as low productive. These points concluded that BVG's HHs are more suffering with 'low productivity' by dominating cows number in winter calving while similar issues observed in MVG by dominating spring and autumn calving. On the other hand the majority numbers of cows belonging to those calving season suffered from forage shortage.

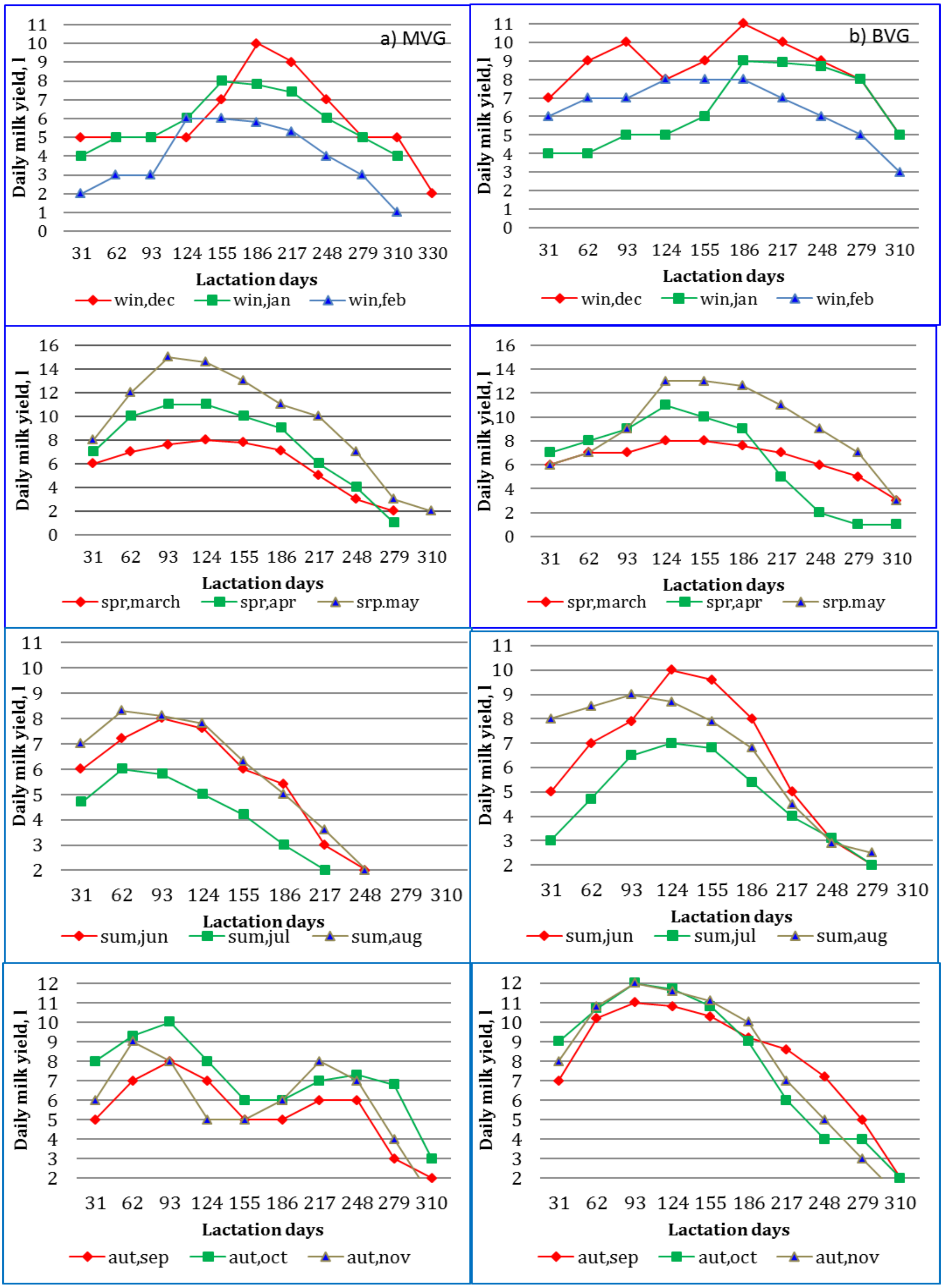


Figure 4.16 Forage effect on seasonal lactation curve
Source: Field survey, 2010

4.8 Wood's Model: Factors Affecting the Lactation Curve of Cows

Data used were obtained from a total of 98 mixed-breed herds under conditions varying from a smallholding herd in BVG. The proposed model is reasonable and appropriate for a complete description of lactation trends of individual cows based on monthly test-day milk yield data. Variations in the shape of the lactation curve (LC) for dairy cows are believed to stem from both genetic and environmental factors (Wood, 1969). Wood (1969) inferred that the suitability of empirical models of the lactation curve does not depend on the mathematical form of the function alone, but rather more on the biological nature of the lactation. Seasonal patterns in pasture availability, for instance, are a major environmental factor contributing to a typical lactation that cannot be adequately described by standard models. Of particular significance are animals in agro-pastoral production systems in BVG, where farmers are largely constrained in terms of management, lack of supplementary feeds, diseases and seasonal forage shortages. Lactation curve represents the relationship between milk yield and time after calving. In dairy cattle, milk production typically rises to a peak between 2 to 8 weeks post-partum and steadily declines thereafter (Wood, 1969; Kamidi, 2005). The lactation curve technique is often used to estimate lactation yield, expected time of peak milk production, peak milk yield, and persistency of yield and this is useful for managers of cows in culling low milk producers and in planning for feed and farm resources (Anwar et al., 2009).

This study focuses on peak yield, persistency and lactation yield that are clearly the parameters of major interest in individual lactation curves. The study intends to use Wood's model (Gama model) to estimate parameters of the lactation curve and analyse the influence of some determining variables on the parameters of the lactation curve in BVG.

4.8.1 Empirical Strategy

The empirical technique employed for this study is based on the gamma function Wood model (1967) as follows:

$$\boldsymbol{Y_n = \beta_0 n^{\beta 1} e^{-\beta 2n}} \qquad \textbf{(1)}$$

Where Y_n *is the average monthly milk yield in month n,* β_0 *is the scale parameter (Initial milk Yield),*β_1 *and* β_2 *are the shape parameters of the curve, for the increasing and decreasing phases of the curve respectively.*

The gamma model is transformed logarithmically into a linear form as follows for least squares regression analysis:

$$\mathbf{ln(}\boldsymbol{Y_n}\mathbf{)=ln}\boldsymbol{\beta_0}\mathbf{+}\boldsymbol{\beta_1}\mathbf{ln(n)-}\boldsymbol{\beta_2}\mathbf{n} \qquad \textbf{(2)}$$

Ordinary Least Squares (OLS) estimates of constantβ_0, coefficients β_1 and β_2 from above equation can be used to calculate time to peak milk production, time to peak production and the persistence of the yield curve. Time to peak milk production is calculated by using the ratio of β_1 and β_2 coefficients whereas peak milk yield and persistence of the yield curve are estimated using the following formulas:

Peak Milk Yield[14]: $\boldsymbol{\beta_0(\beta_1/\beta_2)^{\beta 1}\exp(-\beta_1)}$ **(3)**

Persistence: $\boldsymbol{[(\beta_1+1)*\ln\beta_2}$ **(4)**

The above-mentioned features of the lactation curve are further analysed by lactation stage, lactation length, months of calving and the season of calving. The study to analyse the shape of the lactation curve in Kyrgyzstan takes into consideration four main variables. They are the parity, month of calving, season of calving and lactation length. Number of cows used for this

[14] The exponential function is used to model a relationship in which a constant change in the independent variable gives the same proportional change (i.e. percentage increase or decrease) in the dependent variable. The function is often written as exp(x), especially when it is impractical to write the independent variable as a superscript.

study has been categorized based on the stage of lactation (Table 4.7 and 4.8.). The mean milk yield for all cows was of 1358.65kg and the standard deviation is 522kg.

Apart of parity, other factors considered are month of calving (month a calf is delivered), season of calving (season a calf is delivered) and the lactation length (duration of lactation from beginning to the end of calving) (Table 4.10).

Table 4.10 Descriptive Statistics of Lactation Data & Determining Factors of Milk Yield Curve

Parameters	N	Mean	Standard Deviation	Minimum	Maximum
Milk Yield	89	1358.65	522.74	540	3090
Parity	6	-	-	1	6
Calving period	12	-	-	1	12
Calving season	4	-	-	1	4
Lactation Length	5	8	1.58	6	10

Calving months were grouped into 12 periods, running from January to December. There were four seasons and they are winter (December to February), spring (March to May), summer (June- August) and autumn (September-November). The lactation lengths were grouped into five (5) categories comprising cows with lactation length of up to six (6) months. The overall least squares mean lactation yield for cows was 1,239.02 kg with a standard deviation of 105.43 kg. The mean lactation length was 8 months with a standard deviation of 1.58 months. The overall estimates for initial milk yield (β_0), inclining slope (β_1) and declining slope (β_2) were 175.084 (1.040), 0.946 (0.081) and 0.317 (0.021) respectively with standard errors enclosed in parenthesis. All of the parameters of the lactation curve are significant at 1%. The R-squared for the transformed logarithmic gamma function is 0.27. The estimated lactation curve together with actual curve is shown the Figure 4.17. Both actual and predicted monthly milk yields increase to reach a peak within few months and, thereafter, decline over several months, which is the defining characteristic of lactation curves. Over the entire duration of lactation, the predicted lactation yield curve lies below the actual lactation yield curve, indicating that the predicted milk yield underestimates actual milk yield of all cows considered under this study.

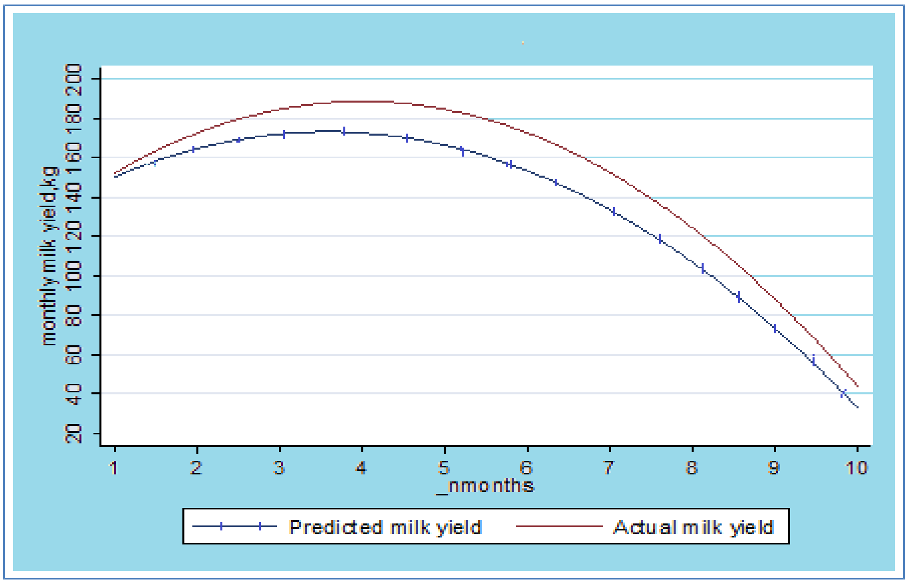


Figure 4.17 Overall actual and predicted lactation curves of cows

4.8.2 Parity

Table 4.11 shows the values of initial milk production (β_0), the inclining coefficient of the lactation curve (β_1) and the declining coefficient (β_2) from first parity to sixth together with their standard errors (se). Initial milk yield, inclining coefficient and the declining coefficients are highest among fourth stage calving. The lowest initial milk yield was, however, observed among first parity cows. Both the inclining and the declining coefficients are lowest among parity six (6) cows. All the parameters of the lactation curve by parity are all significant at 1%. The R-squared for the transformed logarithmic gamma function is 0.24.

Table 4.11 Main model least squares mean lactation curve constants for cows with different parity

Parity	β_0	$\beta_0$se	β_1	$\beta_1$se	β_2	$\beta_2$se
Overall	175.084***	1.040	0.946***	0.081	0.317***	0.021
By parity						
1st	149.249***	1.072	1.118***	0.155	0.370***	0.043
2nd	161.400***	1.091	0.791***	0.177	0.252***	0.045
3rd	153.697***	1.086	0.870***	0.172	0.284***	0.045
4th	253.168***	1.089	1.496***	0.175	0.501***	0.045
5th	188.949***	1.130	0.807***	0.258	0.313***	0.068
6th	227.955***	3.096	0.715***	0.226	0.265***	0.059

***- significant at 1%

4.8.3 Calving Season

Various seasons had differing impact of the parameters on the lactation yield curve (see Table 4.12). Initial milk yield was highest among autumn season calving and lowest among spring calving as shown in Table 4.12. The inclining slope was highest among summer calving and lowest in winter. The declining slope was highest in summer but lowest in winter and spring. This implies that the lactation curve for winter calving is flatter and lactation lasts over longer duration as compared to other calving season. The R-squared for the transformed logarithmic gamma function is 0.31.

Table 4.12 Main model least squares mean lactation curve constants for cows with different calving season

seasons	β_0	$\beta_0$se	β_1	β_{01}se	$\beta_2$se	$\beta_2$se
Winter	197.98***	1.05	0.98***	0.11	0.32***	0.03
Spring	141.33***	1.06	0.99***	0.13	0.32***	0.03
Summer	187.20***	1.17	1.19***	0.37	0.45***	0.11
Autumn	238.90***	1.15	1.10***	0.33	0.43***	0.09

***significant at 1%

4.8.4 Calving Period

Initial milk yield is highest in May calvers and lowest among July calvers (Table 4.13).

Table 4.13 Main model least squares mean lactation curve constants for cows with different calving period

Calving Month	β_0	$\beta_0$se	β_1	$\beta_1$se	β_2	$\beta_2$se
January	187.237	1.068	0.990	0.133	0.319	0.034
February	170.421	1.103	0.970	0.207	0.321	0.055
March	131.370	1.074	0.985	0.146	0.310	0.038
April	170.595	1.184	1.491	0.418	0.528	0.130
May	245.987	1.141	1.225	0.300	0.500	0.083
June	193.545	1.249	1.835	0.613	0.823	0.217
July	110.114	1.236	1.245	0.501	0.375	0.144
August	176.582	1.142	1.439	0.315	0.491	0.091
October	207.341	1.170	0.975	0.364	0.395	0.105
November	206.525	1.254	1.269	0.506	0.393	0.141
December	132.815	1.128	0.947	0.249	0.327	0.065

The inclining slope is steepest in June calvers and lowest among December calvers. The declining slope was highest in June and lowest in March. No clear pattern has emerged in analysing the lactation curve by the month of calving. The R-squared for the transformed logarithmic gamma function is 0.57.

4.8.4 Lactation Length

The initial milk yield increased with lactation length, reach its maximum at lactation length of 244 days and begin to fall (see Table 4.14). The inclining slope is highest in lactation length of 215 days and lowest in lactation length of 305 days. The declining slope is highest in lactation length of 215 days and lowest in 305 days. This implies that the lactation curve is flattest in the case of lactation length of 305 days, and lactation lasts over a longer duration as compared to other lactation lengths. The R-squared for the transformed logarithmic gamma function is 0.45.

Table 4.14 Main model least squares mean lactation curve constants for cows with different lactation length

Lac length	β_0	$\beta_0$se	β_1	$\beta_1$se	$\beta_2$se	$\beta_2$se
186 days	163.32***	1.15	1.42***	0.38	0.58***	0.13
215 days	185.01***	3.15	1.60***	0.38	0.60***	0.12
244 days	222.84***	1.06	1.51***	0.13	0.55***	0.04
273 days	179.21***	1.06	1.18***	0.13	0.39***	0.03
305 days	73.02***	1.08	1.07***	0.15	0.3***	0.04

***significant at 1%

4.8.5 Results and Discussions

Milk production is largely dependent on the shape of the lactation curve. Relevant elements of the lactation pattern are the peak yield, which represents the maximum milk yield during the lactation, and the lactation persistency, which expresses the ability of animals to maintain a reasonably constant milk yield after the lactation peak. Thus, cows with persistent lactation tend to have flatter lactation curves. Parity had a significant effect on lactation parameters. Calvers with high initial milk yield tend to have higher peak milk (see Table 4.15). In general, higher parity cows, on average, tend to have shorter time to peak milk and weak lactation persistence as compared to low parity calvers. For instance, fourth parity calvers have highest initial milk and peak milk, but time to peak and lactation persistence are low, implying the higher parity calvers are relatively inefficient.

Table 4.15 Changes in initial and the peak milk yield with time and lactation persistency by parity

Parity	Initial milk	Peak milk	Time to peak	Persistence
1^{st}	149.249	167.86	3.02	(0.91)
2^{nd}	161.400	181.06	3.14	(1.07)
3^{rd}	153.697	170.52	3.06	(1.02)
4^{th}	253.168	291.70	2.99	(0.75)
5^{th}	188.949	180.84	2.57	(0.91)
6^{th}	227.955	226.82	2.70	(0.99)

The effect of season of calving was highly significant. Cows calving in winter and autumn have high initial milk and peak milk levels as compared to spring and summer calvers. Winter and summer have longer time to peak and strong lactation persistence as compared to the other seasons. Summer and autumn have shorter time to peak milk production as compared to winter and spring (see Table 9). The above analysis implies that winter calvers tend to have high peak milk while at the same time efficient as evidenced by larger lactation curve.

Table 4.16 Changes in initial and the peak milk yield with time and lactation persistency by calving season

Calving seasons	Initial Milk	Peak milk	Time to peak	Persistence
Winter	197.98	220.25	3.05	(0.97)
Spring	141.33	158.48	3.03	(0.97)
Summer	187.20	181.11	2.64	(0.76)
Autumn	238.90	221.20	2.53	(0.76)

The 8th lactation length has both the highest initial milk and the highest peak milk. Time to peak is positively related with lactation length (see Table 4.16). Lactation persistence is higher for calvers of longer lactation length. It is clear that calvers with longer lactation length are more preferable.

Table 4.17 Changes in initial and the peak milk yield with time and lactation persistency by lactation length

Lactation length	Initial Milk	Peak milk	Time to peak	Persistence
186 days	163.32	139.76	2.44	(0.57)
215 days	185.01	182.20	2.69	(0.59)
244 days	222.84	228.40	2.76	(0.66)
273 days	179.21	203.50	3.03	(0.89)
305 days	173.02	219.13	3.39	(1.04)

4.9 Conclusion

The last decade has seen considerable changes taking place in livestock population, structure, and management systems in Ala-Buka district especially in mixed crop-livestock production systems, with different predominance of livestock. Change in livestock population is closely associated with land holding, forage and the availability of grazing land. The households' own perceptions of changes in their herd sizes show total livestock population increasing in both VGs' HH. By species, cattle and goats number in MVG and sheep number in BVG changed positively. The most noticeable change is the considerable decline in cattle and goats number in BVG and in sheep number in MVG households. During five years changes in herds was slow in BVG, whereas in MVG the numbers increase rapidly. Herd composition of the households indicates that there were more female animals than male. The higher number of female cattle is believed to correlate with the major reason for keeping cattle, which is milk production, which is for self-consumption, and selling in the market, and also using dung as winter fuel. For other species, as well they have more female in order to increase herd size and to sell live animals to augment household income.

However, traditional and modern private livestock management strategies have been developed to regulate herd size based on the available fodder supplies. The sale of animals in autumn, after returning from summer pastures or slaughtering at the beginning of winter are some of such management strategies. Livestock can be sold all year round, but major sale takes place in August-October, when livestock return from pastures. Cash income from such sale is mainly used in preparation for wheat sowing in autumn and for growing season in spring. Another major sale takes place in February-March when forage shortage occurs. This time the sale of livestock is high with low price which exacerbates poverty, as poor people are forced to make such sales. This provides new opportunity for ‘new businesses’. Here wealthier farmers or other businessmen buy livestock at lower price and send them to summer pastures. They sale them in autumn at higher price. This type of business has temporarily increased livestock numbers among buyers’ household.

Livestock contribute 21% of household income in BVG and in MVG 31%. Besides, it also provides products for home consumption. The main reason of changes in herd composition was income level and market demand in general. In case of sheep, higher demand for meat led to increase in population of Gissar breed. Goats’ number is increasing in the herds of MVG households. Less cropland area and easy access to common property pastures, well-adaptation of goats to harsh climate conditions and natural resource based fattened feeding systems make the goats more preferable. A high demand for goat milk and less feed requirement made goats well-accepted by poorer households. In future, there is an uncertainty, whether they can be replaced with cattle in rural area with improvement of welfare among rural poor. Increase in numbers of intermediary women buyers of milk and milk products in BVG led to increase in cattle numbers in the herd, majority of which are retained in near-village pastures all year round. Horse and donkey numbers increased due to necessity of draft power in the households. The attributes of draft animals are subsidiary for agricultural machines that help in performing plugging and threshing the land, transporting of physical products, income-employment gain (services to other farmers) and socio-cultural (nomadic culture, having a horse) and ecological services. Lac of roads in remote pastures enhanced the use of donkeys and horses as main transport during transhumance. The increase number of horses and donkeys can be indication of advanced rural poverty as poor prefer to use livestock in order to avoid extra expenditure for tractor services, fuel and payments. On the other hand, the increase in the use of livestock for agriculture operation decreases the use of agricultural machines; thereby leading to low carbon agriculture. This will be crucial in mitigating adverse impact of climate change on human beings and environment through reduced GHG emissions.

Forage scarcity, especially from the end of winter to mid spring is the main constraint. In addition, time shortage in hay-making in summer because of lack of labour as well as in favourable changes in pasture brought by climate change is another important constraint. Declining pasture productivity was observed even in not stocked intensive and remote pastures of the study area. Thus, forage species are suffering from triple risks; overgrazing, dominating non-edible plants and climate change. Forage shortage and poisonous grass species increase livestock mortality in early spring.

Forage availability and scarcity affect milk yield and made significant change in lactation curves by calving season. The number of cows in summer and autumn calving is lower in both VGs, even though those calving seasons have significant positive changes in lactation curves. The lactation curves are very sensitive in winter and autumn calving in MVG and in winter and summer calving in BVG. Higher decrease in milk yield is observed in these seasons that affect the total milk production in local and district level as all cows became less productive. Therefore, it concluded that BVG's HHs are suffering from 'low productivity'. Besides, majority numbers of cows belonged to winter and spring calving season suffered from forage shortage. This affects total milk yield at district and national levels because of the decline in milk yield as cows become less productive.

Lactation curve calculation had two limitations; usually milk yield is taken weekly, for this calculation used the amount of monthly milk yield. Secondly, lactation curve for season was very sensitive due to forage shortage, which has high number of standard error. The effects of farm operation, calving stage, calving season, period and length must also be taken into consideration when evaluating cows' productivity. The mean milk yield for all cows was of 1358.65kg and the standard deviation is 522kg. The overall estimates for initial milk yield (β_0), inclining slope (β_1) and declining slope (β_2) were 175.084 (1.040), 0.946 (0.081) and 0.317 (0.021) respectively with standard errors enclosed in parenthesis. All of the parameters of the lactation curve were significant at 1%. The R-squared for the transformed logarithmic gamma function is 0.27. Highest peak and lactation yields were associated with cows that calved in autumn and winter. Persistency was higher for 4th stage cows (the favourable lactation persistence as compared to calvers of other stages) and cows that calved in winter and spring. Summer and autumn have shorter time to peak milk production as compared to winter and spring. Time to peak is positively related with lactation length. The 8th lactation length has both the highest initial milk and the highest peak milk. Lactation persistence has no definite relationship with lactation length. Among the different measures of persistency, the ratio of lactation to peak yield may be desired by breeders because of its higher lactation yield and easy for calculating. Further analysis of the calving season, stage, and period, especially with regard to consumption of winter forage and grazing and farming operation would be of interest.

Chapter V Land Management: Cropland and Pastures

5.1 Introduction

Agricultural land is classified into two main components: arable land, which is the cultivable land to grow crops, and pastures, the uncultivated component used for grazing animals. Pastures make up 85% of agricultural land in Kyrgyzstan, with arable land accounting for the remaining 15%. As the privatization process approached its completion, the total arable land in individual use (by peasant farms and household plots combined) stabilized at around 920,000 hectares, with the remaining agricultural enterprises and other users controlling less than 400,000 hectares. The main crops grown in Kyrgyzstan are wheat, maize (for grain and silage), potato, forage crops, industrial crops (oilseed crops, tobacco, and cotton), and vegetable. Since independence, the need for local food self-sufficiency has given wheat production importance by replacing forage crops and barley, which previously was the main crop for intensive livestock industry. The cropping patterns in the study area vary due to self-consumption, forage and cash income from farming. In the case of income, costs and benefits from crop species depends on crop land size, productivity and demand for those crops. However, in the last decade, this proportion was altered by the use of the land for more profitable crops, mainly fodder crops in response to the fast growing livestock economy.

According to report by MoE (1998), a range of factors over the last century have had an impact on biodiversity in Kyrgyzstan, resulting in declines in many groups, and leading to concern for a growing number of species, including key ones of economic importance. Pastures are formed by the variable climate of certain areas and the composition of plant species adapted to grow in those particular conditions. In these areas, primary biological production – animal breeding – supports an important sector of the economy upon which the majority of the population depends. On the other hand, both a rise in average temperatures and an increase of extreme weather conditions are putting pressure on biodiversity, landscape, and agriculture.

This chapter analyses past and current changes in cropping patterns, pasture types and its management through farming and animal husbandry activities. It reports the results of a study of farming economics, which is reflected by inputs and outputs of farming systems. The results of the pasture studies conducted in two types of pastures aims to gain information about the condition of mountain pastures in the study area. Results are obtained by two main methods: the first is to examine the current condition of pastures in terms of coverage, composition, and factors of pasture degradation. The second was to analyse socio-economic and environmental context of pasture management by pastoralists and large herd owners.

5.2 Background: Land Holding and Cropping Pattern in Kyrgyzstan

Agricultural land is classified into two main components: arable land, the cultivable land to grow crops, and pastures, the uncultivated component used for grazing animals. Pastures make up 85% of agricultural land in Kyrgyzstan, with arable land accounting for the remaining 15%. Pastures were not subject to privatization and remained state property. Privatization efforts focused only on arable land. While reform legislation is in place in Kyrgyzstan (See Annex 1), and about three-quarters of former collective farm households have now become private farmers, implementation of the reforms is not yet complete. The land reform legislation set a privatization target of 75% of arable land, with the remaining 25% to be held in a State Land Redistribution Fund for future contingencies. As the privatization process approached completion, the total arable land in individual use (by peasant farms and household plots combined) stabilized at around 920,000 hectares, with the remaining agricultural enterprises and other users controlling less than 400,000 hectares. By February 2009 the number of land-share owners had reached 2.7 million individuals or more than 80% of the rural population (Lerman et al., 2009; Gosregister, 2009).

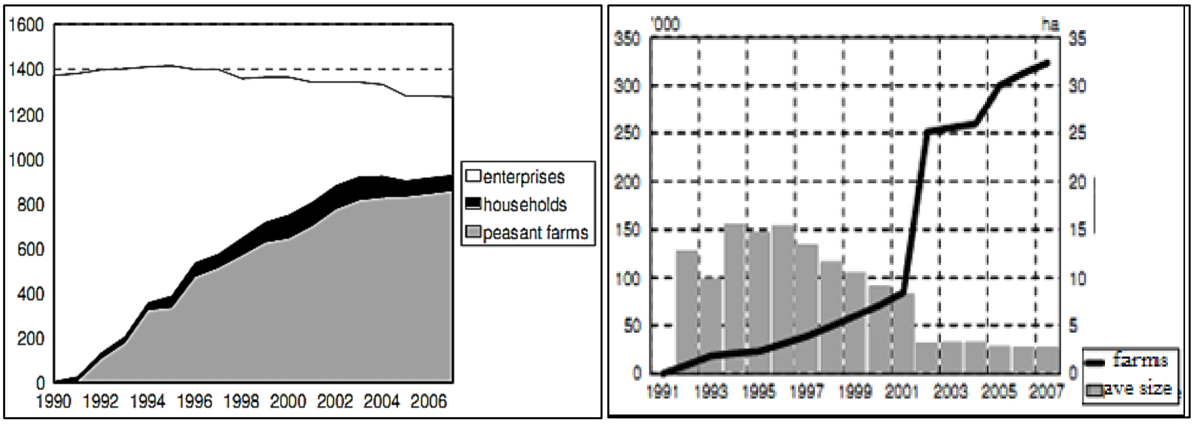


Figure 5.1 Arable lands in individual farms and development of peasant farms in Kyrgyzstan
Source: Lerman et al., 2009

The increase in the number of peasant farms outstripped the growth of arable land, resulting in a sharp decline in average farm size – from 15 hectares in 1994-96 to 3 hectares since 2002 (Figure 5.1 and 5.2).

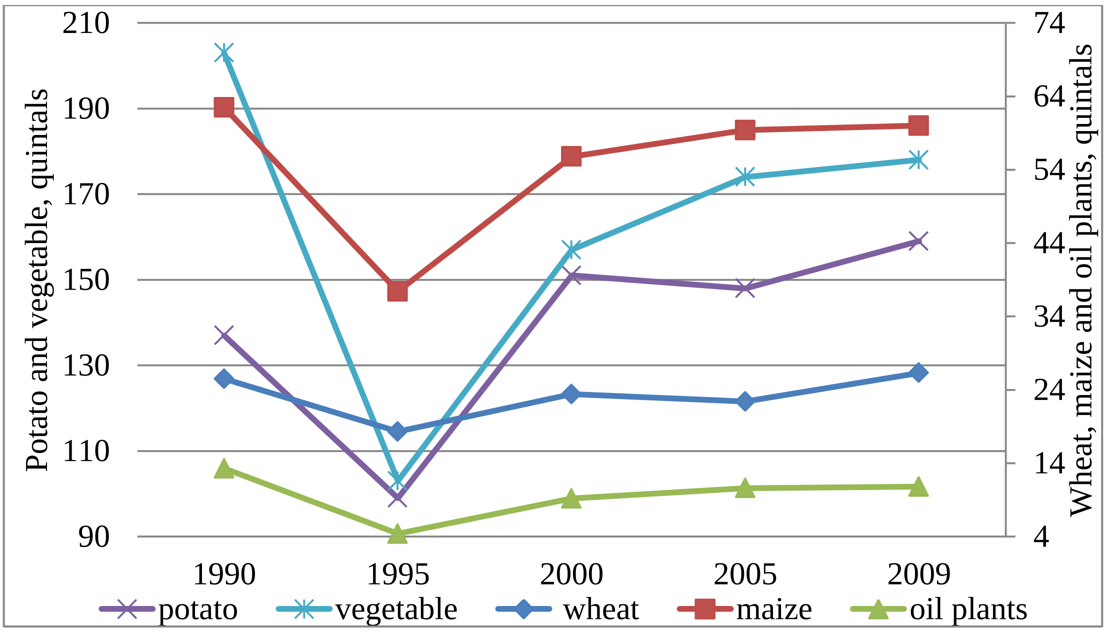


Figure 5.2 Yield (quintals/ha) of some selected crops in Kyrgyzstan between 1990 and 2009
Source: NSC, 2010

Land uses of farms of the three main types are agricultural enterprises, peasant farms, and household plots. Individual farms (the traditional small household plots outperform the newly emergent peasant farms) achieved consistently higher levels of land productivity than agricultural enterprises. Crop yields dropped between 1990 and 1995 with transition of the traditional Soviet farming system and the disruption of all infrastructures in agriculture. From 1995, because of land and farm reform, crop yield per hectare increased. This was accompanied by land and farm reform; changing landownership from collective farming to individual farming. There were negative impacts of increasing crop yield by land degradation. Arable land contracted from a peak of 1.4 million hectares in 1994 to 1.3 million hectares in 2007, while more than 5 million hectares of pasture land shifted out of productive use by farms and villages. The potentially negative effect of the decrease was reinforced by the shrinkage of machinery inventories and sharp reduction in the use of fertilizers and other purchased inputs and worsening irrigation-drainage systems (Lerman et al., 2009).

5.3 Changes in Cropping Pattern

The main crops grown in Kyrgyzstan are wheat, maize (for grain and silage), potato, forage crops, industrial crops (oilseed crops, tobacco, and cotton), and vegetable (Figure 5.3). Since independence, the need for local food self-sufficiency has given wheat production importance. According to NSC (2010) data, a total of 193 582 ha of wheat were grown in 1990, it increased to 549638 ha in 1997, whereas in 2009 it declined to 402575 ha (both irrigated and rain fed land) by replacing forage crops and barley, which previously was the main crop for intensive livestock industry. This reflects diversion of land to more profitable crops, mainly fodder crops in response to the fast growing livestock economy. As a result, the area cultivated for fodder crops has increased by 43 % or by nearly 90 000 ha from 2003 to 2010, particularly in the South part of the country, where it has doubled (FAO/WFP, 2010).

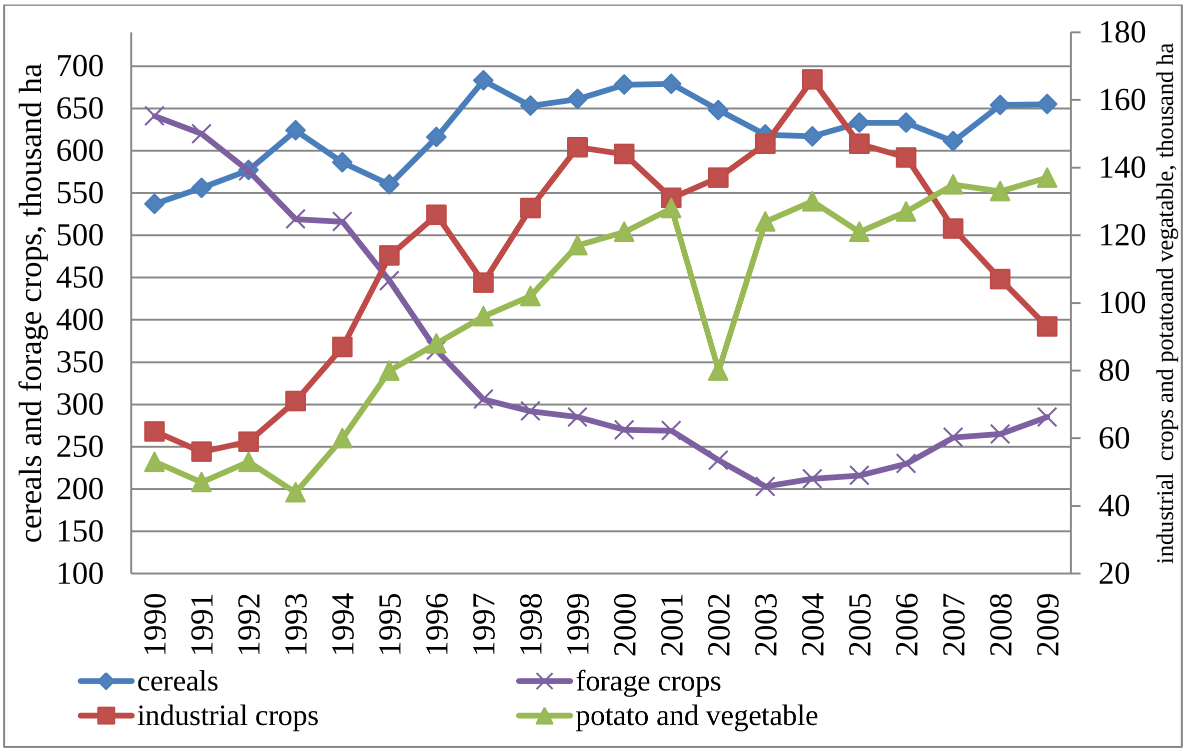


Figure 5.3 Trends in sown area of major crops in Kyrgyzstan between 1990 and 2009
Source: NSC, 2010

Another reason of decreasing wheat cropland area is agriculture machines; cereals are almost entirely harvested by combine harvesters, and this represents the most important cost for producing staple crops. The acute machinery deficit was estimated in 2009 at 45% for combine harvesters, 40 % for tractors with different tools and 30% for seeders. As a result, farmers losses were 15-25% higher (the amount is higher in remote areas) than normal losses (FAO, 2009). Oil seed crops (irrigated crops of sunflower and rape, and mainly rain-fed crops of safflower) have shown a remarkable increase from a total of 7 801ha in 1990 to a total of 66192 ha in 2009. The largest area of oilseed crops (86941 ha) were sown in 2004. The area cultivated for food self-sufficiency crops, such as potato and vegetables has increased substantially; potatoes from 25 188 ha in 1990 to 87227 ha in 2009, and vegetable crops from 20 655 ha in 1990 to 43447 ha in 2009. This also reflects a growing demand in urban areas and neighbouring countries.

Compared to other crops, maize decreased slightly with significant change in proportion between grain and silage production. Maize was planted in a total of 155 261 (65664 ha or 42.3% for grain and 89 597 ha or 57.7% was for silage) ha of land. The data for 1999 show decrease in sown area; a total of 81 560 ha planted with maize (a reduction of 73 701 ha) of which 61 009 ha (74.8%) was for grain, and 20 551 ha (25.2%) for silage (Central Asia Project, n.d).

Seed quality plays important role in farming. Decreasing maize cropland can coincide with lack of machinery, such as feed combines, cutters and rollers. In individual sector, harvesting is almost done manually by requiring high labour. On the other hand, insufficiency and high diesel prices, which are almost not acceptable by the majority peasant farmers, negatively affect land preparation in spring, cultivation in summer and harvesting in summer and in autumn. This mainly happens in spring, when mostly households have financial shortage which is combined with forage shortage for animals, low price for livestock in the market and food shortage for households. These factors contributed to the reduction of spring crops or late sowing in spring. Irrigation also plays major role in farming, where most of annually grown cereals, potato, vegetable and industrial crops are grown on irrigated land, whereas other dry land crops strongly depends on precipitation. As FAO/WFP reports of Kyrgyzstan (2009) point out other factors affecting crop yield are fertiliser supply, which decreased in amount per hectare supply after independence. Fertiliser price and availability (sometimes will be high in demand, even if it is in high price) represent a significant constraint to increase fertiliser use by farmers in individual sector.

In the mixed crop-livestock farming systems, livelihood and livestock rely on arable land including irrigated and dry land with integrated crop land (Wright et al., 1995). The average size of owned land also plays important role in sustainable farming. The size of owned land varies in both VGs; in BVG was a total of 0.20 ha arable land including 0.17 ha irrigated and 0.03 ha dry land, whereas in MVG it was a total of 0.18 ha arable land, including 0.12 ha irrigated and 0.06 ha dry land area. This variation depends on the size of former kolkhoz's (1-May kolkhoz-MVG) and sovkhoz's (Birlik sovkhoz-BVG) arable land area and its population. The average land holdings in each VG by land size stratification is given in Table 5.1.

Table 5.1 Number and percentage of households by owned land size (hectare)

Land size	BVG		MVG	
	HHs	%	HHs	%
No land	13	10.8	25	20.8
0-1 ha	35	29.1	63	52.5
1-5 ha	65	54.1	31	25.8
5-<	7	5.8	1	0.9

Source: Field survey, 2010

Majority of households, 63 or 52.5 % have 0-1 ha of land in MVG (in BVG 35 or 29.1%), while in BVG, majority of HHs; 65 or 54.1 % (in MVG 31 or 25.8 %) hold 1-5 ha of land. Seven or 5.8 % of HHs in BVG own and rent more than 5 ha of land and in MVG only one HHs has such amount of land. Excluding owned land, majority of HHs have rented land from the State Land Redistribution Fund (SLRF) and from neighbours. Latter one can be rented from poor HHs, mainly those who are not able to use it due to high expenditure of cropping and lack of labour. Land holding by land types and ownership forms, with main crop varieties are given in Table 5.2. In general, land size for all types are larger in BVG, excluding hay land (0.32 in MVG and 0.23 ha in BVG). The average size of arable land is 1.56 ha in BVG and 1.12 ha in MVG respectively. Water availability and condition of irrigation-drainage systems are also important in land use. The size of irrigated land is larger in BVG (1.01 ha) than in MVG (0.62 ha). Water to the irrigated land areas in MVG is supplied by three old pump stations and channels, which were constructed during the Soviet time and require capital repair. Each year, during the growing season those pumps and channels are destroyed by heavy rain and increasing water amount due to melting snow. The large size of total arable land and especially irrigated land area is due to the availability of ground water in three high populated villages in BVG.

Table 5.2 Operated land area with mean number and different crop varieties

Land, ha	BVG			MVG		
	Total land	Mean	HHs *n*=107	Total land	Mean	HHs *n*=95
Total arable land	165.73	1.56	107	105.36	1.12	95
Irrigated	108.1	1.01	107	60.25	.62	89
Dry land	22.76	.48	48	21.24	.48	45
Hay land	2.12	.23	9	5.08	.32	19
SLRF land	32.78	2.04	16	15	2.01	7
Orchard	12.35	.65	19	3.79	.27	14
Crop						
Wheat	62.75	.89	71	24.78	.52	47
Maize	33.19	.46	76	33.41	.36	66
Sun flower	34.03	.54	64	12.97	.36	37
Potato	14.93	.24	47	4.62	.14	34
Vegetable	2.5	.08	31	2.38	.10	23
Forage crop	18.33	.52	37	26.26	.47	34
Tobacco	.38	.12	3	.94	.26	4

Source: Field survey, 2010

The cropping patterns in the study VGs is reflected by mainly food crop self-sufficiency. Majority HHs in BVG (71 HHs) used the main land area for wheat growing, whereas in MVG, number of HHs is lesser (47 HHs). The next important crop is maize in both VGs and the number of HHs is even higher than numbers of wheat growing; 76 HHs in BVG and 66 HHs in MVG. This suggests that majority HHs use their land for livestock forage, thereafter they can sell their livestock and buy wheat (after harvesting with low price) or wheat flour from the market. That type of purposive cropping includes Lucerne. Those purposes of cropping of maize and forage crops are more profitable than other crops (pers.comm., 2010). The cultivation of potatoes, sunflower and vegetables grown as cash crops, for self-consumption can be grown in household plots. The increased cultivation of potato as contrasting to other cereals and forage crops led to lower animal feed resources because it does not produce forage for animals itself. However weeds in potato crop land give significant amount of 'hay'. Lack of herbicides leads to increase weeds in crop land. During the Soviet time, tobacco was one of the main industrial crops in Kyrgyzstan. All activities related to tobacco growing was mechanised and man-labour was required in sorting and pressing. After independence, tobacco planted areas drastically reduced because of the gap in demand, and lack of labour. In the study VGs, few farmers grow tobacco; a total of 0.38 ha and in 0.94 ha area was planted by 3 HHs in BVG and by 4 HHs in MVG.

The cropping patterns in the study area vary for self-consumption, forage and cash income from farming. In case of income, costs and benefits from crop species depends on crop land size, productivity and demand for those crops (Figure 5.4 and Annex 4). Cultivation of the described major crops provide significant savings for the farmer, the greatest benefit recorded for vegetables due to higher inputs and high demand with proper price at local and urban markets. The vegetables include carrot, onion, garlic, tomato, cabbage and paprika. However, vegetable requires more input in terms of labour than other crops. Farmers mainly grow them in their plot(s) and this calculation did not include the cost for transporting. This benefit interrelate with climatic conditions and labour, which, in turn, provide greater flexibility in their management practice. Usually, vegetables are grown in household plots, which reduce time and expenditures for harvesting and transportation.

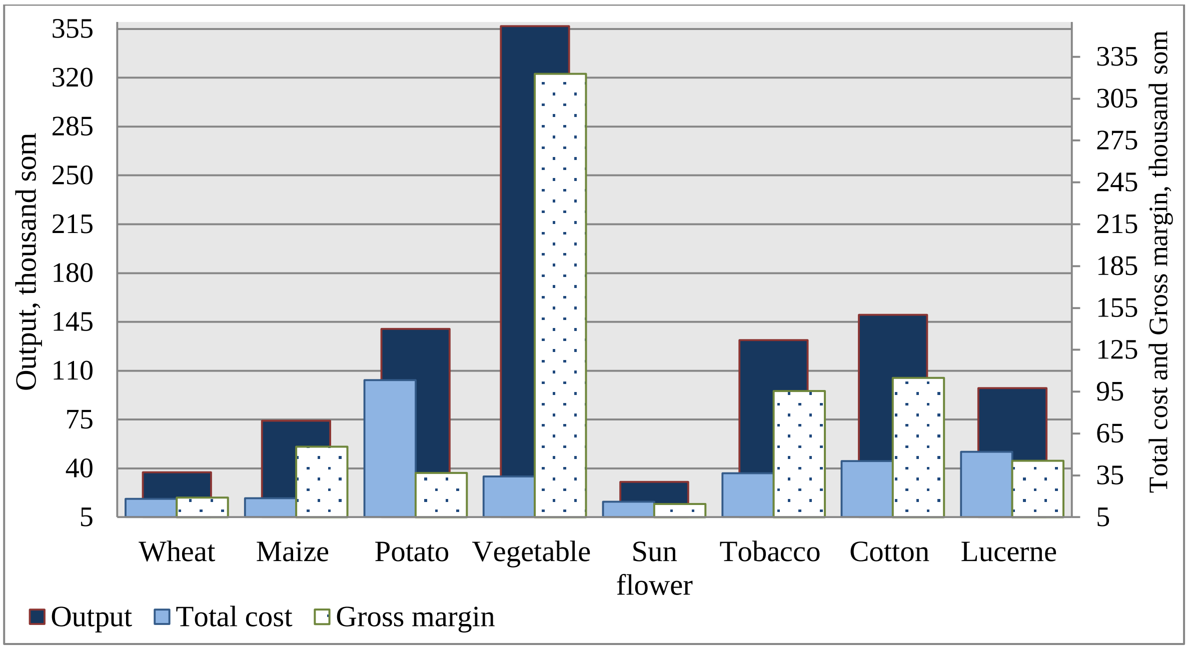


Figure 5.4 The total costs and profit margins for major crops in the study area (som/ha)
Source: Author's calculation from primary data, 2010

These costs and margins were calculated for average price of per kilogram of crops. However, majority of HHs sell their crop in autumn at lower price. In case of vegatables, the fresh types' availability is seasonal, it can be sold in summer and autumn at lower price. Because some crops need expenditure for storing during winter time and there is always high risk due to sudden cold weather. Other cash crops, such as tobacco and cotton also have higher benefits. However, they are grown by few HHs in small land sizes. Unlike these cash crops, potato has less profit with higher cost because of bought seeds from market or from other farmers. Potato can also be sold as seed in the local and neigbouring regions' markets (pers.comm., 2010). Wheat, maize and sunflower are regular crops, which are mainly grown for self-consumption and for livestock forage. These crops are grown in larger areas, even though the profits are lesser compared to other crops. In case of Lucerne, main output comes from supplied labour for three times mowing growing season, due to lack of grass cutter machinery in the study area. Instead of this outputs, it causes other dificulties such as high time consuming and being late to water for the next mowing. Such system could appeal to part-time farmers, who may not benefit directly, but rather in terms of improved labor productivity, which increase income from off-farm employment from both an economic and social context.

Farmers were asked about their perception for changes of crop yield and productivity of crop varieties during 2005-2010 in the study area.They gave different results. Majority HHs (44 HHs in BVG and 51 HHs in MVG) responded that the crop yields for major crops decreased. Fifty six HHs in BVG higher than MVG (41 HHs) had no any change in crop yield. Increase in crop yield was only in 7 HHs in BVG and 3 HHs in MVG respectively. Farmers' perception for low crop yield related problems are given in Figure 5.5.

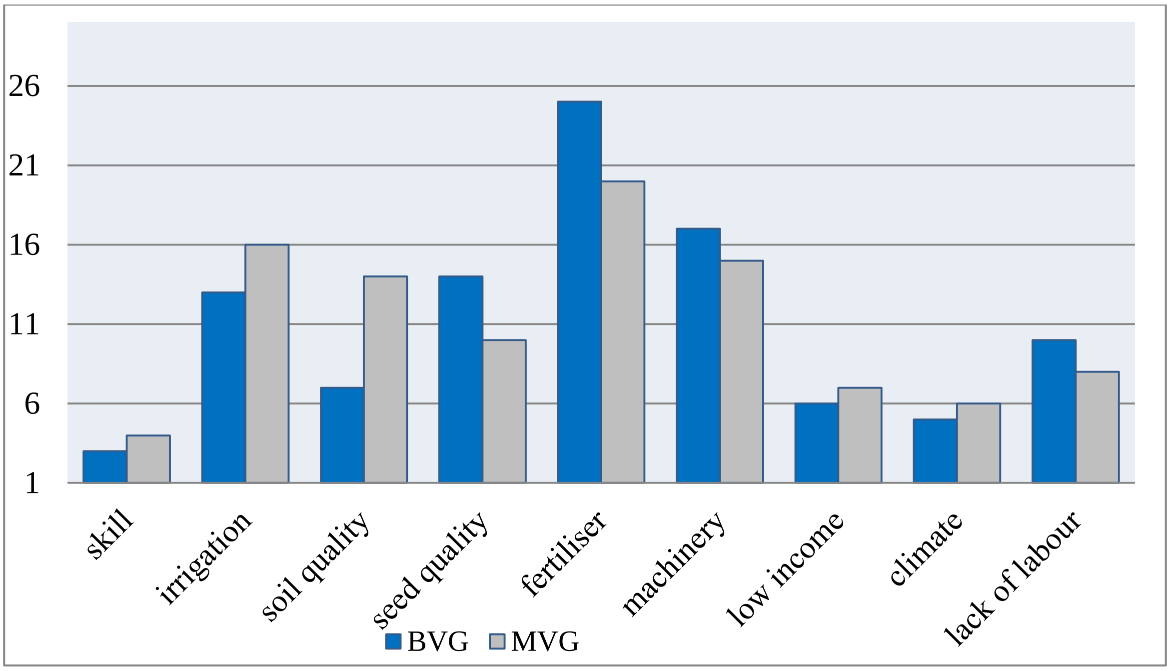


Figure 5.5 Percentage of farmers' perception for low crop yield related problems
Source: Field survey, 2010

The most important problem in both VGs was insufficient agricultural inputs, such as fertiliser (25 % in BVG and 20% in MVG), machinery (17% and 15 %) and seed quality (14% and 10%) of crops. Irrigation related problems followed those problems with 13 % in BVG and 16 % in MVG. Lack of machinery (mainly combine harvesters and mowers in both

VGs) increased problem because of shortage of labour during growing season. The low yields for wheat were attributed to changes in weather condition (continuosly occuring rain and humid condition in April and May) in the study area elevated levels of new crop diseases. As a result, farmers currently obtained skills are not enough to identify and to prevent, and to use proper chemical treatments (pers.comm.2010). As a consequence of the mild and humid weather, fungal desiseas (*Stripe rust, Stem and Leaf rust*) are a challenge to farmers. Moreover, plant diseases (mostly for maize is fungus -corn smut-*Ustilago maydis*), weeds and insects (for potato is the Colorado potato beetle – *Leptinotarsa decemlineata*, for maize and tomato is the larva of moth – *Helicovera zea*) increased due to continuos monocultural cropping in the same land area. Suddenly, a sharp increase in temperature in May and June caused unfavorable condition for seedlings; after heavy rain, soil surface become hard and seedlings cannot grow up. Thereafter, farmers have to reseed crops. However, all farmers cannot afford to reseed, due to lack of finance and machinary. Thus, cropland remains with less dencity, which leads to low crop yield. Soil quality is an important factor for crop productivity. HHs (7%) in BVG considered fertiliser insufficiency in general, whereas HHs (14%) in MVG considered physics-mechanic content of soil (stony and saline) which does not favor all crops.

5.4 Pasture Types and Condition

5.4.1 Climate

The territory of the Kyrgyz Republic can be subdivided into the following four climatic zones: The Northern and North-Western Kyrgyzstan, which include Chui, Talas and Kemin valleys embraced with mountain ridges; The South-Western Kyrgyzstan that includes Fergana, Chatkal and Alai valleys embraced with ridges; The North-Eastern Kyrgyzstan that includes

Issyk-Kul hollow embraced with mountain ridges and The Inner Tien-Shan system.

South-Western Kyrgyzstan is the warmest and dewy climatic zone, where, in contrast to the other climatic zones, a considerable proportion of precipitation falls during wintertime (Figure 5.6).

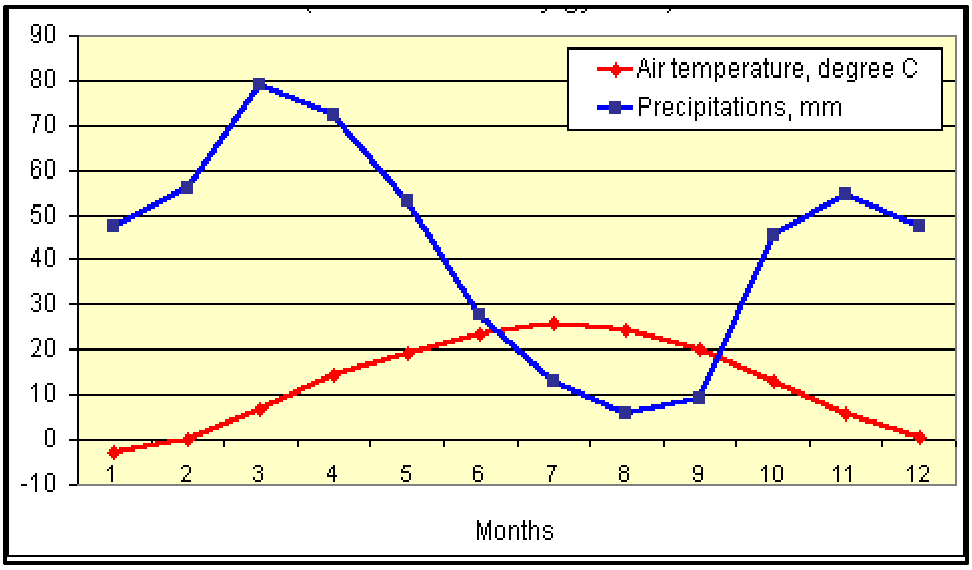


Figure 5.6 Average long-term data for Zhalal-Abad city, South-Western Kyrgyzstan
Source: UN Framework Convention on Climate Change in Kyrgyzstan, 2003

This changes in precipitation and temperature is based on the south-western part which is under the strong pressure of the southern cyclones bringing humid air while the other climatic zones experience the influence of Siberian anti-cyclones. At the foothills of Fergana valley, the average air temperature is 8 to 12°C; the average temperature of January is about -3 to -4°C; and the average temperature of July is 23 to 26°C. The absolute maximum of temperature is about 40 degrees while its absolute minimum ranges from -23°C to -29°C. The annual precipitation level at the foothills varies from 300 to 650 mm. The altitude increases, the level of precipitation also increases. At the slopes of sub-meridian ranges (Ugamskiy, Sandalshskiy, Pskemskiy, Ferganskiy and Chatkalskiy), the annual precipitation level ranges from 1,000 to 1,500 mm.; at the slopes of sub latitudinal ranges (Turkestanskiy, Alaiskiy and Zaalaiskiy) the precipitation fallout is lower (Climate of Kyrgyzstan, n.d.).

5.4.2 Biodiversity

The ecosystems represent a range from high mountains, to lowland fertile plains and large freshwater systems. The character of biodiversity in the country reflects the high altitude of much of the land, being dominated by montane and alpine species. A range of factors over the last century have had impact on biodiversity in Kyrgyzstan, resulting in declines in many groups, and leading to concern for a growing number of species, including key ones of economic importance. Seasonal pastures are formed by variable climate of certain areas (e.g. the direction of prevailing winds) and the composition of plant species adapted to grow in those particular conditions. In these areas, primary biological production – animal breeding – supports an important sector of the economy upon which the majority of the population depends. This activity, if managed appropriately, conserves vegetation cover, thereby preventing soil erosion on mountain slopes, and reducing the likelihood of flooding In total, 22 different classes of ecosystem are recorded in Kyrgyzstan (Table 5.3). Most of these ecosystems (14 or 63.6%) are found between 2000-3000 m altitude, although only 30.8% of the territory lies within this range. Furthermore, the range of ecosystems is not evenly distributed throughout the country. Sixteen ecosystems (72.7%) are found in Western and Central Tien Shan (the northern part of the study district included in this group), while the Ferghana valley (includes the southern part of the study district) and Southern Kazakhstan biogeographic region have the fewest ecosystems, three and five respectively (Figure 5.7). Thirteen ecosystems are represented in Alai, while ten ecosystems are found in other Northern Tien Shan and Issyk-Kul biogeograhic regions. A number of ecosystem types are very fragile, and are threatened by human activities.

Table 5.3 Ecosystems of Kyrgyzstan

Ecosystems	Area sq.km	%	Ecosystems	Area sq.km	%
1.Spruce forest	2,772	1	12. Cryophilic steppe	21,413	11
2. Juniper forest	2,680	1	13. Cryophilic desert	1,911	1
3. Broad-leafed forest	464	>1	14. Mid-mountain meadow	8,764	4
4. River forest (tugai)	226	>1	15. Mid-mountain steppe	17,643	9
5. Small-leafed forest	771	>1	16. Mid-mountain desert	2,543	1
6. Mid-mountain deciduous shrub land	970	>1	17. Mountainous dry-farming land (bogara)	2,791	1
7. Mid-mountain pterophilic shrub land	2,317	1	18. Foothill steppe	823	>1
8. Savannah	6,081	3	19. Foothill desert	8,768	4
9. Almond and pistachio forest	182	0.1	20. Pterophilic lowland shrub	181	0.1
10. Glacier and subglacier	11,527	6	21. Lakes and wetlands	393	4
11. Cryophilic meadow	27,242	14	22. Cultivated land	12,475	7

Source: Ministry of Environmental Protection, 1998

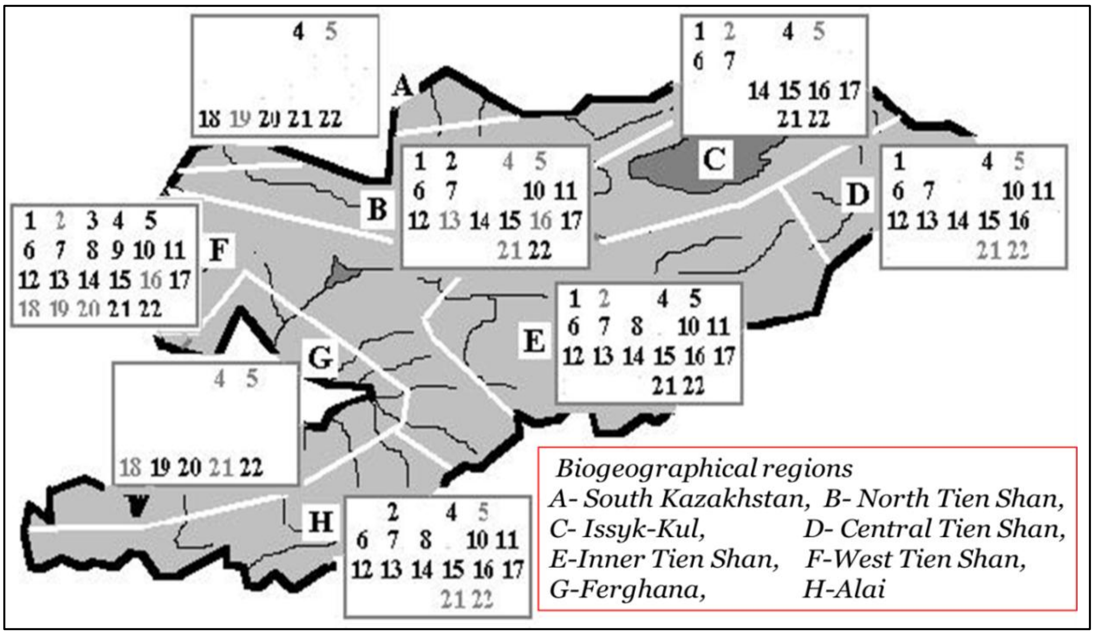


Figure 5.7 Ecosystem map of Kyrgyzstan
Source: Ministry of Environmental Protection, 1998
Note: The numbers show ecosytems (the same in Table 5.3) which are found in biogeographical regions

The most threatened ecosystems in Kyrgyzstan include the fruit and nut forests of the south (threatened by overuse), fragile mountain forest communities, steppes near large human settlements, high mountain meadows (threatened by overgrazing), and some areas of semi-desert and dry steppe (which are easily degraded through grazing, MoE, 1998). There are all kinds of soil erosions on Kyrgyzstan's territory: pasture, wind, water, irrigation surface, and ravine erosion. Now, 5302.1 thousand hectares of arable lands are exposed by erosion, including about 968 thousand hectares of arable lands, about 4544.8 thousand hectares of pasture, and about 87.1 thousand hectares of hay cultivation[15].

5.4.3 Impact of Climate Change

Climate, Land, Biodiversity, Livestock and People – interrelationship among them varies differently in different parts of the Earth. They are interdependent. Ignoring one of them causes another problem. In agro-pastoral systems social, economic, and environmental constraints cannot be solved in isolation or independently or just by providing some projects or policy intervention to one factor and it cannot give successful results. Both a rise in average temperatures and an increase of extreme weather conditions are putting pressure on biodiversity, landscape, and agriculture.

The occurrence of maximum precipitation varies significantly among different parts of the country. This has significant effect to ecosystems. There is evidence of a long-term rise in temperature that has been faster in Kyrgyzstan than in the rest of the world (the average annual temperature has risen 1.6°C in Kyrgyzstan[16] during the last century versus the global average rise of 0.6°C). According to the assessment conducted in the First Review of

[15] "Demonstrating Sustainable Mountain Pasture Management in the Susamyr Valley, Kyrgyzstan" GEF/UNDP Project, 2008

[16] Government of the Kyrgyz Republic, First National Communication of the Kyrgyz Republic under the United Nations Framework Convention on Climate Change, (UNFCCC) and Zholdosheva, 2009.

Climate Change in the Kyrgyz Republic (2003), possible climate scenarios to 2100 show average annual warming varying from 1.8 to 4.9C, and annual precipitation falling slightly (by 6%) to considerable increase (by 54%). Such important changes in climate parameters will have an impact on natural systems through various activities.

5.4.4 Pasture Types and Condition

Chapchyma (location $41^{0}25^{/}$N, $70^{0}57^{/}$E, 2500-3000 m altitude, survey area-3.2 ha, MVG) and *Chanach-Say* (*Ak Tash kungoy (*sunny side)) remote pastures (location $41^{0}34^{/}$N, $71^{0}29^{/}$E, 1800-2400 m altitude, survey area - 3.4 ha, BVG) are located in the south part of Western Tien-Shan. The main features considered were vegetation composition by altitude, utilisation and livestock species compostion by altitude. The soils of the study area mainly composed of meadow and alpine meadow soils in Chach-Say pasture, while meadow steppe soils covered large area in Chapchyma pasture (The Atlas of Kyrgyz SSR, 1987). Rock layer content of the surveyed area is mainly covered by limestone in Chach-Say (6%), whereas sandstone and other siliceous rocks cover was larger in Chapchyma (8%) pasture (Figure 5.8).

In the northern part of Chach-Say pasture, there are kinds of trees (27%) such as: firtree *Picea schrenkiana*, broad-leafed species including poplar *Popules ssp*., willow *Salix spp* in general. In the western part, with drier territories, pistachio-tree *Amuldalus communic* and walnut trees *Junglans regia* grow. On the drier mountain slopes of Chapchyma (10% of total coverage) different kinds of the wood *Juniperus spp*. occur. From the bushes, mainly *Rosacea* spp. are dominant in both pasture types. Pasture species in both area are predominatly cryophit forage species (see Annexes 2 and 3, about found forage species in surveyed area). Non-edible plants are mainly dominant in the low altitudes, such as *Artemisia* and *Stipa spp*.

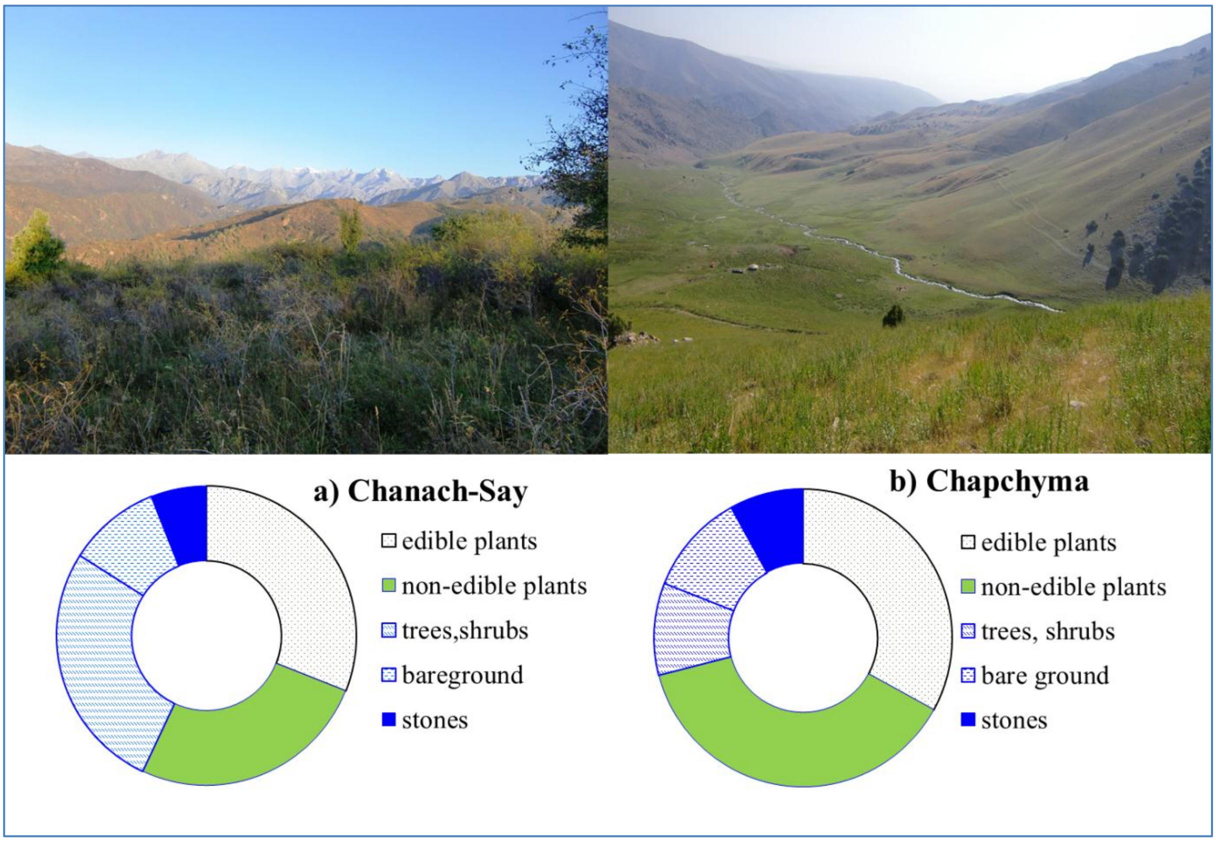
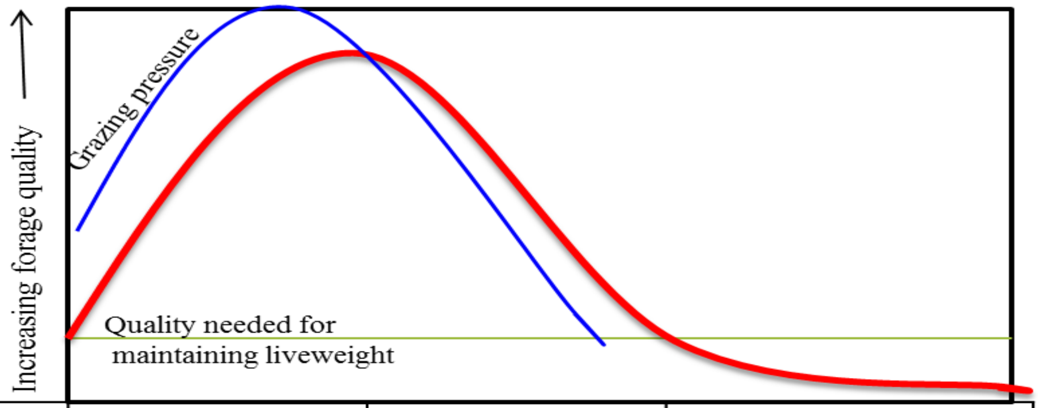


Figure 5.8 Pastures (rangelands) condition with composition profiles
Source: Field survey, August, 2010

Changes in pasture condition occur according to time of rainfall, pasture plants stage of growth, plants type (Grass vs. Forbs) and soil fertility. In poor condition, pasture areas have few non-edible grasses or bareground cover, whereas this area is larger in Chapchyma pastures (11%).

Plant growth stage is a major factor affecting forage quality (Figure 5.9). Forage quality increases rapidly from May to July in both pasture areas. As grasses mature after flowering (late July-August) their quality declines due to increase in the proportion of less digestible material. On the other hand, this change has positive effect in increase fat content of milk with decline protein content. Grazing management is important in all stages, to conserve pasture species; early movement to pasture decreases number of new growing forage species, overstocking decreases number of flowering species and continuosly raining and early



Climate	Rain, temperature	Temperature	Rain, snow temperature
Growth stage	Germination , new growth	Flowering Maturity	Drying Dry feed
Season	Midspring to midsummer	Summer, autumn	Autumn ,early spring

Figure 5.9 Forage quality changes according to climate and plant's stage of growth. Adopted from Henri et al., 1995

snowing decrease seeding of plants. Latter one is due to climate, as well as livestock is returned to villages at that time.

5.5 Pasture Management

Summer pastures are used by minority HHs (pastoralists; hired shepherds and large herd owners from G3 and G4) as part of the agro-pastoral systems[17]. To use remote pastures for grazing, herd should consist of at least 300-500 sheep and goats, 15-40 horses, 20-30 lactated cattle or 100-200 dry cattle. However, majority of HHs in G3 and G4 have more than the above numbers of livestock. Movement of HHs to pastures closely depends on income sources obtained from pasture side (Table 5.4). The main income comes from the selling of livestock and its products (in autumn) and from payment for herding. Recently, horse milk products became in high demand and more attractive for pastoral tourism, especially in summer, increased number of people in pastures, who goes to drink raw horse milk for health.

[17] According to Law on Pasture, 2009, farmers, who wants to use summer pastures, they should buy pasture ticket and the price of ticket is based on livestock number and varies among species

Table 5.4 Percentage of income sources for pastoralists

Sources	Chapchyma (MVG)	Chanach-Say (BVG)
Dairy products *	21	18
Honey	11	13
Selling animals	25	27
Medicinal herbs	6	9
Selling dung	5	3
Tourism	7	6
Selling hay	4	7
Hire for herding	14	12
Others	7	5

Source: Field survey, 2010

*It includes melted butter (*sarymay*) and its residue (*totro*), dried yogurt (*kurut),* cheese *(byshtak),* fermented horse milk *(kymyz),*and raw horse milk

This type of tourism can coincide with the selling of honey and medicinal herbs and dairy products at pasture side. On the other hand, hired shepherds increase in rural areas; 4-5 hired shepherds randomly[18] collect livestock from their own and from other villages and even other districts. Herding costs vary among species; higher in the first month for each animal; 70 (for other month 50) som[19] for per sheep and goat, 200 (250) som per cattle and 250 (300) som per horse. Due to bad animal performance in early spring, high mortality risk, less grass in pastures (too early movement) and harsh climate conditions. Sometime farmers exchange butter and other products for herding. High herding cost for sending livestock to summer pastures creates difficulties for poorer households. However, HHs, who own on average 20-25 sheep and goats, 2-5 cows, rare 1-2 horses are not able to pay for herding and livestock have to remain in near-village pastures all year round (Figure 5.10). .

[18] Divided to less labour required and more labour required; randomly collected herd composition depends on pasture topography, distance from the village and purposed livestock product types (milk products: horse and cow) and physiological state (age of animals in case of cattle). On the other hand, before the collecting animals, hired shepherds should bargain the grazing payment for each livestock species with elders of the village. They will make oral contract and some elders will be guarantor for hired shepherds, to control payments. And also those elders are make negotiation between farmers and shepherds about payment for lost animals (some animals die with different reason or become sick or stealing of animals from summer pastures and etc.)

[19] 1USD equal to 46.52 som (August, 2010)

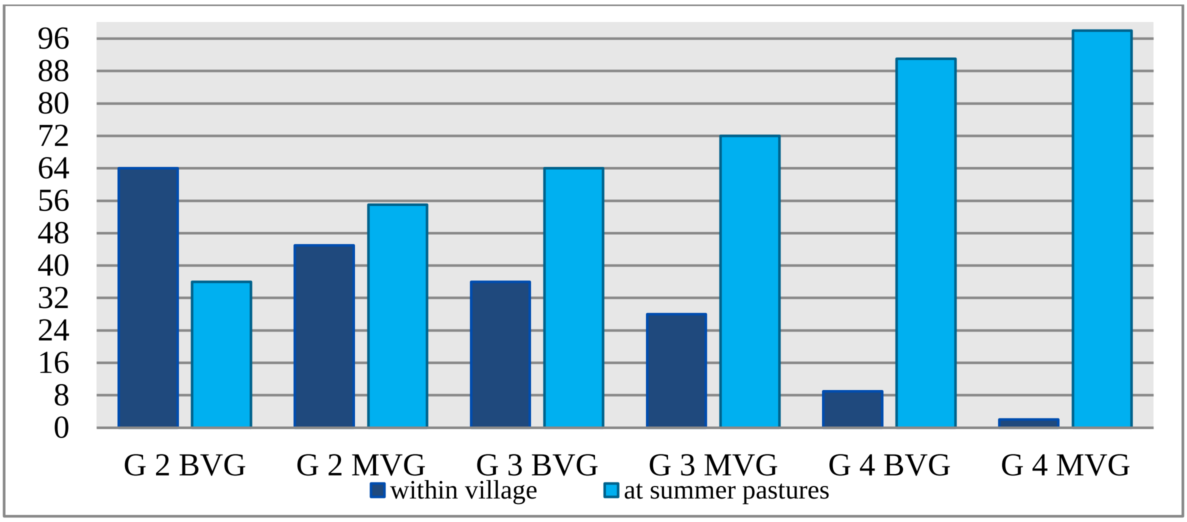


Figure 5.10 Variation in percentage of sent and retained animals during summer among Groups' categories
Source: Field survey, 2010

A high number of retained animals for all group categories are observed in BVG in general compared to MVG. Among groups a higher number are in G2 HHs in BVG (62%) and in MVG (42%). Payment of retained animals for herding in both VGs are different. Two types of herding are observed; the first *Bada* system (hired 3-4 shepherds and cowboys) from spring till autumn, ussually applied for lactated cows. And payment per lactated cow is 100 som per month. The second type of herding is *Kezuu* (Turn in rotation), every day one person from each 2-4 HHs look after the herd. HHs' number for rotation depends on herd size and season; in spring and autumn increases and in summer decreases due to availability of grasses and avoid damage of croplands.

5.6 Factors of Pasture Degradation

Definition of pasture degradation can be shown by different evidences by farmers, ecologists and policy makers. Also, a defined and quantified degree of degradation is also important for future land-use options. Pasture condition is also influenced by a combination of grazing pressure and climate. Pasture quality changes according to precipitation, pasture plants growth stage and plants types (grasses or forbs) which assess forage nutritive value. Pasture condition is related to botanical composition, cover and yield potential of the pasture, proportion of edible and non-edible plants, ground cover, woody weeds or re-growth problems and sign of erosion or soil degradation. Thus, pasture types have different levels of resilience to inappropriate grazing management and unfavorable seasons. In both pastures percentage of edible species reduce by replacing non-edible plants and bushes. Most of the researches also highlight that the main indicators of pasture degradation are overstocking and overgrazing in near village and intensive pastures (Esengulova,2007; World Bank Report, 2005; Shukurov, 2004; Zholdosheva, 2009). It was reported that lack of land availability (especially irrigated) and areas of pressure on resources are higher in Ala-Buka district than other neighbouring districts, which increase overgrazing and deforestation. New agriculture development and recent human occupation gave pressure on mountain slopes. Since this district is located on transboundary zone, the use of pasture and forest resources has international political-economical implications (EnvSecurity, 2005). However, surveys showed pasture degradation in terms of declining productivity in not stocked intensive and remote alpine Chapchyma and Chanach-Say pastures of the study area.

Quantitative assessments of pasture condition show differences between changes in 500 m altitude, in terms of total coverage, edible, non-edible plants, height of grasses and temperature (Figures 5.11 and 5.12). Average temperature decrease with altitude increase by 300 C to 210 C upto in Chapchyma pasture, while in Chanach-Say, temperature rose with increase in altitude by 14.70 C to 26.20 C. Observations show that in Chapchyma pasture, till 2750 m altitude. High temperature has significant effect on composition of plants with a few dominating heat-drought tolerated non-edible species. Beside this, the height of plants also shortened. A number of forage species increased with decrease in temperature.

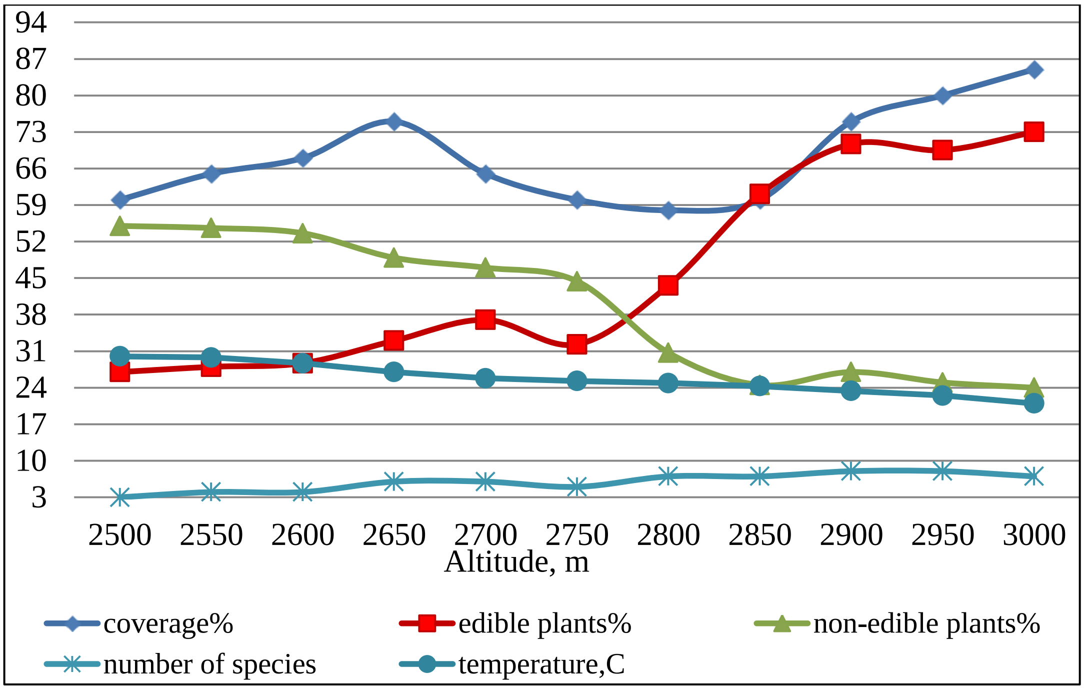


Figure 5.11 Chapchyma pasture condition, MVG
Source: Field survey, 2010

These changes marked topography of pastures, glacier surface and wind speed. Disappearing glaciers had significant effect on ecosystems in this grassland. As mentioned above, these vegetation changes also varied with annual precipitation amount. Usually, in the pasture, annual precipitation is about 600-700 mm, which mostly occurs in winter and early spring (Climate of Kyrgyzstan, 2007). In Chanach-Say, up to 2100 m altitude pasture coverage and balance of edible-and non-edible plants did not give much difference and started to decline sharply of forage species by substituting non-edible plants (Figure 5.12). For increase in temperature within increase in altitude can be explained by different reasons. Firstly, it can be a temperature inversion, an increase in temperature with height. With sufficient humidity in temperate areas, fogs present below the inversion cap.There is a relationship between surface air temperature, inversion temperature difference and inversion depth. It is clear that when surface air temperature is warm (cold), inversion depth and inversion temperature difference will be small (large).

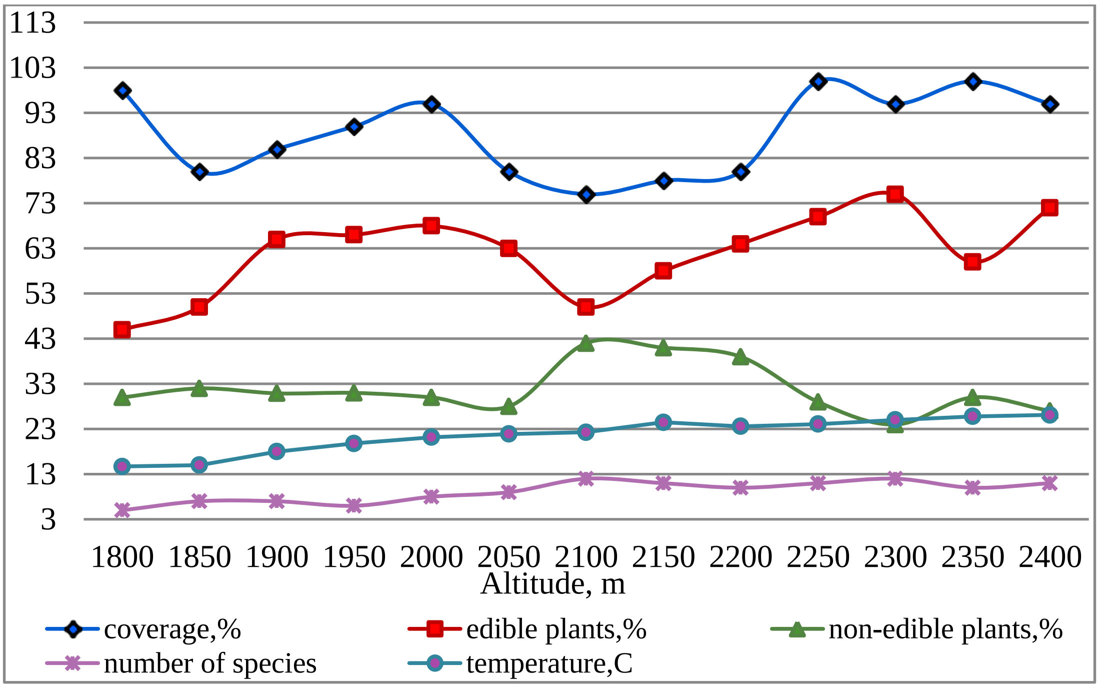


Figure 5.12 Chanach-Say pasture condition, BVG
Source: Field survey, 2010

Secondly, drying of Aral Sea brought tangible changes in climate conditions and destroyed water circulation. The increase of dust aerosols on glacier surfaces (brought with western wind) and led to intensive melting of glaciers in South-Western Tien-Shan. Sand-and-salt aerosol effects soils and pastures by replacing multilayer plant species by singlelayer species with decrease in a number of forage grasses.

A significant number of drought and heat tolerated steppe and semi-desert plants have appeared in Chapchyma pastures, while Chanach-Say pastures invaded with semi-arid zone bushes and shrubs. Relevant functions such as providing water quantity and quality, slope stability and biological processing of matter ensure ecosystem services such as cultural/medicinal plants, forage production, water infiltration and storage, nutrient retention, and insurance of catastrophic slope failure (Ministry of Environmental Protection,1998). The main indicator of pasture degradation is the changes in vegetation species composition, replacing of edible species by non edible, decreasing of coverage and biomass (Natsagdorj, 2003). During field survey, the above mentioned changes in pasture composition and conditions were observed in both pasture sides. According to results of the survey in Chapchyma pasture, pasture degradation can be classified in three groups (Figure 5.12). Light level of degradation (2700-2950 m) has no changes in biomass, but percentage of edible plants were decreased. Quantity of *Artemisia* appears by dominating in downhill pastures. Moderate level of degradation (2650-2750 m) has significant increase of *Artemisia* by moving to uphill. Decrease in numbers of total and edible species. And severe level (2500-2650 m) destroyed vegetation composition. *Artemisia* becomes dominant. *Artemisia* already moved up by 200 m in this level of degradation. Valuable forage species with affect growth stage are replaced by *Artemisia* because of drier and hotter weather, which started to increase in downhill pastures 7-8 years ago (pers.comm., 2010).

Changes in vegetation also caused by *Stipa* spp. In the north-western part of Chapchyma pasture, *Stipa kirghisorum* specie significantly increased. In moderate degradation indicated significant increase of feather grass (in some literatures mentioned as needle grass) *Stipa kirghisorum* in sunny side of pastures. It is a common forage grass in steppe regions. Feather grass is not a valuable fodder plants, and, therefore, in areas dominated by meadow vegetation, is considered as a weed. But due to its weak root system, it cannot spread on meadows for long-term. However, due to the fact that the feather is more resistant to drought than other perennial grasses, it can start to dominate the vegetation in those areas which, although they do not belong to the dry steppes. These processes affect the ecosystem, as the feather in the first place, does not form a black soil (high nutritive soil), and secondly, in its rhizomes after the end of the growing season (which ends in early enough) begins to develop fungi that produce enzymes in the soil acidic. These factors impede restoration of valuable grass after the drought. Such a process leading to degradation of vegetation in some sources called steppe or *Stipa* dominated pastureland. In the Soviet Union in areas adjacent to the feather grass steppes, the meadows were at risk of steppe, waged the struggle against this phenomenon, which consisted of periodic crops of valuable perennial grasses (especially after the drought years), as well as flooding the most arid areas (The Great Soviet Encyclopedia, 1990). Grazing on *Stipa* dominated pastures in late summer leads to feather disease - awn feather stick into the skin of animals, especially small ruminants; sheep and goats, causes its inflammation.

In case of Chanach-Say pasture, degradation levels and unbalanced composition type varied from Chapchyma pasture as shown in Figure 7. Numbers of valuable cryophilic forage species of Poacea, Asterecae, Fabaceae and Lamiacae significantly lessen. In general, there is no change in biomass, quantity of forage species decreased in uphill and replaced with mainly Rosaceae *(Rosa kokanica, Rosa maracandica, R. canina)* bushes. The recent years in downhill Artemisia covered areas enlarged. Decrease in quantity of *Juniperus* species *(J. seravschanica, J. semiglobosa* and *J. turkestanica)* raise landslides, visible soil erosion in sunny hillside by reducing temperate zones' plant density. Semi-arid and arid zones' plant species are moving up from low altitudes. Increasing temperature affect forest-grassland mixed pasture areas converting it into semi-arid steppes.Temperate zone's forage species are suffering from triple risks; overstocking, dominating non-edible plants and finally, changing climate.

Zholdosheva (2010) points out that *Juniper* (locally called *archa*) forests are important in water circulation in alpine pastures. The largest areas of *archa* forests are concentrated in Osh and Batken regions on the slopes of the Turkistan and Altai mountain ranges, but it is also found extensively in Zhalal-Abad region, in Chatkal, **Ala-Buka** and Aksy districts on mountain slopes at altitudes from 1200 to 3200 masl. Archa forests are located on steep mountain slopes and they perform important water regulation and water conservation functions, preventing soil erosion and preventing mud- and landslides. Over the last 25 years, the archa forests acreage has diminished by 18% and the rate of degradation has reached 0.8% per year. Over the last 25 years, the desertification border advanced vertically into the mountains by 500 m. One effect of the increased summer temperatures is that the archa forest ecosystem will gradually move higher, and by 2100 could be 150–200 m higher than now. According to Ionov (2004), as impact of climate change in South-Western Kyrgyzstan, desert area will move up 200 m, steppes – 250 m and for rangelands, it will be 150 m. *Artemisia-Ephemera* 'community' will dominate savannah and mid-mountain meadows. Area of deserts will increase. Annual ephemeras and ephemerides with short spring vegetation will increase. It will cause pasture shortage during dry summer and autumn by giving pressure to near-village pastures. The degradation of the mountain vegetation is caused by the progressive aridization of the mountain slope pasture lands and overall climate aridization.

There are many uncertainties in observation of climate patterns in subalpine and alpine pastures and pastoral systems. Thus many studies and observations in remote areas of Kyrgyzstan are still needed. Poor policy limits people's capacity to adapt to the changes being brought by global warming. There persists among many governments, the beliefs that local people are a problem and that their knowledge and ways of life are outdated. A set of policy narratives have remained very strong, and continues to influence how governments intervene in these areas. The need of stay above the 'carrying capacity' emphasizes the problem of 'overgrazing' and 'the tragedy of the commons'. Researches in the past 15-20 years have shown these concepts to be unhelpful. Many dryland grazing systems are well managed by local pastoral systems, given the highly uncertain patterns of rainfall (rather than overgrazing) that are primary cause of shifts in vegetation availability (Anderson, 2010).

Grazing lands - alpine pastures and meadows - are critical to both the ecological and economic functioning of mountain regions. Climate and land use change drive changes in the vegetative cover and the use of this land affecting ultimately the carbon, nitrogen and water cycles, the stability of mountain slopes and household economies (GLOCHAMORE, 2005). Changing climate presents agro-pastorals with most reflective and complicated challenges. There are few facts on how the costs and benefits of climate adaptation are scattered in reality and how greater evenhandedness can be brought into the distribution process. Valuable coping strategies of agropastorals should be strengthened by joint environmental and agrarian policy and government support as adaptive strategies to changing climate and changing ecosystems.

5.7 Conclusion

The cropping patterns in the study area vary for self-consumption, forage and cash income from farming. Majority HHs in BVG use the main land area for wheat growing, whereas in MVG, maize was grown in large areas. Wheat cropland area decreased due to lack of properly worked agriculture machines because cereals are harvested by combine harvesters, and this represents a significant loss of crop yield during the harvesting of crops. This suggests that he majority of HHs use their land for livestock forage. Thereafter, they can sell their livestock and buy wheat after harvesting with low price or wheat flour from the market. This type of purposive cropping coincides with forage crops also. Another side, lack of herbicides leads increasing weeds in crop land. The greatest benefit recorded for vegetables due to higher inputs and high demand with proper price at local and urban markets. This benefit corresponds with climatic conditions and labour, which, in turn provides greater flexibility in their management practice. Wheat, maize and sunflower are grown in larger areas, even though the profits are lesser compared to other crops. In case of Lucerne, main input is from supplied labour for three times mowing growing season, due to lack of grass cutter machinery in the study are.

The perception of HHs for the changes of crop yield and productivity of crop varieties during 2005 to 2010 in the study area gave different results. Majority of HHs responded that the crop yields for major crops decreased and only few HHs had increase in crop yield. The most important problem in decreasing crop yield was insufficient agricultural inputs, such as fertiliser, machinery and seed quality and unsatisfactory irrigation.

The data obtained from *Chapchyma* and *Chanach-Say* pasture in terms of pasture coverage are different. Chanach-Say pastures vegetation are dominated by several kinds of forage species, trees and bushes, while Chapchyma has less Juniperus numbers and mainly cryophyte forage species. Pasture degradation was also observed at non-stocked pastures. Other important differences between the two pastures are changes in temperature within altitude. In Chapchyma, temperature decreased with increase altitude, while in Chach-Say an opposite situation was observed; increasing temperature with increase in altitude. This can be one impact of climate change. Non-edible plants (*Artemisia* and *Stipa* spp.) are mainly dominant in the low altitudes in Chapchyma, while number of Rosacea and other ephemeral bushes increased in Chanach-Say pastures due to increasing temperature in mountain pastures. Changes in number of forage quality is reflected by weather condition, grazing and dominated by non-edible, steppe species. Thus, forage species are suffering from triple risks; overgrazing, dominating non-edible plants and climate change.

Summer pastures are used by two types of HHs; large herd owners-pastoralists and hired shepherds. Movement of HHs to pastures closely depends on income sources obtained from pasture side. The main income comes from the selling of livestock and its products and from payment for herding. High demand for horse milk becomes more attratictive for pastoraltourism. This type of tourism increased the selling of collected different products at pasture side. On the other hand, higher herding cost creates difficulties for poorer households and livestock have to remain in near-village pastures all year round. High number of retained animals for all group categories are observed in BVG in general compared to MVG. These high retained numbers lead to overgrazing of near-village pastures.

Chapter VI Conclusion and Recommendations

6.1 Conclusions

This research was conducted with specific objectives of studying the population and composition of livestock diversity by comparing two types of agro-pastoral systems (mainly livestock - additional crop, mainly crop–additional livestock); analysing feed types and feeding systems and derived productivity of livestock; studying cropland and pasture management by analysing economic cost-benefits from crops and measuring condition and botanical composition of pastures by assessing the extent of utilisation and examining the social and economic context of agro-pastoral systems in terms of income sources. This research highlighted the main factors affecting agro-pastoral systems by identifying constraints and opportunities.

Livestock diversity: trends in population and composition:

From the survey and analysis of livestock sector at national and district levels, it was found that the last decade has seen considerable changes taking place in livestock population, structure, and management systems in Ala-Buka district especially in mixed crop-livestock production systems, with different predominance of livestock. Change in livestock population is closely associated with land holding, forage and pasture availability. The HHs own perceptions for the changes in their herd sizes show that the total livestock population increasing in both VGs; BVG (65%) and MVG (62%). By species, cattle and goats number in MVG and sheep number in BVG change positively. The higher number of female cattle is believed to correlate with the major reason for keeping cattle, which is the milk production, which is for self-consumption, and selling in the market, and also using dung as winter fuel.

However, traditional and modern private livestock management strategies had been developed to regulate herd size based on the available fodder supplies.

Socio-economic context of production systems:

Livestock contribute 21% of household income in BVG, while in MVG is 31%. Besides, it also provide products for home consumption. Main reason of changes in herd composition was income level and market demand in general. In case of sheep, higher demand for meat led to increase in population of Gissar breed. Goats' numbers are increasing in the herds of MVG households. Less cropland area and easy access to common property pastures, well-adaptation of goats to harsh climate make goats more preferable. In future, there is an uncertainty, whether they can be replaced with cattle in rural area with improvement of welfare among rural poor.

Increase in numbers of intermediary women buyers of fresh milk and dairy products in BVG led to increase in cattle numbers in the herd, majority of which are retained in near-village pastures all year round. Horse and donkey numbers increased due to necessity of draft power in the households. The attributes of draft animals are subsidiary for agricultural machines, that help in performing plugging and threshing the land, transporting of physical products, income-employment gain (services to other farmers) and socio-cultural (nomadic culture, having a horse) and ecological services.

Feeds, feeding methods and forage shortage problems:

Forage scarcity, especially from the end of winter to mid spring is a main constraint. In addition, time shortage in hay-making in summer because of lack of labour as well as in favourable changes in pasture brought by climate change is another constraint. Declining pasture productivity was observed even in not stocked intensive and remote pastures of the study area. Thus forage species are suffering from triple risks; overgrazing, dominating non-edible plants and climate change. Forage shortage and poisonous grass species increase livestock mortality in early spring.

Forage availability and scarcity affect milk yield and made significant change in lactation curves by calving season. Numbers of cows in summer and autumn calving are lower in both VGs, even though they have significant positive changes in lactation curves. The lactation curves are very sensitive in winter and autumn calving in MVG and in winter and summer calving in BVG. Besides, majority of numbers of cows which fall into winter and spring calving season suffered from forage shortage. This affects the total milk yield at district and national levels because of the decline in milk yield as cow becomes less productive.

Land holding and changes in cropping patterns

The cropping patterns in the study area vary as for self-consumption, forage and cash income from farming. Majority of HHs in BVG use the main land area for wheat growing, whereas in MVG, maize was grown in large areas. Wheat cropland area decreased due to lack of properly working agricultural machines because cereals are harvested by combine harvesters and this represents the loss of significant crop yield during the harvesting of crops. This suggests that the majority of HHs use their land for livestock forage. Thereafter they can sell their livestock and buy wheat after harvesting with low price or wheat flour from the market. Lack of herbicides leads increasing weeds in crop land.

In case of income, costs and benefits from crop species reflected by crop land size, productivity and demand for those crops. The greatest benefit recorded for vegetables is due to higher inputs and high demand with proper price at local and urban markets. This benefit corresponds with climatic conditions and labour, which, in turn, provide greater flexibility in their management practice. In case of Lucerne, the main input is from supplied labour for three times mowing growing season due to lack of grass cutter machinery in the study area.

The perception of HHs for the changes of crop yield and productivity of crop varieties during 2005-2010 in the study area give different results. Majority of HHs responded that the crop yields for major crops decreased and only few HHs had increase in crop yield. The most important problem in decreasing crop yield was insufficient agricultural inputs, such as fertiliser, machinery and seed quality and unsatisfactory irrigation. The low yields for all crops were attributed to changes in weather condition in the study area increased new crop diseases. Suddenly a sharp increase in temperature in May and June caused unfavourable condition for seedlings, which decreased crop yield.

Pastures condition and factors of pasture degradation:

Grazing lands; alpine pastures and meadows, are critical to both the ecological and economic functioning of mountain pastures and settlements. Pasture degradation was also observed at non-stocked pastures. Non-edible plants (*Artemisia* and *Stipa* spp.*)* are mainly dominant in the low altitudes in Chapchyma, while a number of *Rosaceae* and other ephemeral bushes increased and number of *Juniperus* spp. significantly reduced in Chanach-Say pastures due to increasing temperature in mountain pastures. Thus, forage species in pastures are suffering from triple risks; overgrazing, dominating non-edible plants and climate change.

Pasture management:

Summer pastures are used by two types of HHs; large herd owners-pastoralists and hired shepherds. Movement of HHs to pastures closely depends on income sources obtained from pasture side. The main income comes from the selling livestock and its products (in autumn) and from payment for herding. On the other hand, a higher herding cost creates difficulties for poorer households and livestock have to remain in near-village pastures all year round. High number of retained animals for all group categories are observed in BVG in general compare to MVG. These retained numbers leads to overgrazing of near-village pastures.

6.2 Recommendations

Livestock and forage, its derived productivity issues

Inputs and outputs from livestock are related to household welfare. At the same time household welfare depends on livestock number and its productivity. On the other side, increase in livestock numbers in the study area is related to livestock revolution in developing countries.

- Increased number of livestock mainly based on the pastures availability; natural resource based livestock keeping requires the consideration of winter forage and to increase the amount of stored forage. Thus, the early movement to pastures reduces and prevents overgrazed based pasture degradation. Households need training skills on how to improve feed quality and feeding conditions.
- Send animals to summer pastures and improve its utilisation; it will reduce labour for stall feeding, who can then be involved in other farm or off-farm activities.
- Some households informed about trades of livestock fodder as additional income. This suggests the necessity of support for enhancing forage trading at local and national levels
- Livestock population and productivity can be improved by involving artificial insemination (AI) and basic information on tackling some diseases. On the other hand, it reduces the expenses for keeping bulls and diseases caused by natural breeding.
- Improved marketing and processing-market chains for livestock products will increase net return from livestock.

Land management and cropping patterns

Majority of households informed that lack of agriculture machines, fertilisers; insufficient irrigation and increasing plant diseases were the main problems in their farming activities.

- Mostly agricultural machines are very old and consume a lot of fuel, and they were mainly designed to be use in large land areas of state-owned enterprises. They are uncomfortable for individual sector's small land size. Modern individual sector needs mini tractors and combine harvesters for the efficient use of land and harvest crops on time, and it require less amount of fuel.
- Depending on chemical fertilisers is from former farming methods; the price of fertilisers and unavailability during growing season cause difficulties for the majority of HHs. The study suggests the provision of trainings on how to prepare farm yard manure (FYM) and compost.
- Insufficient irrigation is caused not only by bad conditions of irrigation-drainage systems and pump stations, but also by ineffective use of available water in marginalised croplands by small land size. If 100 litres of water was enough for irrigating 10 ha land on the whole by collective farms during the Soviet time, now it is not enough for 10 ha land, which was distributed at least to 10-12 HHs. On the other hand, different crops require different time for water, which cause other difficulties for farmers. This cause late sowing and harvesting and conflicts between farmers. The study suggests the establishment of cooperatives to rationally use the land and water resources to improve rural livelihood.
- Increasing plant diseases are caused by changing weather conditions and by monoculture crops. A research is required on the vulnerability and adaptive capacity of farmers to climate change and the suggestion of new crops. There may be potential to introduce leguminous crops after the major crops harvesting, which produce green fodder and improve soil quality. Also trainings on rotational and intercropping and use of organic pesticides to decrease crop diseases and weeds are needed.

- Since Kyrgyzstan is temperate zone country, there are some positive effect of climate change on horticulture and farming. This requires more research.

Pastures and pasture management

The results of this study show that the factors of pasture degradation are caused by overgrazing, climate change and effect of drying Aral Sea.

- Early movement of livestock to pastures has negative impact on vegetation and preliminary degradation of pastures. As a result, forage scarcity in early spring will cause early movement of livestock to near-village and intensive pastures. At this time, the soil is usually soft because of the recently melting snow, and rains are frequent. At the same time, the plants must have an opportunity to produce leaves and strengthen their root systems; otherwise their subsequent growth will be reduced. The study suggests the increase of winter forage or to reduce numbers of animals in the herd and to move to pastures at the appropriate time to make better use of their potential.
- Rotational grazing and reducing number of animals in near-village pastures during summer can be one of the solutions of preventing pasture degradation. The increase of livestock numbers in remote pastures (Chanach-Say pastures) can control the bush dominated areas.
- It requires deep research on pasture condition and grazing management; how climate change impact on ecosystems and mountain pastures. The study suggests a research on the socio-economic context and vulnerability of pastoralists.
- Recently, a demand for horse raw and fermented (*kymyz*) milk at pasture side of the study area is increasing. Besides, visitors can buy organic products (grazing based livestock products, honey and medicinal herbs). The study suggests improving pastoral tourism in in this area; providing services by pastoralists and conservation of

natural resources. This can also be a good source for ethnobotanical research and conserving traditional knowledge in pastoralists' livelihood.

Annexes

Annex1. Chronology of land legislation in Kyrgyzstan

Reform phases	Date	Name of Legislation
First phase	Feb 1991	Law on Peasant Farms (superseded by 1999 law)
	Feb 1991	Law on Enterprises
	Apr 1991	Law of Land Reform
	Apr 1991	Measures for Implementation of Land Reform
	Jun 1991	Land Code (superseded by 1999 code)
	Dec 1992	Measures for Continuing Implementation of Land and Agrarian Reform
	May 1993	New Constitution of KR
Second phase	Feb 1994	Measures on Deepening Land and Agrarian Reform
	Mar 1994	Creation of the National Land Fund (later renamed Land Redistribution Fund)
	Aug 1994	Procedures for Implementation of Land and Agrarian Reform
	Aug 1994	Procedures for Reorganization of Agricultural Enterprises
	Aug 1994	Procedures for Land Share Determination and Issue of Land Use Certificates
	Jun 1998	Referendum on Private Landownership (leading to a new constitution)
	Oct 1998	Presidential Decree on Private Land Ownership
	Dec 1998	Law on State Registration of Immovable Property Rights and Transactions in Them
	May 1999	Law on Mortgage (Ch. 6: Special features of land mortgage)
	Jun 1999	Land Code (superseded the 1991 code)
	Jun 1999	Law on Peasant Farms (supersedes the original 1991 law)
	Jan 2001	Law on Agricultural Land Management: lifting the moratorium on land sales (Mar 2001)
	Jan 2002	Law on Access to Pasture
Third phase	Apr 2004	New Directions and Measures of Land and Agrarian Reform
	Jun 2004	Law on Cooperatives
	Jun 2007	Standard Procedure for Agricultural Land Leasing from the State Redistribution Reserve
	Oct 2008	Tax Code (Section XIV, Chapters 48-51): Land Tax
	Jan 2009	New Law on Pastures

Annex 2 List of major pasture plants found in Chapchyma and Chanach-Say pastures

Scientific name	English	Russian	Family	Pasture type
Artemisia cina O. Berg & C.F.Schmidt	Santonica, sagebrush	Полын цитварная	Asteraceae	*I*
Artemisia maritime L.	Sea wormwood	Полынь приморская	Asteraceae	*I,N, R*
Artemisia sogdiana	Sogdiana mugwort	П. согдийская	Asteraceae	*I*
Artemisia tenuisecta Nevski	Nevski wormwood	П.тонкорассеченная	Asteraceae	*R,I*
Alcea nudiflora (Lindl.) Boiss.		Шток-роза голоцветковая	Rosaceae	*I,N*
Alchemilla retropilosa Juz.	Lady's mantle	Манжетка	Rosaceae	*R*
Alopecurus pratensis L.	Meadow foxtail	Лисья хвость луговая	Poaceae	*I,N*
Artemisia dracunculus L.	Tarragon	Полын эстрагон	Asteraceae	*R,I*
Artemisia ferganensis Krask & Polyakov	Fergana mugwort	Полын ферганская	Asteraceae	*R,I*
Artemisia vulgaris L.	Common wormwood, mugwort	Полын обыкновенный	Asteraceae	*R,I*
Bothriochloa ischaemum (L.) Keng	Yellow bluestem,Turkistan bluestem	Туркестанская плодоножка	Poaceae	*R,I*
Bromopsis inert	Hungarian brome	Кострец	Bromeliaceae	*R*,I*
Bromopsis ramosa	Hairy brome	Кострец	Poaceae	*R,I*
Calamagrostis epigejos (L.) Roth	Wood small-reed	Ве́йник назе́мный	Poaceae	*I*
Chorispora elegans	Mustard family’	Хориспора	Brassicaceae	*R,I*
Cichorium intybus L.	Chicory	Цикорий обыкновенный	Asteraceae	*I,N*
Cynodon dactylon (L.) Pers	Bermudagrass (devil grass)	Свиноро́й па́льчатый, пальча́тник	Poaceae	*R,I,N*
Dactylis glomerata L.	Cocks foot	Ежь сборный	Poaceae	*R*
Descurainia Sophia (L.) Webb. ex Prantl	Herb sophia	Дескурения Софии или гулявник	Brassicaceae	*R,I,N*
Dichodon cerastoides	Starwort mouse-ear chickweed	Ясколка	Caryophyllaceae	*R,I*
Elymus dasystachys	Wildrye	Дикая рожь	Poaceae	*I*
Elytrigia repense (L.)	Couch grass	Пыре́й ползу́чий	Poaceae	*I*
Elytrigia trichophora (Link) Nevski	Piliferous bluegrass	Пырей волосоносный	Poaceae	*R,I*
Epilobium palustre L.	Marsh willowherb	Кипрей	Onagraceae	*R,I*
Eremurus altaicus (Pall.) Steven	Foxtail lilies, desert candle	Еремурус алтайский	Asphodelaceae	*R,I*
Erigeron speciosus	Aspen fleabane	Мелколепестник	Asteraceae	*R*
Festuca kryloviana	Krylov fescue	Овсяница Крылова	Poaceae	*R,I*
Festuca valesiaca Gaud.	Volga fescue	Овсяница (betege)	Poaceae	*R,I**

Geranium himalayense Klotzsch	Himalayan crane's-bill	Герань гималайская	Geraniaceae	*R*
Geranium pretense L.	Meadow crane's-bill	Герань луговая	Geraniaceae	*R*
Glycyrrhiza glabra L.	European licorice	Солодка голая	Fabaceae	*I,N*
Hordeum bulbosum	Bulbous barley	Ячмень луковичный	Poaceae	*R,I*
Hordeum turkestanicum Regel	Turkistan barley	Ячмень туркестанский	Poaceae	*R,I*
Hypericum perforatum L.	Common St. Johnswort	Зверобой продырявленный	Hypericaceae	*R,I,N*
Inula rhizocephala	Inula'	Девясил	Asteracea	*R,I,N*
Lagotis korolkowii Maxim.	Lagotis'	Логотис	Scrophulariaceae	*R*
Ligularia alpigena Pojack	Ragwort	Бузульник высогорный	Asteraceae	*R*
Medicago lupulina L.	Black medick	Люцерна серповидная	Fabaceae	*I*
Melilotus officina-lis (L.) Desr	Yellow Sweetclover	Донник лекарственный,	Fabaceae	*I,N*
Origanum vulgare L.	Oregano	Душица обыкновенная	Lamiaceae	*R,I*
Oxytropis rosea Bunge	Rosea Bunge	Остролодочник	Fabaceae	*R,I(ende mic)*
Phleum phleoides	Timothy	Тимофеевка	Poaceae	*R,I*
Phlomoides oreophila	Oreophila (mountain loving)	Зопник	Lamiaceae	*R*
Poa angustifolia L.	Narrow-leaved meadow-grass	Мятлик	Poaceae	*I,N*
Poa litvinoviana	Glaucous bluegrass	Мятлик сизый	Poaceae	*I*
Poa nemoralis L.	Wood bluegrass, wood meadow grass	Мятлик дубравный	Poaceae	*I,*
Poa pratensis L.	Kentucky Bluegrass	Мятлик луговой	Poaceae	*R,I*
Potentilla nivea L.	Snow cinquefoil	Лапчатка	Rosaceae	*R*
Prangos pabularia Lindl.	Prangos forage	Прангос кормовой	Apiaceae	*R,I*
Ptilotus obovatus F. Muell.	Silvertail	Птилотус серебристый	Amaranthaceae	*I*
Stipa kirghizsorum L.	Feather grass, needle grass	Ковыл, чий кыргызов	Poaceae	*R,I*
Trisetum spicatum L.	Northern oat grass	Трищетинник	Poaceae	*R,I,N**
Ziziphora pedicellata Pazij et Vved.	Thymus	Зизифора ложноножковая	Lamiaceae	*R,I*
Trifolium pratense L.	Red clover	Клевер луговой, или красный	Fabacea	*I,N*
Trifolium repens L.	White clover	Клевер ползучий, или белый	Fabacea	*I,N*
Note: R-remote, I- intensive, N- near-village pastures, * - grows only in limited areas of pastures, with dominating numbers				

Annex 3. Dominated near-village pasture plants: weeds, poisonous and harmful plants

Scientific name	English name	Russian name	Family	Poisonous level
Silybum marianum (L.) Gaertn.	Variegated thistle	Расторóпша пятни́стая	Asteraceae	Poisoning can occur, sheepand cattle are allowed to access to large amounts of plant or when conditions are suitable for the plant to accumulate nitrates(herbicides can increase nitrate content)
Xanthium pungens Nallr.	Noogoora burr	Дурнишник	Asteraceae	Harmful plant, hooks clinging to passing animals, vegetable faint and low price of wool. Poisonous when seedling is two leave stage (cotyledons acute liver damage)
Xanthium spinosum L.	Bathurst burr	Дурнишник игольчатый	Asteraceae	Weed
Atriplex muelleri Benth.	Mueller's saltbush	Солянка Мюллера	Chenopodiaceae	Grows in high saline soils, hungry or travelling stock may suffer poisoning on pastures flushed with new growth of it. Death from nitrate poisoning is rapid while the effects of oxalate poisoning are prolonged
Chenopodium album L.	Fat hen	Солянка	Chenopodiaceae	the nitrates in the plant can be converted very efficiently to nitrites in the rumen of cattle, leading to changes in hemoglobin and reducing the ruminants' oxygen binding capacity.
Neobassia proceriflora F. Muell.	Soda bush	Солянка степная	Chenopodiaceae	Prefer clay soils and saline or scalded areas. Especially the pasture has been overgrazed Often grazed without ill effect. However, it can be poisonous, occurs mainly with hungry, inexperienced stock, particularly after travelling or being released from yards.
Sclerolaena birchii *S.lanicuspis* F.Muell. *S.muricata* (Moq.)	Galvanised burr Woolly copperburr Black roly-poly	Оцинкованная Шерстистый меди заусенцев Черный Сайкин	Chenopodiaceae	Dense stands of these plants indicate a recent history of disturbance by drought and or overgrazing. The plants increase in a run of wet winters after drier summers. Harmful for wool.
Swainsona microphylla (A.Gray)	Small-leaved Darling pea	Мелколиственн ый горох	Fabaceae	Affected animals are said to be "pea struck". All parts of the plant poisonous at all growth stages. Signs take several weeks to develop. Loss of condition, nervous signs,easily excited, head-shaking, staring eyes and uncoordinated gait. Pregnant cows may abort or deliver short-lived calves.
Abutilon leucopetalum (F. Muell.)	Desert Chinese lantern or Flannel weed	Китайский фонарик или фланели	Malvaceae	Can dominate pastures near stock camps
Hibiscus trionum L.	Bladder ketmia	Гибискус тройчатый, или	Malvaceae	It is often a weed in cultivation but is not aggressive

		гибискус северный		
Malva parviflora L.	Small-flowered mallow	Мальва	Malvaceae	Weed. The plant can be toxic to sheep, cattle, horse and poultry. Poisoning occur where large amounts of plants Have been consumed. Lambs are most susceptible
Haloragis odontocarpa F. Muell.	Mulga nettle or Raspweed	Малга крапивы или рашпиль	Haloragaceae	Weed
Salvia reflexa Hornem	Mintweed	Шалфей	Lamiaceae	It is serious weed in cultivation, poisonous. Poisoning due to nitrates in the plants.
Portulaca oleracea L.	Pigweed	Портулак огородный	Portulacaceae	However oxalate or nitrate poisoning occurs when hungry or travelling stock it alone.
Tribulus terrestris	Caltrop or goathead or cat-head	Я́корцы стéлющиеся	Zygophyllaceae	Cause liver damage, when rarely grazed when little other feed aviable. It can either cause staggers or photosensitisation in sheep and goats.
Papaver rhoeas L.	Corn poppy, red weed	Мак самоцветка	Papaveraceae	The leaves and latex have an acrid taste and are mildly poisonous to grazing animals
Sorghum halepense (L.) Pers.	Johnson grass	Сóрго алепское, Гумай	Poacea	Johnson grass has been used for forage and to stop erosion, but it is often considered a weed for the following reasons:Foliage that becomes wilted from frost or hot dry weather can contain sufficient amounts of hydrogen cyanide to kill cattle and horses if it is eaten in quantity. The foliage can cause 'bloat' in such herbivores from the accumulation of excessive nitrates; otherwise, it is edible .It grows and spreads so quickly that it can 'choke out' other cash crops that have been planted by farmers.
Stellaria graminea L.	Grass leaf starwort	Звездчатка злаковидная	Caryophyllaceae	Weed
Critesion murinum subsp.glaucum (Steud.) W.A.	Northern barley grass	Ячмень заячий	Poaceae	Harmful grass. Well grazed during autumn and winter before the sharp bristles of seed heads develop. The seeds penetrate the skin of sheep particularly their mouths and eyes and can be fatal. They also cause vegetable contamination of wool

Annex 4. An economic cost-benefit analysis of major crops cultivation (1 hectare) in study area (price for items is given for 2010)

No	Activities and cost	Amount and cost	Crop varieties							
			Winter wheat	Maize	Potato	Vegetable	Sun flower	Tobacco	Cotton	Lucerne
1	Ploughing	Labour payment, som/ha	550	550	550	550	550	550	550	550
		Diesel fuel, 35 l/ha	1225	1225	1225	1225	1225	1225	1225	1225
2	Levelling (Harrowing)	Labour payment, som/ha	250	250	250	250	250	250	250	250
		Diesel fuel, 10 l/ha	350	350	350	350	350	350	350	350
3	Sowing	Labour payment, som/ha	300	300	300	300	300	300	300	300
		Diesel fuel, 7 l/ha	245	245	245	245	245	245	245	245
4	Row bedding	Labour payment, som/ha	200	200	200	200	200	200	200	200
		Diesel fuel, 7 l/ha	245	245	245	245	245	245	245	245
	Total cost for land preparation	Labour payment, som/ha	1300	1300	1300	1300	1300	1300	1300	1300
		Diesel fuel, 59 l/ha	2065	2065	2065	2065	2065	2065	2065	2065
		Total cost	**3365**	**3365**	**3365**	**3365**	**3365**	**3365**	**3365**	**3365**
5	Intercultural operations 1*	Labour payment, som/ha		150	150	150	150	150	150	
		Diesel fuel, 10 l/ha		350	350	350	350	350	350	
6	Intercultural operations2	Labour payment, som/ha		150	150	150	150	150	150	
		Diesel fuel, 10 l/ha		350	350	350	350	350	350	
7	Intercultural operations3	Labour payment, som/ha			150	150		150	150	
		Diesel fuel, 10 l/ha			350	350		350	350	
8	Intercultural operations4	Labour payment, som/ha			350	350		350	350	
		Diesel fuel, 10 l/ha			150	150		150	150	
	Total cost for cultivation			**1000**	**2000**	**4000**	**1000**	**2000**	**2000**	
9	Seed	Sown kg/ha	300	20	3000	5	15	0.1	60	20
		Price per kg, som	15	20	25	600	45	9000	65	150
		Total price, som	**4500**	**400**	**75000**	**3000**	**675**	**900**	**4000**	**3000**

10	Fertiliser	Required kg/ha	300	300	400	500	250	400	400	300
		Price per kg, som	15	15	15	15	15	15	15	15
		Total price, som	4500	4500	6000	7500	3750	6000	6000	4500
		Application payment	200	200	200	200	200	200	200	200
		Total cost, som	**4700**	**4700**	**6200**	**7700**	**3950**	**6200**	**6200**	**4700**
11	Pesticide Herbicide	Total price per ha/som	600	600	1000	1000	400	600	1000	
		Spreading payment	200	200	200	200	200	200	200	
		Total cost, som	**800**	**800**	**1200**	**1200**	**600**	**800**	**1200**	
12	Water	Each time payment, som	45	100	100	100	100	100	100	100
		Total payment	**135**	**300**	**400**	**400**	**300**	**700**	**800**	**400**
13	Harvesting	Total cost	3000	5000	10000	10000	3000	9000	12000	15000
14	Transporting	Total cost	700	1000	3000	3000	1000	3000	5000	8000
15	Cleaning	Total cost	300	500	500	500	500			
16	Land tax		306	306	306	306	306	306	306	306
17	Social Fund		306	306	306	306	306	306	306	306
18	Other expenses			1000	1000	8000	1000	10000	10000	16888
19	**Total cost, som (1+18)**		**18112**	**18677**	**103207**	**42777**	**16002**	**36577**	**45177**	**51965**
20	Crop yield ton/ha		2.4	5.5	10	17	1.9	2.4	2.5	13
21	Cost per kg/ yield	100%	**7.56**	**3.39**	**10.32**	**20.08**	**8.42**	**15.24**	**18.07**	**39.97**
22	Market price of crops, som/kg	min	6	5	8	7	12	45		
		max	25	22	20	35	20	65		
		average	**15.5**	**13.5**	**14**	**21**	**16**	**55**	**60**	**7.5**
23	Output	Min price	14400	27500	80000	116000	22800	108000		
24	Gross margin	Min price	-3712	8823	-23207	76223	6798	71423		
	Output	Max price	60000	121000	200000	595000	38000	156000		
	Gross	Max price	41888	102323	96793	552223	21998	119423		
23	**Output**	Ave price	**37200**	**74250**	**140000**	**354000**	**30400**	**132000**	**150000**	**97500**
24	**Gross margin**	Ave price	**19088**	**55573**	**36793**	**314223**	**14398**	**95423**	**104823**	**45535**

***-** this activity includes hoeing, weeding and threshing

References

Abdurasulov, Y. (2009). *Condition of Agrarian Sector of Kyrgyzstan.* Bishkek: AKIpress.

Adam,B.A.,Young,A.M.Nicol and Degen,A.A. (1984). Energy Costs of Eating in Cattle Given Diets of Different Form. *Animal Production*, 38:53-56.

ADB. (2007). *The Kyrgyz Republic Natural Resource Sector Study* .

AFFRCS. (1999). *Japanese Feeding Standard for Dairy Cattle.* Tokyo: Japan Livestock Industry Assosiation.

AFRC. (1993). *Energy and Protein Requirements of Ruminants.* London, UK: CAB International.

Ajibekov, A. (2005). Animal Husbandry in Kyrgyzstan. *Strategies for Development and Food Security in Mountainous Areas of Central Asia* (p. Paper 5.). Dushanbe: GTZ.

Alymeev,A. Abdurasulov,A.H. Nogoev,A.I. Toygonbaev,S. Catkankulov,E. Jeenbekova,B. (n.d.). *Charachteristics of Southern Kyrgyzstan's goat breeds and types* . Bishkek.

Anderson, G., Cunningham, C., & Heishman, J. (1966). A Comparison of Three Methods of Feeding Hay to Wintering Yearling Cattle. *Agricultural Experiment Station,West Virginia University*, 534:5-8.

Anderson, S. (2010). Climate Change for Agrarian Societies in Drylands:Implications and Future Pathways. In R. a. Mearns, *Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World* (pp. 199-227). Washington: The World Bank.

Anvar, M. P., Cain, P. R., Kahn, M., Abdallah, M., & Babarences, M. E. (2009). Factors Affecting the Shape of the Lactation Curve in Pakistan. *Pakistan Journal of Zool. Suppl.Ser, N9*, 201-207.

Aydaraliev, A. (2001). *Mountains of Kyrgyzstan.* Bishkek.

Balyan, G. (1978). *Forage Plants ofKyrgyz Republic: its cultivation in acclimatized deserts, semideserts and steppes.* Frunze: Kyrgyzstan.

Beever,D.E. and Thomson, M.J. (1985). The Digestion of Fresh Perennial Ryegrass and White Clover by Grazing Catttle Fed Indoors. *British Journal of Nutrition*, 54:763-775.

Beever,D.E.,Terry,R.A. and Wallace, A.S. (1978). The Digestion of Spring and Autumn Harvested Perennial Ryegrass by Sheep. *Journal of Agricultaural Science, Cambrige*, 90:463-470.

BetaA.Miller. (2001). *Empowering Women to Achieve Food Security Rights to Livestock.*

Blummel,M., Wright,I.A. and Hegde,N.G. (2010). Climate Change Impact on Livestock Production and

Adaptation Strategies: A Global Scenario. *Lead Paper, ISDA, India*, 136-147.

Borril, M. (1976). Temperate Grasses. Lollium Festuca Dactylis, Phleum, Bromus in N.W.Simmonds, ed.Evolution of Crop Plants. *Longman Group LTD, London*, 137-142.

CACILM. (2005). *National Framework Program, Kyrgyz Republic.* Bishkek: http://www.adb.org/Projects/CACILM/milestones.asp.

Cees da Haan, P. G. (2010). Structural Change in the Livestock Sector. In H. M. Steinfel, *Livestock in a Changing Landscape Volume 1* (pp. 35-51). Washington /Covelo/London : Island Press.

Chilonda, P. a. (2006). *Indicators to monitor trends in livestock production at national, regional and international levels.* Rome: FAO, Animal Production and Health Division, Livestock Research for Rural Development 18(8) .

Commitee, N. S. (2004). *Kyrgyzstan in Figures.* Bishkek: NSC,KR.

Correa, J. E. (1999). *Grazing Systems.* Alabama and Mandauburn Universities.

CSIRO. (1990). *Feeding Standards for Australian Livestock Ruminants.* Australia: CSIRO Publication.

DA. (2010). *The passport of Ala-Buka District.* Ala-Buka: DA, District Administration of Ala-Buka.

DADD. (2009). *Report on Agrarian Sector of Ala-Buka District -2010.* Ala-Buka District Department of Afrarian Development.

Delgado,C.,Rosegrant, M.,Steinfeld,H. Ehui,S. and Courbois,C. (1999). *Livestock to 2020: The Next Food Revolution.* Washington,DC: IFPRI,FAO,ILRI. Agriculture and the Environment Discussion Paper.

Dijkman, J. (2000). Researchand Development Challenges in Livestock Production Systems: A Report of the E-Conference. In P. M.-S. Tulachan, *Contribution of Livestock to Mountain Livelihoods* (pp. 109-123). Kathmandu: ICIMOD.

Djikman, J. (1999). *Livestock Production in Areas of High Pressure Crop-Livestock Farming Systems in the East African Highlands.*

Dufrasne,I., Gielen,M., Limbourg,P., Hornick,J.L. and Istasse, L. (1994). Effects of Inclusion of a Grazing Period on performance of Fattening Bulls. In L. a. Mannetje, *Grassland and Society* (pp. 224-226). European Grassland Federation.

ECE, U. (2009). *Kyrgyzstan:Environmental Performance Review.* Geneva.

Environment and Security,OSCE, NATO,UNDP, UNEP. (2005). *Environment and Security: Central Asia - Ferghana Valley.*

Esengulova, J. A. (2007). *Community Management of High -Alpine Grasslands in the Kyrgyz Republic: Social, Economic and Ecological Implications.* Bishkek: Public Fund 'Ak Terek'.

FAO. (1994). *The State of Food and Agriculture.* Rome: FAO,Agriculture Series, No. 27.

FAO. (2007). *The State of the World's Animal Genetic Resources for Food and Agriculture, 550 pp.* Rome: FAO.

FAO. (2010). *Climate Change Impacts on Forest Management in Eastern Europe and Central Asia.* . Rome: Forests and Climate Change Working Paper 7.

FAO, Suttie,J.M.Reynolds,S.G. (2003c). *Transhumant Grazing Systems in Temperate Asia.* Rome: FAO Plant Production and Protection Series No.31.

FAO/WFP. (2010). *Crop and Food Security Assessment Mission in Kyrgyzstan.* Rome: FAO and World Food Programme.

Farrell, D.J., Leng,R.A. and Corbett, J.L. (1972). Undernutrition in Grazing Sheep,II. Calorimetric Measurements on Sheep Taken from Pasture. *Australian Journal of Agricultural Research*, 23:466-509.

Farrington, J. (2005). De-development in Eastern Kyrgyzstan and Persistence of Semi-nomadic Livestock Herding. *Nomadic Peoples*, 9(1-2):171-197.

Fitzherbert, A. (2005). *Country Pasture/Forage Resource Profiles.Kyrgyzstan. Grassland and Pasture Crops.* Bishkek: FAO.

GEF/UNDP. (2008). *Demonstrating Sustainable Mountain Pasture Management in the Susamyr Valley, Kyrgyzstan.* Bishkek.

Ghosh, A. (2003). *Role of Cooperative on Dairy Development and Its Impacts on Rural Income Generation in Bangladesh.* Higashihiroshima: Hiroshima University, GS for IDEC.

GLOCHAMORE. (2005). *Global Climate and Mountain Regions: An Integrated Assessment of Causes and Consequences* .

Goat Handbook, G. F. W. Haenlein; R. Caccese; U. Delaware, Newark. (1992). *Goat Handbook.* USA: Agricultural Research Service, USDA.

Gosregistr. (2009). *Information about land.* http:/www.gosreg.kg: Gosregistr, KR.

Graham, N. (1980). Variation in Energy and Nitrogen Utilization by Sheep between Weaning and Maturity. *Australian Journal of Agricultural Research*, 31:335-345.

Graham, N. (1985). Draught Animal Power for Production. *Australia Center Integrated Agricultural*

Resource and new Zealand Society of Animal Production, 96-108.

Greenhalgh, J.F. and Wainman, F.W. (1972). The Nutritive value of Processed Roughages for Fattening Cattle and Sheep. *Proceedings of the British Society of Animal Production.*, 61-72.

Hennessy,D.W., Williamson,J.V., Kempton,T.J. and Leng,R.A. (1983). The Roles of Enegrgy or Protein -rich Supplements in the Subtropics for YoungCattle Consuming Basal Diets Those are low in Digestible Energy and Protein. *SASAS*, 100:657-666.

Henry,D.R.Hall,T.J.,Jordan, D.J.,Milson, J.A.,Schefe,C.M.,Silcock,R.G. (1995). *Pasture Plants of Southern Inland Queensland.* Queensland: Department of primary Industries.

Hodgson and White. (1999). *New Zealand Pasture and Crop Science.* Oxford University Press.

Hugo Li Pun and Victor Mares. (2000). The Sustainable Development of Mountain Regions: A Paradigm Shift and New Considerations. In *Contribution of Livestock to Mountain Livelihoods, Chapter 2.* (pp. 35-43). Kathmandu, Nepal: ICIMOD.

IFAD. (1995). *Common Property Resources and the Rural Poor in Sub- Saharan Africa.* Rome.

IFAD. (1999). *Integrated Feed and Livestock Production in the Steppes of Central Asia.* Rome: IFAD, Livestock and Rangelend Related Technical Assistance Grant.

IFAD. (2004). *Livestock Services and the Poor a Global Initiative Collecting, Coordinating and Sharing Experiences.* 152 p. www.ifad.org/lrkm/book/english.pdf: IFAD, DANIDA, The World Bank. .

Ionov, P. (2004). *Vulnerability and Adaptation of Plant Species and Communities to Climate Change.* Bishkek: UDK528:581.524:577.41.

IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability;Summary for Policy Makers.* http://www.ipcc.eg/SPM13apr07.pdf.

Jensen and de Wit. (1996). *Livestock and the Environment: Finding a balance..*. Rome: FAO, Corporate Document Repository.

Jodha, N. S. (2000). Livestock in Mountain/Highland Production Systems: Challenges and Opportunities. ICIMOD.

Kamidi, R. E. (2005). A Parametric Measure of Lactation Persistency in Dairy Cattle . *Livestock Production Science, ILRI, No 96*, 141-148.

Kaufmann and Mohamed Saleem. (2000). Animal Agriculture and Watershed Management: Reconciling Public and Private Good. In *Contributioon of Livestock to Mountain Livelihoods, Chapter 15* (pp. 203-221). Kathmandu: ICIMOD.

Kerven, C. (2005). *Cashemere Marketing: A new Income Source for Central Asian Livestock Farmers.*

Kerven,C.,Alimaev,I.,Behnke,R.,Davidson,G.,Franchois,L.,Malmakov,N., Mathijs, E., Smailov, A., Temirbekov,S. and Wright,I. (2004). Retraction and Expansion of Flock Mobility in Central Asia: Costs and Consequences. *African Journal of Range and Forage Science*, 21(3):91-102.

KR, U. (2005). *Global Environmental Conventions:Crossectoral Interaction and Capacity Building in Kyrgyzstan.* Bishkek.

Kristjanson, P. (2004). *Pathways out of poverty in Western Kenya and the Role of Livestock.* PPLPI, Working Paper, 14.

Lemus, R. and Brown, K. (2008). *Feeding Small Ruminants: Developing a Grazing System for Sheep and Goats* . Mississippi State University, Cooperative Extension Service.

Leng, A. (1993). Quantitative Ruminant Nutrition -A Green Science. *Australian Journal of Agricultural Research*, 44:363-380.

Leon-Velarde and Quiroz, P. Z. (2000). Sustainability Concerns of Livestock-Based Livelihoods in the Andes. In *Contribution of Livestock to Mountain Livelihoods* (pp. 183-201). ICIMOD.

Lerman, Z. (2009). *Agrarian Reforms in Kyrgyzstan Achievments and the Unfinished Agenda.* FAO, Regional Office for Europe and Central Asia Policy Studies on Rural Transition No.2009-1.

Lushihin, M. (1959). *The Kyrgyz Fine-fleece Wool Sheep.* Frunze: Kyrgyz State Printing.

Ly,C.,Fall,A. and OkikeI. (2010). West Africa. The Livestock Sector in Need of Regional Strategies. In P. H. Gerber, *Livestock in a Changing Landscape. Volume 2.* (pp. 27-54). Washington: IslandPress.

Lynch,J.J.,Brown,G.D. and Donnelly J.B. (1972). The Effect of Withholding Drinking Water on Wool Growth and Lamb Production of Grazing Merino Sheep in a Temperate Climate. *Australian Journal of Agricultural Research*, 23:659-668.

Marston, H. (1948). Energy Transaction in Sheep I.The Basal Heat Production and the Heat Increment. *Australian Journal of Science Research B.*, 1:91-129.

MEA. (2005). *Ecosystems and Human Well-being: Our Human Planet. Summary for Decision Makers.* The Millenium Assessment, http://www.milleniumassessment.org.

Mendelsohn,R. and Dinar,A. (2008). *Climate Change and Agriculture. An Economic Analysis of Global Impacts, Adaptation and Distributional Effects, pp.20-42.* MA, USA: Northampton.

Messerli, B. (1998). *Mountains-Global Priority.* Moscow: Neosphere.

Miller, D. (2001). *Sustainable Development of Mountain Ranglands in Central Asia:an update from the*

Kyrgyz Republic.

Minezawa, M. (2002). *Cattle Genetic Resources in Japan: One Successful Crossbreeding Story and Genetic Diversity Erosion.*

Ministry of Environmental Protection, K. (1998). *Kyrgyz Republic Biodiversity Strategy and Action Plan.* Bishkek.

Moe,P.W.,Flatt,W.P. and Tyrrell,H.F. (1970). Energy Metabolism of Farm Animals. In A. a. Schurch. Juris Druck: Zurich.

Mould,F.L., Orskov, E.R. (1983/1984). Manipulation of rumen fluid pH and its Influence on Cellulosis in Sacco Dry matter Degradability and the Rumen Microflora of Sheep Offered either Hay or Concentrate. *Animal Feed Science and Technology*, 10:1-14.

Mount,L.E., Brown,D. (1982). The Use of Meteorological records in Estimating the Effects of Weather, on Sensible Heat Loss from Sheep. *Agricultural Meteorology*, 27:241-255.

Natsagdorj. (2003). *Impact of Recent and Past Climate Change on Climate Extremes and Climate Variability in Mongolia:Potential Impacts of Climate Change, Vulnerability and AdaptationAssessment for Grassland Ecosystem and Livestock Sector in Mongolia project.* UlaanBaatar: AIACC Annual Report.

Nazarkulov, A.N. Mukashev, Z.M. and Nurdinov M.S. (2003). *The Aikol meat-greasy pedigree group.* Bishkek: KNII Animal Huzbandry, Veterinary and Pastures, UDK 636.082.11 No.25-2003.

Nazarkulov, K. (2009). *Animal Husbandry in Kyrgyzstan. Condition, Problems and Ways of Improvement.* Bishkek: MAWRPI, Bishkek www.agroprod.kg.

Nogoev, A. (2008). *Selectional-technological Methods of Increasing Beef Production in Kyrgyzstan.* Bishkek: Kyrgyzstan.

Nori, M. a. (2007). Change of Wind or Wind of Change? *Climate Change, Adaptation and Pastoralism. The World Initiative for Sustainable Pastoralism.* Nairobi: IUCN.

NRC. (1981a). *Effect of Environment on Nutrient Requirements of Domestic Animals.* National Research Council, Washington DC.

Peeters, A. (2004). *Wild and Sown Grassess. Profiles of a temperate species selection: ecology, biodiversity and use.* Rome: FAO and Blackwell Publishing.

Pender, J. .. (2006). *Strategies for Sustainable Land Management in the East African Highlands.* Washington,D.C.: International Food Policy Research Institute.

Poppi,D.P., Minson,D.J. and Ternouth,J.H. (1981). Studies of Cattle and Sheep Eating Leaf and Stem Fraction of Grassess,II. Factors Controlling the Retention of Feed in the Rectilo-rumen. *Australian Journal of Agricultural Research*, 32:109-121.

Project, C. A. (n.d.). *Agriculture Sector of Kyrgyzstan*. http://www.centralasia-biz.com/cabiz/.

Reid,J.T.,White,O.D., Anrique, R. and Fortin, A. (1980). Nutritional Energetics of Livestock: Some present boundaries of knowledge and future research needs. *Australian Journal of Animal Science*, 51:1393-1415.

Rinne, K., Suvitie,M. and Rinne, S.L. (1992). *Indoor Feeding or Grazing*. Agricultural Research Center, North Savo Research Station, Finland.

Ruth,B. Franziska,K.Brigitta,A.Gabriele,C.Willy,T. (2008). Vegetation History of the walnut forests in Kyrgyzstan(Central Asia):natural or anthropogenic origin? *Quatemary Science Reviews*, 621-632.

Schmidt, P. (1969). *Behavior of Cattle in a Hot Dry Climate*. University of New England, Master Thesis.

Seinfeld,H., Gerber,P., Wassenaar, T., Castel, V., Rosales, M.,De Haan,M. (2006). *Livestock's Long Shadow: Environmental Issues and Options*. Rome, Italy: FAO.

Sere,Steinfeld. (1996). *World Livestock Production System: Current status, issues and trends*. Rome: FAO Animal Production and Health Paper 127.

Sheets,W. and Tuckwiller,R.H. (1926). *Effect of Winter Rations on Gains of Calves marketed as 3 years-old Steers, 1431:5-11*. USDA, In Cooperation with the West Virginia Agricultural Experimental Station.

Shukurov, E. (2004). Ecologcal Value of the Kyrgyzstan's Forests and the State Support for Their Preservation. *Regional Forest Congress*. Bishkek.

Sileshi, Z., & Tegegne, A. (2000). Challenges and Opportunities for Livestock Development in the highlands of Ethiopia. In P. M.-H. Tulachan, *Contribution of Livestock to Mountain Livelihoods* (pp. 95-102). Kathmandu: ICIMOD.

Silva, F., G., B. M., & Ponte, R. (2011). Estimation of the Milk Production Function: Application of the Incomplete Gamma Function in the Sao Miguel Island (Azores). *Centro de Estidos de Economia Aplicado do Atlantico, CEEAplA WP 16*.

Singh, M. (2007). *Contribution of Farming on Rural Livelihood in Nepal: Focusing on Dairy Farming in Chitwan*. Higashihiroshima: Hiroshima University, GS for IDEC.

Singh, V. (1999). *Draught Animal Power in MOuntain Highland Agriculture: Issues and Options*. India:

GB Pant University of Agriculture and Technology.

Southcott, W.H. and McClymont,G.L. (1960). Drought Feeding of Cattle II. Comparison of daily and weekly feeding of all-grain rations: with observations on Vitamin A status. *Australian Journal of Agricultural Research*, 11:445-456.

Squires, V.R. and Wilson,A.D. (1971). Temporal Patterns of Activity in a Small Flock of Merino Sheep as Determined by an Automatic Recording Technique. *Australia Journal of Agricultural Reasearch,* 22:283-90.

Staal, S. J., & Jabbar, M. A. (2000). Markets and Livestock in the Coming Decades: Implications for Smallholder Highland Producers. In P. M. Tulachan, M. A. Saleem, J. Maki-Hokkonen, & T. Partap, *Contribution of Livestock to mountain Livelihoods Chapter 4.* (pp. 57-71). ICIMOD.

Steinfeld, H. S. (2010). *Livestock in a Changing Landscape.* Washington: Islandpress.

Sulastri, E. (2007). *Dairy Development in Indonesia: Role of Dairy Cooperative in Developing Dairy Farming of Daerah Istimewa YogyaKarta, PhD, Thesis.* Hiroshima University, IDEC.

Tashi, N., & Partap, T. (2000). Livestock Based Livelihoods in Tibet, China, and Sustainability Concerns. In P. M. Tulachan, M. A. Saleem, J. Maki-Hokkonen, & T. Partap, *Contribution of Livestock to Mountain Livelihoods: Research and Development Issues* (pp. 171-183). Kathmandu: ICIMOD.

Taylor, P. (2009). *Methods of Change and Financial Performance of Dairy Farms Before and After a Switch to Management Intensive Grazing.* Plan B Paper.

The Great Soviet Encyclopaedia. (1929-1990). Moscow.

The Atlas of Kyrgyz SSR. (1987). Moscow: Atlas Kirgizskoy SSR, in Russian.

Thornton, T. (2002). *Mapping Poverty and Livestock in the Developing World.* ILRI.

Tulachan, P. (1998). *Gender Differences in Livestock Production Management in Chitwan Diostrict of Nepal.* Kathmandu: ICIMOD.

Tulachan, P. (2000). Livestock Production and Management Strategies in the Mixed Farming Areas of the Hindu Kush-Himalayas, Asia. In P. M.-S. Tulachan, *Contribution of Livestock to Mountain Livelihoods: Research and Development Issues* (pp. 123-135). Kathmandu: ICIMOD.

Tulachan, P. (2000). Livestock Production and Management Strategies in the Mixed Farming Areas of the Hindu Kush-Himalayas,Asia. In P. M.-S. Tulachan, *Contribution of Livestock to Mountain Livelihoods: Research and Development Issues* (pp. 123-135). Kathmandu: ICIMOD.

UNCCD. (2006). *National Report of the Kyrgyz Republic on Implementationof UNCCD.* Bishkek.

UNDP, K. (2005). *Functional Review of the Ministry of Ecology and Emergency Situations of the Kyrgyz Reoublic.* Bishkek.

van Veen, T. (1995). *The Kyrgyz Sheep Herders at a Crossroads.* Pastoral Development Network,Series 38.

Wendy, B. (2005). *Kyrgyz Herds:A Report to Investigate Ways to Improve Productivity.*

Wood, P. (1967). Algebraic Model of the Lactation Curve in Cattle. *Nature, London*, 216:164-165.

Wood, P. (1969). Factors Affecting the Shape of the Lactation Curve in Cattle. *AnimalProduction*, 11:307-316.

World Bank. (2000). *Livestock Development: Implications for Rural Poverty, the Environment, and Global Security.* World Bank.

World Bank. (2005). *Kyrgyz RepublicLivestock Sector Review: Embracing the New Challenges.* World Bank.

Wright, I., & Duncan, A. (2005). *Livestock, Fodder, Pastures and People An Integrated Study in the Northern Areas of Pakistan.* Kathmandu, Nepal: ICIMOD.

Zapata, A. (1997). *Systems of Milk Production in the Andean Regions: A Paradigm Shift and New Considerations.* Colombia: Fundation CIPAV.

Zarate, A. (2000). Livestock biodiversity in Mountains/Highlands - Opportunities and Threats. In *Contribution of Livestock to Mountain Livelihoods, Chapter 5* (pp. 71-83). ICIMOD.

Zhang,Y., Kurokawa, Y., Motobayashi,T., Kamada,T., and Itabashi,H. (2008). Rumen Fermentation, Blood Metabolism and Milk Production by Dairy Cows Fed Rice Whole Crop Silage. *The Japanese Journal of Animal Hygiene*, 34:51-59.