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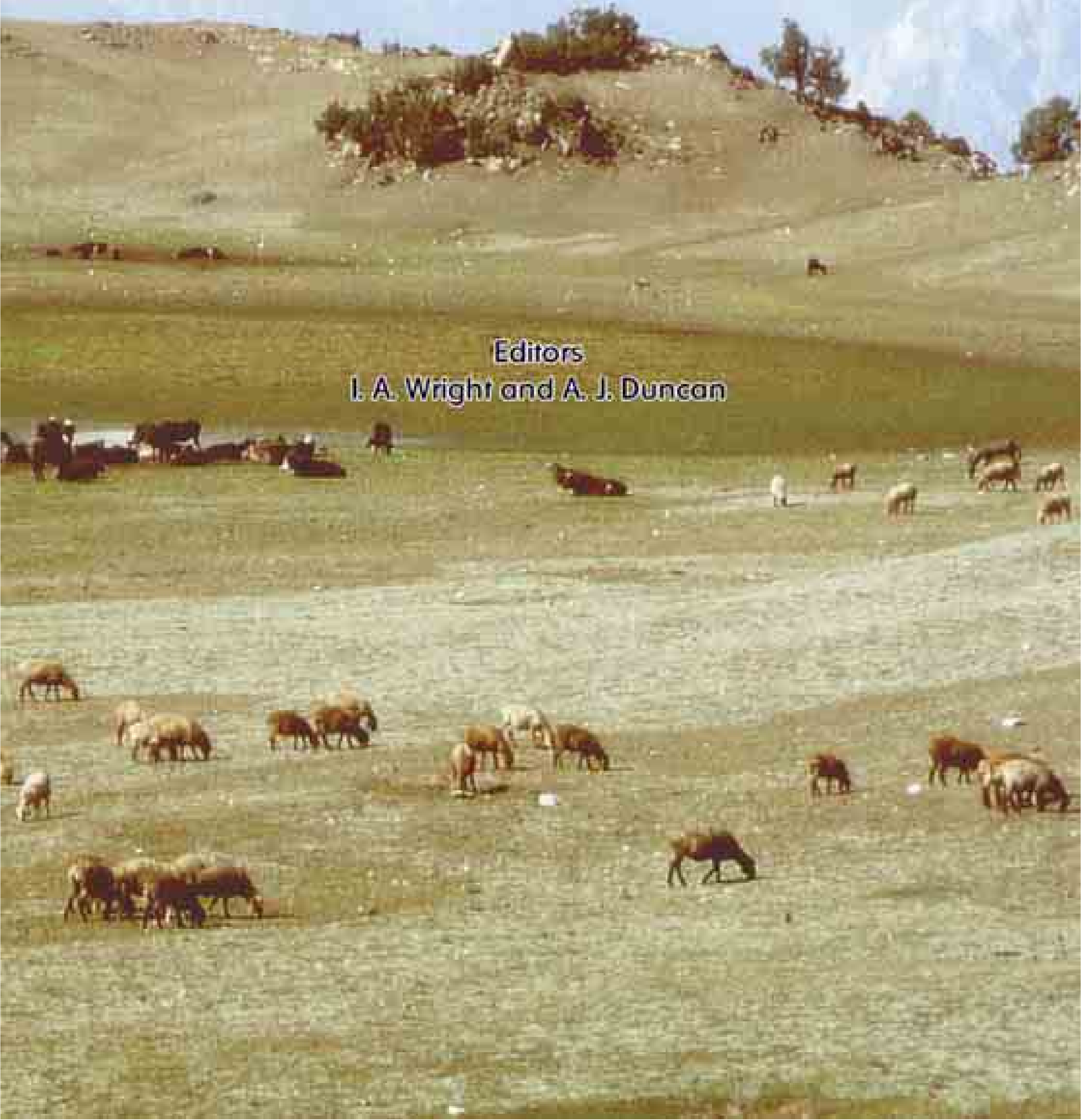
Livestock, Fodder, Pastures and People

An Integrated Study in the Northern Areas of Pakistan



Editors
I. A. Wright and A. J. Duncan

About the Organisations

The **International Centre for Integrated Mountain Development** (ICIMOD) is an independent 'Mountain Learning and Knowledge Centre' serving the eight countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and the global mountain community. Founded in 1983, ICIMOD is based in Kathmandu, Nepal, and brings together a partnership of regional member countries, partner institutions, and donors with a commitment for development action to secure a better future for the people and environment of the Hindu Kush-Himalayas. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations.

The Macaulay Institute is a scientific research organisation based in Aberdeen, United Kingdom. We bring together many disciplines to develop a better understanding of the environment and society's interactions and impacts on it; the quality and relevance of our work have established the Institute as a premier centre for land use research in Europe. The Institute's goal is "research today for land use tomorrow".

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- quality of life, the public good and wealth creation,
- the impact of land use on environmental quality, and
- evaluating the trade-offs between the environmental, economic and social objectives of land use.

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Editors’ Preface

In 1998 a research project began to study the possibilities for improving livestock productivity in the Karakoram Mountains in Northern Pakistan. The project, known as the Agri-Karakoram Project, aimed to examine the constraints to livestock production and to explore ways of overcoming some of those constraints while sustaining the fragile mountain ecosystem. The research was funded by the European Commission under the INCO-DC programme and involved seven organisations:

- The Macaulay Institute, United Kingdom,
- Spanish Council for Scientific Research (Consejo Superior de Investigaciones Cientificas), Spain,
- Department of Geography, University of Bonn, Germany,
- The Aga Khan Rural Support Programme, Pakistan,
- Pakistan Forest Institute, Pakistan
- Pakistan Agricultural Research Council, Pakistan, and
- International Centre for Integrated Mountain Development, Nepal.

This book represents the outcome of that project. It describes the research process, summarises the findings by identifying some of the key biological and socioeconomic constraints to the improvement of livestock productivity, and suggests ways in which some of those constraints may be overcome. We thank ICIMOD for making their facilities and expertise available to publish the findings.

Although the project was undertaken in Northern Pakistan, we believe that some of the principles identified are of wider relevance to other similar mountain agricultural systems. The project ended in 2002, the International Year of the Mountains. We hope that the findings in this book will make a small contribution to the livelihoods of mountain people in general and to those in the Karakoram Mountains in particular.

We dedicate the book to all those in Northern Pakistan who contributed to the project, but particularly to the people of Bunji, Minapin, Morkhun, Bargo-Bala, Gahkuch-Bala, and Darkut, and to the numerous staff of the Aga Khan Rural Support Programme who participated in many ways.

Iain Wright
Alan Duncan
The Macaulay Institute

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The editors and authors of this book thank the European Commission INCO-DC programme for funding this project; we are particularly grateful to Mr Dirk Pottier of the European Commission for his support and guidance during the conduct of the project. We wish to thank Professor Ehlers (University of Bonn) for academic background and support to the socio-economic studies. We are also grateful to the staff at ICIMOD, and in particular A. Beatrice Murray, Dharma R. Maharjan, and Matthew Zalichin for undertaking the technical editing, design layout, and distribution of this book. We owe our sincere thanks to the many staff from the Aga Khan Rural Support Programme who assisted in many ways to make the project possible, often under difficult circumstances. Above all, we owe very sincere thanks to the many people in the communities and in different government and non-government institutions who provided not only data and local expertise, but also showed such generous and welcoming hospitality to us all.

Executive Summary

The Northern Areas of Pakistan is a mountainous, semi-arid region. Livestock are an important component of the local economy and are managed according to a system of transhumance. Animals are kept in villages in the valleys over winter where they subsist on a diet of cereal crop residues and alfalfa, while in the summer they are moved to high pasture areas. The area has undergone rapid change over the last 20 years as a result of the construction of the Karakoram Highway, as well as of the activities of the Aga Khan Development Network and other agencies. A multi-participant research project was established in 1998 to assess the impact of development change on the livestock sector. The objective of the project was to examine the influence of infrastructural change on livestock management with a view to suggesting ways of improving livestock-dependent livelihoods while sustaining the fragile natural resources in the region. The study was carried out in villages from two geographical transects, differing in ease of access, and from three agro-ecological zones. The Karakoram Highway transect (KKH) ran along the Karakoram Highway and benefited from the associated improvements in infrastructure. The Gilgit-Ghizer Region transect (GGR) was mainly served by unmetalled roads with a less-developed communication infrastructure. The project focused on (1) livestock production and nutrition, (2) pasture resource utilisation, and (3) socioeconomic aspects of livestock production.

The results on livestock production and nutrition showed that among the major stored feeds, wheat straw was used in highest quantity, followed by alfalfa, maize stovers, and wild grass. Overall, the average liveweight and body condition scores were highest in late summer and then declined, reaching the lowest levels in February. The summer maxima were higher in the GGR transect than in the KKH transect. The households in the GGR transect kept more livestock, but the amount of feed resources stored for use over winter relative to herd requirements for maintenance were significantly lower than in the KKH transect. In winter, livestock in the GGR transect lost liveweight and body condition faster than in the KKH transect. Also, average milk production per mature adult cow was greater, and reproductive efficiency higher, in the KKH than in the GGR transect. The amount of fodder sold was significantly higher in the GGR than in the KKH transect.

The pasture ecology component of the project emphasised the important role that pastoral resources play in the overall livestock enterprise. Until now there has been little information available on the nature of the pasture resources and the extent to which they are over- or under-utilised. The project classified the vegetation communities present in the Northern Areas for the first time. Pasture productivity was found to be low on foothill rangelands, intermediate on dry-temperate pastures, and high on alpine pastures. There was also a change in

vegetation type from predominantly shrub-based vegetation on foothill and dry-temperate pastures to a vegetation resource dominated by grasses and forbs on alpine pastures. Seasonal data on pasture utilisation indicated that production and utilisation were reasonably well-matched on alpine pastures, but that a potential biomass surplus existed on dry-temperate pastures in spring. The utilisation of alpine pastures appeared to be lower in the KKH transect than in the GGR transect, suggesting that more animals could be grazed on the KKH pastures. Quantitative data on the seasonal availability of biomass for utilisation by livestock will help to inform decisions about potential changes to patterns of pasture management. Such information is particularly important with current changes in traditional patterns of transhumance which are being driven by external changes such as improved infrastructure, and educational and off-farm employment opportunities.

The final component of the project addressed socioeconomic and external issues surrounding livestock production in the Northern Areas. An important focus of this part of the research was on farmers' perceptions of opportunities and constraints in the livestock subsector. The results showed that farmers keep livestock for a number of reasons with milk and dung production being high among their priorities.

Various external factors are currently leading to changes in farm economies, especially the introduction of cash cropping, such as potato production, and improvement of access to off-farm employment and education facilities. In areas where these pressures are most acute, such as along the KKH transect, this is leading to a change in the role of livestock within the household economy. Increased off-farm employment and increased levels of education are reducing the availability of labour for tending livestock. The livestock sub-sector, however, appears to have been insulated from increased accessibility to markets, since animal products tend to remain within farm households. Improved infrastructure appears to have led in some cases to reductions in utilisation of alpine pastures with animals being stall-fed throughout the year near homesteads. In spite of growing demands within the region for meat and milk, only a few livestock owners have thus far started regular marketing of animal products.

The picture that emerged from the project is of an area undergoing transition. Livestock production remains a very important component of the household economy in this mixed mountain agricultural system. Infrastructural development, while opening marketing channels, also appears to have improved opportunities for non-livestock related activities, with the result that farmers in the KKH transect in particular appeared to be less heavily dependent on livestock production than those in the GGR transect. Despite this, production efficiency appeared to be higher and more seasonally stable in the KKH transect even though animal numbers were lower.

There is both a quantitative and qualitative shortage of fodder in winter and a number of ways have been identified to alleviate this shortage. Little attention, however, has been paid to ways of improving the utilisation of the grazed pasture in spring and summer which could ensure maximum recovery of body condition of livestock in summer and so reduce winter feed requirements; this is an area that deserves further research. Since individual livestock production in many cases is low, there may be a case for reducing livestock numbers per household, but this may conflict with traditional or cultural requirements. Currently most livestock products stay within the household and there is considerable scope for improving the commercial aspects of livestock production, including their marketing.

The project has identified a number of constraints and options for the future development of the livestock subsector in the Northern Areas of Pakistan. What is now needed is adaptive, participatory, action research to develop the most promising of those actions.

Acronyms and Abbreviations

AKRSP	Aga Khan Rural Support Programme
AOAC	Association of Official Agricultural Chemists
AUE	animal unit equivalents
BCS	body condition score
DCZ	double cropping zone
FAO	Food and Agriculture Organization
GGR	Gilgit-Ghizer Region
GLM	generalised linear models
hh	household
HKH	Hindu Kush-Himalayan(s)
KKH	Karakoram Highway
LW	liveweight
ME	metabolisable energy
NGO	non-government organisation
REML	residual maximum likelihood
SCZ	single cropping zone
TCZ	transitional cropping zone
TWINSPAN	Two Way Indicator Species Analysis
VO	village organisation
WO	women's organisation

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1

The Agri-Karakoram Project: An Introduction

Alan J. Duncan[1], **Farman Ali**[2], and **Iain A. Wright**[1]
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The Northern Areas of Pakistan

The Northern Areas of Pakistan lie at the junction of the Karakoram, Western Himalayan, and Hindu Kush mountain ranges. The Western Himalayas create a rain shadow, shielding the region from monsoon rains and leading to semi-arid conditions that include typical annual precipitation in the valley floors of 150 mm (Zheng Du 1998). Temperatures can drop to well below freezing in winter, while in summer heat trapped in barren valleys can send temperatures to above 40°C. Despite these harsh conditions, over one million people live in the Northern Areas of Pakistan, with most deriving a substantial proportion of their income from livestock and agriculture (AKRSP 2000). Although precipitation is scant, water is abundant in the form of glacial snowmelt, which is used to irrigate parcels of land via elaborate systems of irrigation channels. The use of irrigation has led to the development of two distinct land-use types within the region. Areas receiving irrigation, known locally as 'below-the-channel', are relatively productive and can support one or two arable crops per year; maize, wheat, and lucerne are the major crops. 'Above-the-channel', the ground supports scrub vegetation dominated by *Artemisia* spp. At higher altitudes, precipitation is greater, and temperate pastures and sparse coniferous woodlands occur.

Livestock production within the agro-pastoral system

The agro-pastoral system found in the Northern Areas includes subsistence arable cropping, fruit production, livestock production, and, to an increasing extent, cash cropping (Saunders 1983). The vast majority of households keep livestock. The characteristics of a typical household (a smallholder farming system with relatively small land holdings supporting a mixed-species herd) are presented in Box 1.1. The livestock enterprise relies on arable production in that winter feeding is dominated by arable by-products. In turn, arable production relies on inputs of manure from the livestock system. Livestock are thus one component of an integrated system, and the keeping of livestock serves multiple purposes.

A key feature of livestock production in the Northern Areas of Pakistan is the practice of transhumance. Livestock are kept within the village during winter and stall-fed on cereal by-products, lucerne hay, and kitchen waste (Wardeh 1989). Animals are also allowed to graze freely on fallow arable fields and on winter

Box 1.1: **Characteristics of a typical household in the Northern Areas**

- 0.9 ha cultivated land
- 6 cows, 17 goats, 8 sheep, 1.4 donkeys
- Major crops: wheat and maize
- Major forage: straw, maize stovers, and lucerne
- Access to communally grazed pastures
- Some family members away from home for seasonal labour

pastures close to the village. During summer, animals move in stages to communally grazed high-altitude alpine pastures, where they are tended by family members (Figure 1.1). This movement of animals from villages to pastures has the dual role of exploiting the nutritive resources of high pastures and avoiding damage to arable crops during the summer months. In the autumn, livestock are returned to the villages to complete the annual transhumance cycle (Nuesser and Clemens 1996).

Recent change in the Northern Areas

The Northern Areas have been subject to rapid development in the last two decades as a result of two main factors. First, construction of the Karakoram Highway, linking Pakistan and China, has led to dramatic improvement in communication infrastructure (Kamal and Nasir 1998). The road has opened the region and has spawned a network of 'jeepable' roads throughout the Northern Areas. The result has been an increase in the movement of commodities and people in and out of the region. Imports of external products have both opened markets for internal produce and led to increased competition in local markets.

The second main stimulus for change has been the activity of the various agencies of the Aga Khan Development Network, notably the Aga Khan Rural Support Programme (AKRSP), along with government line departments and other NGOs. AKRSP has encouraged impressive community-based rural development, which has catalysed a large number of small infrastructure projects including irrigation channels, link roads, and micro-hydel schemes (see Box 1.2). Another consequence of this recent change has been in employment patterns. Improved transport infrastructure has increased the opportunity for short-term migration out of the region, and a substantial proportion of the working population travels outside the region for employment on a seasonal basis. Furthermore, improved education, trade, tourism, and transport have led to increased opportunities for off-farm employment. However, the pace of development has not been uniform across the Northern Areas. Areas close to the Karakoram Highway tend to be at a more advanced stage of development than more remote areas.

AKRSP has become increasingly interested in some of the indirect effects of these changes. For example, changes in opportunities for off-farm employment are likely to impinge upon labour availability for tending livestock. What impact does this have on livestock numbers and on the extent of pasture use? Conversely, are rising human populations mirrored by increased livestock numbers? And what

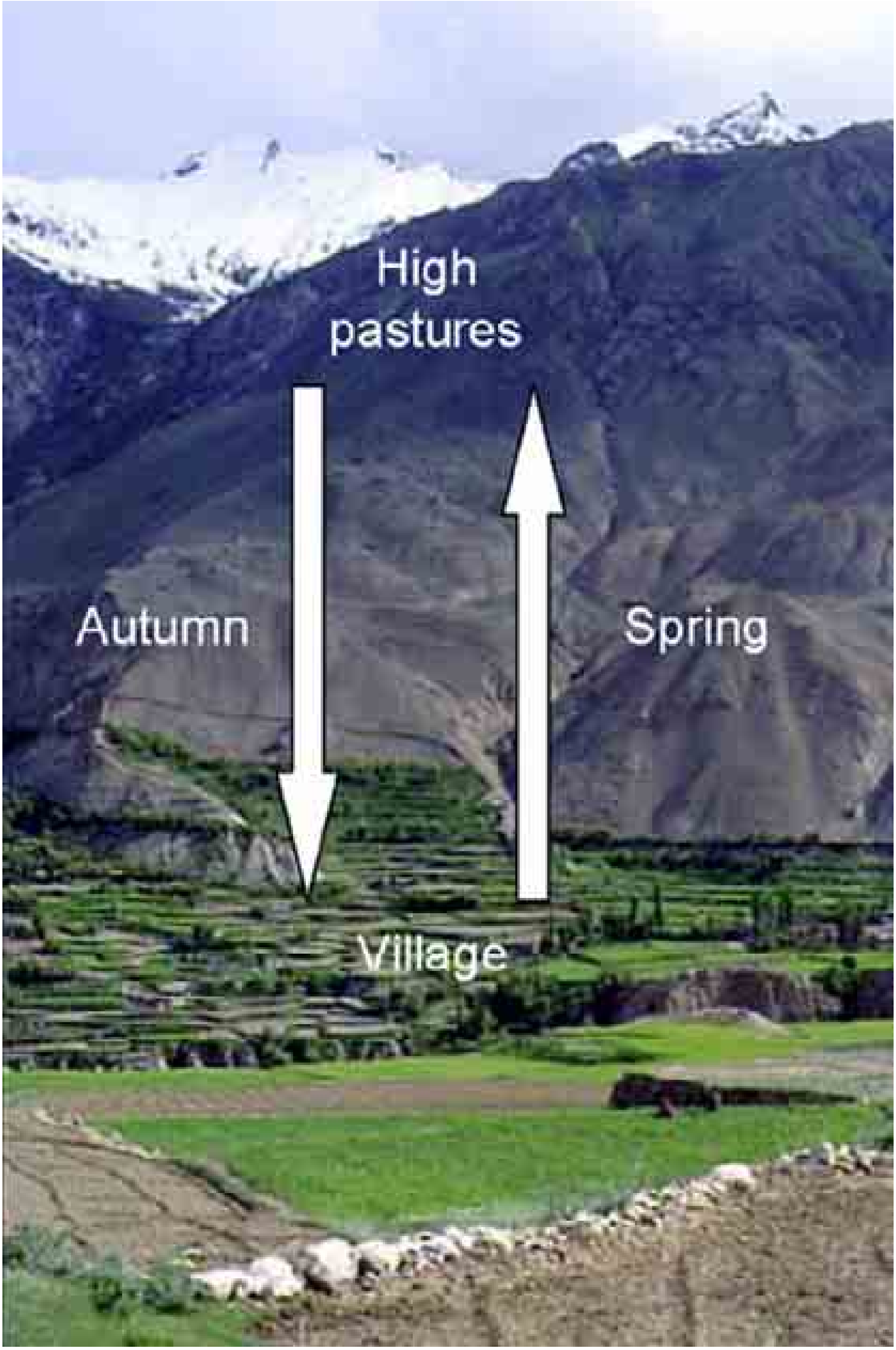

Figure 1.1: **Livestock within the Northern Areas are managed according to a transhumance system with seasonal movements of livestock between villages and high pastures**

Box 1.2: **The Aga Khan Rural Support Programme**

The Aga Khan Rural Support Programme (AKRSP) is a private, non-communal, nonprofit company established by the Aga Khan Foundation in 1982 to help improve the quality of life of villagers of the Northern Areas and Chitral in Pakistan. The organisation is funded by a consortium of bilateral and multilateral donors including the Government of Pakistan with a mandate to focus on income-generating activities in collaboration with national and international development agencies. Since its inception in 1982, the Aga Khan Rural Support Programme has contributed substantially towards the socioeconomic development of the Northern Areas and Chitral.

Mission: AKRSP's mission is to enhance the capacity of the people of the Northern Areas and Chitral to sustain and improve the quality of their lives. This is achieved through institutional and economic development. Institutional development helps to build local capacity and to create an enabling environment for sustainable livelihoods, while economic development initiatives help to alleviate widespread poverty across the programme area through various income generation measures.

Capacity building: AKRSP solicits the active involvement of local communities in identifying, planning, and implementing development interventions. AKRSP has facilitated the formation of almost 4,000 village organisations (VOs) for men and over 2,000 women's organisations (WOs), covering over 85% of rural households in the Northern Areas and Chitral. Human resource development is an important component of AKRSP's development model. Over the years, AKRSP has offered training to build capacity in local communities by invigorating indigenous knowledge as well as introducing new technologies where appropriate. In the process, over 30,000 village specialists have been trained in fields ranging from natural resource management and enterprise development to accounts and book-keeping.

Creation and management of resources: Over 2,200 village- and cluster-level infrastructure projects including irrigation channels, link roads, bridges, protective bunds, and water supply schemes have been completed, benefiting over 166,000 households in the Northern Areas and Chitral. As a result of land development projects, approximately 92,000 ha of new land and over 2.1 million ha of existing land have been developed. AKRSP has also been active in the area of credit and finance; as an outcome of regular saving by around 140,000 savers, the VOs and WOs have evolved a capital base of more than Rs. 430 million.

Poverty alleviation and income generation: To alleviate poverty and enhance income generation, AKRSP has helped increase cultivable land holdings through capital projects leading to improved income generation at the household level. Various natural resource inputs have also been supplied to communities, including over 150 tonnes of improved vegetable seeds, over 3.5 million fruit trees, over 350 tonnes of improved cereal seed, and about 370 tonnes of improved fodder seed. Similarly, as a result of the livestock breed improvement programme, around 500 improved cows, 3,700 improved sheep, 200 improved goats, and 1,200 rams have been supplied to farming households across the programme area. This has helped increase livestock productivity besides increasing the number of improved animals as a result of crossbreeding practices.

are the consequences of these changes for local natural resources? The Agri-Karakoram Project was established in 1998 with questions such as these in mind – sponsored by the INCO-DC programme of the European Union and including a range of partners with skills in both biological and social sciences.

The project had three main components. The first was aimed at studying livestock management with the focus at the village level. The objective was to quantify seasonal resource use by livestock and the outputs derived from the livestock enterprise, with a view to identifying constraints. The second component focused on the grazing ecology of the high pastures, seeking to quantify pasture productivity and botanical composition, as well as assessing the extent of utilisation of high pasture resources. The final component was concerned with the social and economic context of livestock production. The aim was to assess the influence of wider issues, including labour, marketing, and the role of traditions on livestock production. The project thus adopted a systems approach to allow assessment of the impact of change in individual components of the system on the whole system.

Study design

A single-study design was adopted for all three components of the project to allow effective integration of the information from all components. The research was conducted in three agro-ecological zones, along two geographical transects, in a 2 x 3 factorial design. The three agro-ecological zones, at decreasing altitudes, were the single, transitional, and double-cropping zones. In the single and double-cropping zones, one and two arable crops per year are grown, respectively. In the transitional zone, one main crop and one subsidiary crop are generally grown.

The two transects formed the main comparison of the study. The first lay along the Karakoram Highway (termed the KKH transect) and its associated transport infrastructure. The second lay within the Gilgit-Ghizer Region (designated the GGR transect) and was served only by jeepable roads with a limited length of paved road. The selection of these two transects allowed the impact of infrastructure development on the livestock enterprise to be assessed. The two transects were effectively at different stages of the development continuum, allowing the impacts of development to be assessed within the time frame of a three-year project. Six study villages were selected at the start of the project, with one lying in each of the six cells of the 2 x 3 factorial design (Table 1.1, Figure 1.2). Villages were selected on the advice of AKRSP personnel, who were able to provide local knowledge, ensure that all Islamic groups within the region were adequately represented, and generally ensure that village selection was in tune with local politics and the activities of other local NGOs.

Following village selection, a baseline survey was conducted in each village to gather basic information on household size, livestock holdings, and other relevant details. Households were then selected for detailed study on the basis of the

Table 1.1: Study villages		
Village	Transect	Agro-ecological Zone
Bargo-Bala	GGR	Double cropping
Gahkuch-Bala	GGR	Transitional
Darkot	GGR	Single cropping
Bunji	KKH	Double cropping
Minapin	KKH	Transitional
Morkhun	KKH	Single cropping

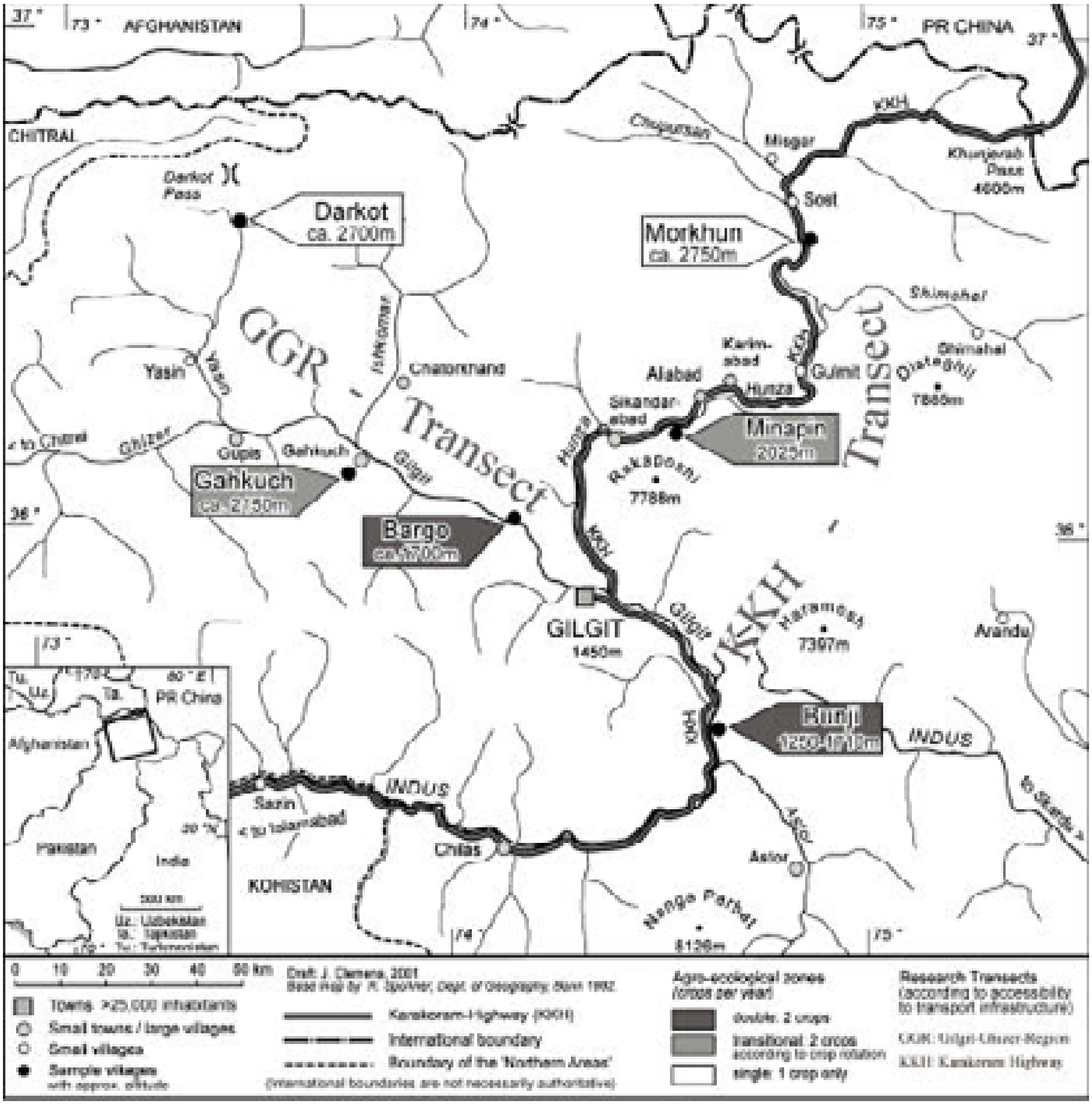

Figure 1.2: **Map of the study region showing location of study villages within the overall study design**

baseline survey, using a stratified, random sampling procedure to ensure that the full range of household sizes was covered. About 20 households in each village were selected for socioeconomic study, with six or seven of these selected for more intensive study as part of the livestock production component.

The chapters that make up the rest of this volume present the detailed findings of the various project components. These are then drawn together in a final synthesising chapter that draws on systems thinking to assess the major constraints to change within the livestock enterprise.

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2

Livestock Feeding and Production

Abdur Rahman[1], **Alan J. Duncan**[1], **David W. Miller**[2], **Pilar Frutos**[3], and **Atiq-ur-Rehman**[4]
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Introduction

Livestock production in Pakistan's Northern Areas is based on a system of transhumance. During the winter months, livestock are based within villages and rely on stall-feeding and free-grazing for their nutrition. During the summer months, livestock undergo a series of migrations to rain-fed pastures at varying altitudes up to around 4000m. The absence of animals from the cultivated village land allows arable production to proceed unimpeded by the presence of livestock. Towards the end of summer, livestock return to their villages to recommence the annual cycle. This cyclical migration of livestock means that nutritional inputs for livestock are derived from a number of sources. In the winter months, livestock are fed on stored feed accumulated during the growing season. This feed includes 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 of *Artemisea* spp. 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.

This component of the research project sought to quantify nutritional inputs to livestock over the winter season and to assess outputs of livestock products over the annual management cycle. In particular, the impact on livestock husbandry of socioeconomic change resulting from improved infrastructure was assessed. The study represents the first rigorous, quantitative assessment of seasonal aspects of livestock production in the region.

Design

The selection of study transects, agroecological zones, study villages, and households are described in Chapter 1. Briefly, the study took the form of a 2 x 3 factorial design of two transects and three ecological zones. One transect lay along the Karakoram Highway (KKH) and was relatively accessible and developed, and the second lay along the Gilgit-Ghizer valleys (GGR) and was relatively inaccessible and underdeveloped. The three agro-ecological zones were the single cropping zone (SCZ), one crop per year; transitional cropping zone (TCZ), one main and one subsidiary crop per year; and double cropping zone (DCZ), two crops per year. One village was selected for each of the six cells in the design, and using a stratified sampling procedure, six to seven households per village were selected representative of the range of herd/flock sizes.

Field collection of data commenced at the start of the winter season in 1999 and lasted for 18 months. All livestock owned by study households were ear-tagged at the start of the study. Thereafter, visits were made to all villages every 6-8 weeks over the entire 18-month period. During visits to villages, information was collected on numbers of livestock, stores of winter feed, and feed inputs to livestock. Data on livestock productivity were also collected. Daily milk yield of all lactating animals was recorded during one day per village visit. Weekly records of milk yield were also collected between village visits by trained household members. All animals in the household were weighed and their body condition recorded at each village visit.

Herd composition and herd weight

Information on average herd sizes in the six study villages is given in Chapter 4. Because of differences in species composition of herds, the herd sizes in the six or seven households used in the livestock study have been converted to a total live-weight basis to allow comparison (Table 2.1). On this basis, the households in the GGR transect had herds that were 35% larger than those in the KKH transect ($p < 0.001$). Herd size was also 22% larger in the double cropping zone than in the single cropping zone ($p < 0.01$).

Table 2.1: Influence of transect and zone on mean herd weight (kg) per household in the study villages

Transect	SCZ	TCZ	DCZ	Transect mean	Transect ***p***-value
GGR	372 ± 117.0	650 ± 188.1	469 ± 277.9	505 ± 114.4	< 0.001
KKH	411 ± 94.5	220 ± 54.8	487 ± 176.1	373 ± 70.3	
Cropping zone mean	391 ± 71.9	451 ± 118.0	478 ± 156.9		
Cropping zone *p* -value		< 0.01			0.072*

SCZ = single cropping zone, TCZ = transitional cropping zone, DCZ = double cropping zone
GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, **p*-value indicates the interaction between transects and cropping zones, values are mean ± S.E.M.

Feed inputs

At the start of winter 1999, all types of stored roughage feed associated with individual households were quantified by estimating their volume within storage areas. Roughage mass was then calculated from estimates of the average density of different roughage types derived from sub-samples of roughage. Measurements were repeated for each household roughly every 50 days over the winter period to assess depletion of feed resources. Representative samples of different feed types were taken from each study household during each of the first three visits and subsequently subjected to chemical analysis to determine dry matter degradability in nylon bags (Ørskov et al. 1980), and crude protein using standard methods (AOAC 1999). Metabolisable energy (ME) was estimated from rumen degradability measurements using published relationships (Chowdhury 1989). These measurements were used to calculate total available feed dry matter, metabolisable energy, and crude protein for each study household.

The influences of transect and agro-ecological zone on stored feed resources and various indicators of animal performance were analysed using residual maximum likelihood (REML) analysis (Patterson and Thompson 1971; Robinson 1987). Fixed terms in the REML model were ‘transects’, ‘zones’, and their ‘interaction’, whereas ‘household’ was entered as a random term to overcome variation between households within a village. The effect of transect and zone on total stored ME was analysed using the ‘generalised linear models’ procedure (GLM; McCullagh and Nelder 1989) of Genstat (Lawes Agricultural Trust 1998).

On average, stored roughage at the start of the winter season, on a dry matter basis, included wheat straw (34%), lucerne (31%), maize stover (19%), wild grasses (9%), and dry leaves (7%). The types of roughage stored were generally similar in both transects, but the proportions differed (Figure 2.1). For example, 22% more cereal residues were stored in the KKH transect than in the GGR transect. In the GGR transect, lucerne was the predominant roughage on a dry matter basis.

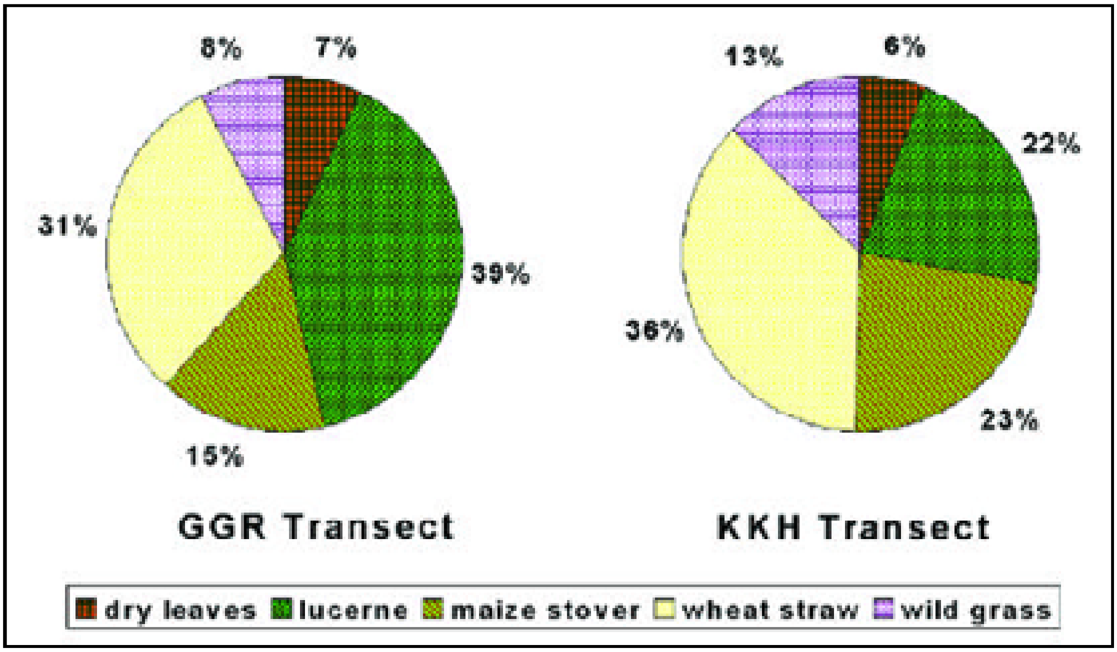

Figure 2.1: **Mean percentage of roughage storage (dry matter) per household at the start of winter in the two transects**

The amount of feed stored for winter increased with increasing herd weight, but not proportionally. Thus, as herd weight (in animal unit equivalents or AUE[1]) increased, the amount of stored feed per AUE decreased (Figure 2.2).

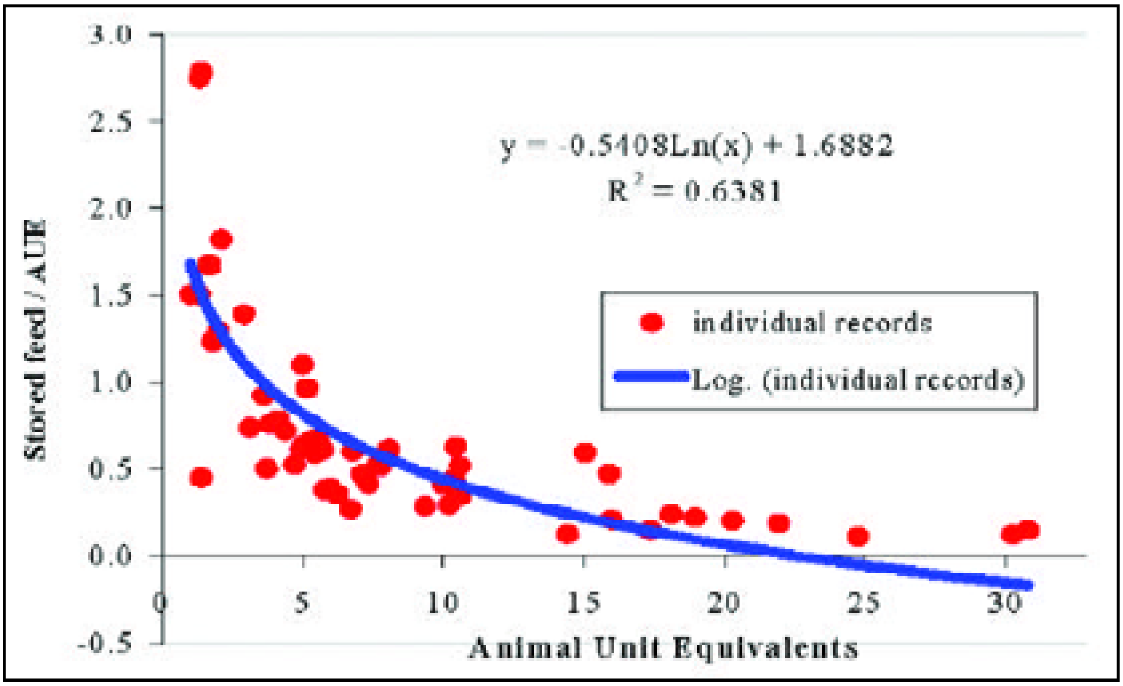

Figure 2.2: **Impact of herd size on stored fodder for winter per animal unit equivalent (AUE) in the study villages**

The amount of ME contained within roughage stores at the start of winter per household (MJ per kg live weight$^{0.75}$/household) was 30% higher in the KKH transect than in the GGR transect ($p < 0.05$; Table 2.2). Agro-ecological zones tended to affect the amount of stored ME resources, but not significantly ($p = 0.77$). However, the households in the transitional cropping zone had 11% higher stored ME resources than those in the double cropping zone. There was a significant interaction between zone and transect, with the transitional zone village in the KKH transect (Minapin) having a lower quantity of stored feed resources than the other KKH villages, but the transitional zone village in the GGR transect (Gahkuch-Bala) having more than the other GGR villages.

The amount of feed offered to livestock was determined by weighing the amount fed to individual animals during the periodic visits to the household. On a dry matter basis, wheat straw was offered in the highest percentage (48%), followed by lucerne (24%), and maize stover (13%; Figure 2.3). Wild grass, dry leaves, and kitchen waste were also offered to livestock as minor components of the overall diet. When expressed on a metabolisable energy basis, local concentrates and kitchen waste formed a more substantial proportion of the overall diet. Lucerne was a major supplier of crude protein, supplying over 50% of dietary crude protein. Although wheat straw accounted for around 50% of feed offered on a dry matter basis, it supplied only 2% of dietary crude protein. Local concentrates

[1] One AUE is the metabolic liveweight of a bovine weighing 150kg, i.e. (liveweight (kg)/150)$^{0.75}$

Table 2.2: Stored metabolisable energy, metabolisable energy required for liveweight maintenance (150 days), and Feed Sufficiency Index in the study households (hh)

Parameter	Transect	SCZ	TCZ	DCZ	Transect mean	Transect *p*-value
Stored ME/kg $^{0.75}$ /hh (MJ)	GGR	48.2 ± 6.6	85.2 ± 8.1	47.9 ± 9.75	61.7 ± 6.17	
	KKH	99.4 ± 4.05	72.4 ± 6.05	92.8 ± 27.1	88.2 ± 9.75	< 0.05
	Zone mean	73.8 ± 9.8	79.3 ± 5.3	70.4 ± 15.3		
	Zone *p*-value		0.744			< 0.05
ME required/kg live weight$^{0.75}$ /hh (MJ)	GGR	74.6 ± 1.59	75.9 ± 1.05	78.6 ± 1.20	76.5 ± 0.79	
	KKH	65.0 ± 2.04	76.8 ± 2.82	79.4 ± 0.72	73.3 ± 1.87	< 0.05
	Zone mean	69.4 ± 1.86	76.3 ± 1.36	78.9 ± 0.70		
	Zone *p*-value		< 0.001			< 0.01
Feed Sufficiency Index	GGR	0.6 ± 0.09	1.2 ± 0.09	0.6 ± 0.12	0.8 ± 0.08	
	KKH	1.3 ± 0.14	1.0 ± 0.08	1.2 ± 0.38	1.2 ± 0.12	< 0.01
	Zone mean	1.0 ± 0.13	1.1 ± 0.06	0.9 ± 0.19		
	Zone *p*-value		0.535			< 0.05*

SCZ = single cropping zone, TCZ = transitional cropping zone, DCZ = double cropping zone
GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, **p*-value indicates the interaction between transects and cropping zones, values are mean ± S.E.M.

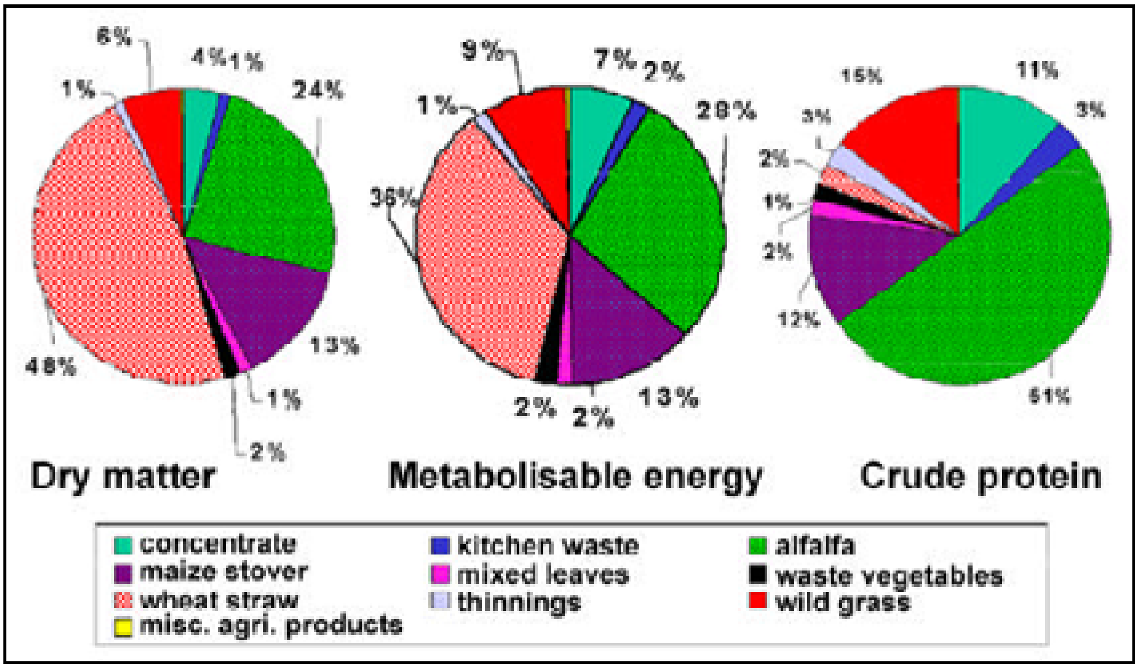

Figure 2.3: **Percentage of overall dry matter, metabolisable energy, and crude protein supplied by different components of the livestock diet**

and kitchen waste, which represented a relatively small amount (5%) on a dry matter basis, were important feeds, because they supplied 15% of dietary crude protein to livestock.

A Feed Sufficiency Index was calculated as the ratio of the feed ME stored at the start of winter to the ME required to feed the herd at maintenance level over the winter period. ME requirements for maintenance of live weight were calculated using the methods of AFRC (1993). Feed sufficiency values of less than 1 indicate that feed resources were insufficient to maintain live weight. The index was 50% higher ($p < 0.05$) in the KKH transect than in the GGR transect (Table 2.2) but did not differ significantly between agro-ecological zones.

Of the feed offered to different livestock species during winter 1999/2000, the largest proportion on a dry matter basis was offered to cattle (41%), with sheep (29%), and goats (23%) receiving lesser amounts. Donkeys received only 7% of the overall feed offered. The average amount of dry matter offered per cow per day during winter was 44% higher ($p < 0.001$) in the KKH transect than in the GGR transect (Table 2.3).

Table 2.3: Mean roughage dry matter (kg) offered per cow per day

Transect	SCZ	TCZ	DCZ	Transect mean	Transect ***p***-value
GGR	3.4 ± 0.33	4.0 ± 0.33	3.2 ± 0.14	3.6 ± 0.16	< 0.001
KKH	5.9 ± 0.59	5.6 ± 0.65	4.3 ± 0.42	5.2 ± 0.32	
Zone mean	4.8 ± 0.40	4.7 ± 0.35	3.8 ± 0.23		
Zone *p* -value		< 0.05			0.224*

SCZ = single cropping zone, TCZ = transitional cropping zone, DCZ = double cropping zone
GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, **p*-value indicates the interaction between transects and cropping zones, values are mean ± S.E.M.

Outputs from livestock

At the start of winter 1999, all animals associated with the study households (approximately 1,100 animals) were ear-tagged for subsequent identification. Live weight of each tagged animal was recorded approximately every 50 days early in the morning, before feeding, using a digital weighing scale. The body condition score of all tagged animals was recorded on a 0 to 5 scale (sheep and goats: Russel et al. 1969; cattle: Lowman et al. 1976).

The mean body condition score of all mature cattle declined over winter and increased over summer (Figure 2.4). The decline in cattle body condition was abrupt in the first half of the winter but less rapid in late winter and reached minimum levels in March. The body condition of cattle started increasing at the start of summer and reached maximum levels by September/October.

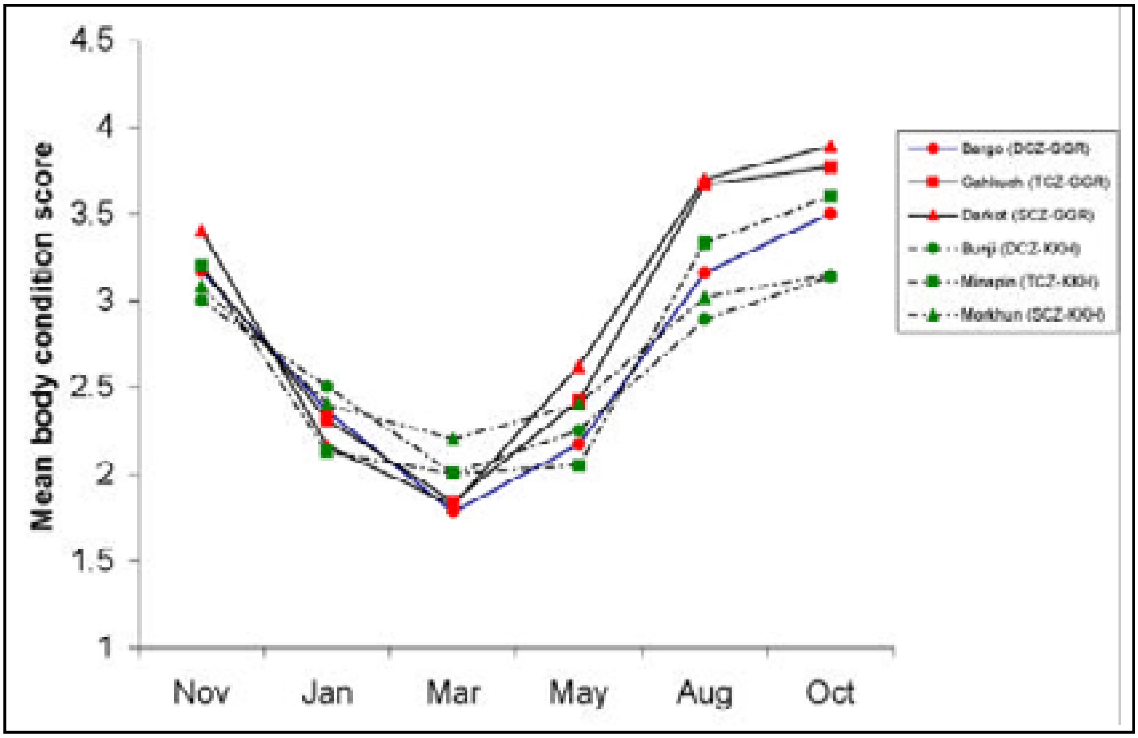

Figure 2.4: **Temporal changes in the body condition score (BCS) of mature cattle in the study villages of the Northern Areas. Solid lines represent GGR transect villages, broken lines KKH transect villages; circles represent the double cropping zone, squares the transitional cropping zone, and triangles the single cropping zone**

The body condition score was higher at the start of winter in the GGR transect, but animals lost condition more rapidly as winter progressed. This more severe loss of condition was presumably associated with the lower feed availability during winter in the GGR transect. In contrast, the higher rate of increase in body condition score in the GGR transect during summer may have been associated with greater utilisation of these pastures than those of the KKH transect villages (see Chapter 3).

The daily milk production of all lactating cattle was recorded on one day per week by a trained member of each study household, and approximately once every 50 days by a researcher.

Cattle in the KKH transect yielded 26% more milk per day than in the GGR transect ($p < 0.05$; Table 2.4). Daily milk yield was significantly higher (55%) in the transitional cropping zone than in the single cropping zone ($p < 0.01$). The interaction of transect and zone was significant ($p < 0.01$) because of the lower milk yield in the village in the transitional zone in the KKH transect (Minapin) compared to the transitional village in the GGR (Gahkuch); in the other two zones the KKH transect village had a higher milk yield than the GGR transect village.

The mean daily milk yield in the first 120 days of lactation showed a significant positive relationship with feed sufficiency ($Y = 3.98 X + 1.46$, $R^2 = 0.58$, $p < 0.01$),

Table 2.4: Mean milk yield (l/day) of cattle in the selected households November 1999 to December 2000

Transect	SCZ	TCZ	DCZ	Transect mean	Transect *p*-value
GGR	0.9 ± 0.04	3.2 ± 0.05	3.2 ± 0.14	3.6 ± 0.16	< 0.001
KKH	2.1 ± 0.08	1.8 ± 0.05	4.3 ± 0.42	5.2 ± 0.32	
Zone mean	1.8 ± 0.06	2.8 ± 0.05	3.8 ± 0.23		
Zone *p* -value		< 0.01			0.224*

SCZ = single cropping zone, TCZ = transitional cropping zone, DCZ = double cropping zone
GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, **p*-value indicates the interaction between transects and cropping zones, values are mean ± S.E.M.

although there was substantial variation in daily milk yield between households. This was probably related to animals being at different stages of lactation.

Lactation length varied from 320 to 550 days, with an average of 450 days, thus cows were in different stages of lactation during the study period. For comparative purposes yield was assessed relative to stage of lactation. Wood's equations (Wood 1965) were fitted to milk yield data to produce lactation curves. Crossbred cattle had much higher milk yields than the local cattle breeds. After correcting for stage of lactation, mean milk yield was significantly higher (40%) in the KKH transect than in the GGR transect ($p < 0.01$; Figure 2.5). The stage of lactation at peak yield (61 days) was latest for crossbred cattle, followed by the

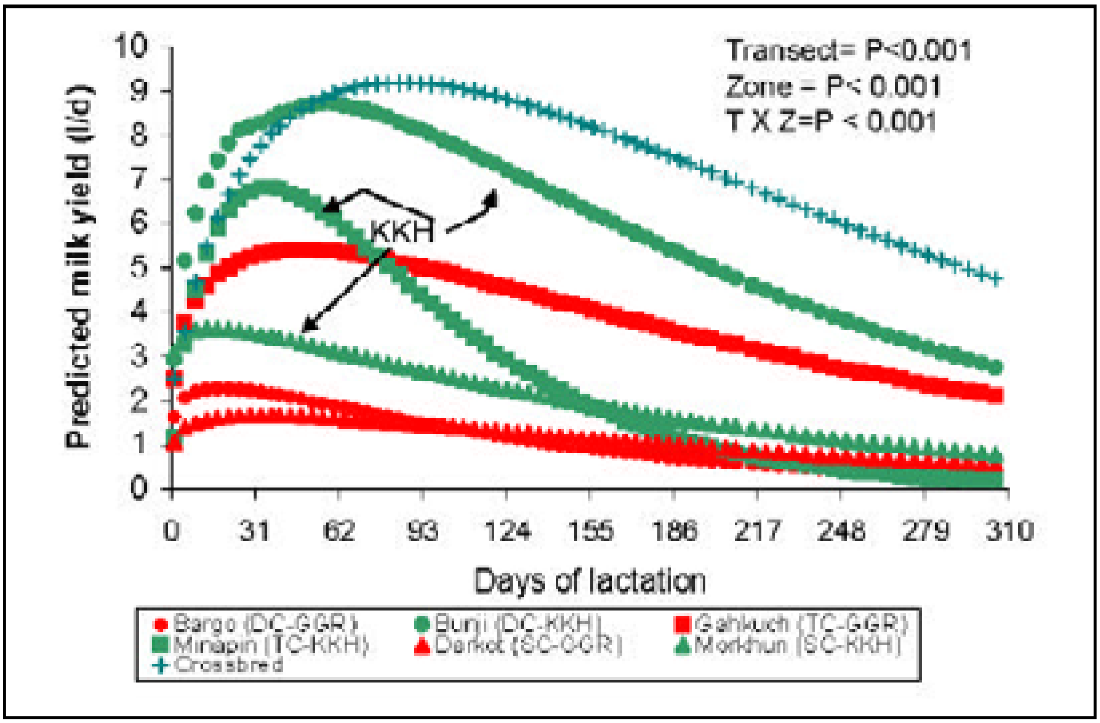

Figure 2.5: **Predicted 305-day lactation curves for local and crossbred cattle of the study villages**

local cattle in Bunji (the village in the double cropping zone in the KKH transect). Peak yield was significantly later in the KKH transect than in the GGR transect ($p < 0.05$), and milk yield at peak lactation was significantly higher (48%) in the KKH transect than in the GGR transect ($p < 0.05$).

The higher level of milk production in the KKH than in the GGR transect provides further evidence that cattle were better fed during winter in the KKH transect. Average daily milk yield per cow in all study households was, however, considerably lower than yields recorded in dairy cows on the plains of Pakistan, which produced on average 3.5-5 litres of milk per day (Mansuri and Dave 1990; Iqbal 1994; Syed et al. 1996). This, coupled with the fact that the milk yield for crossbred cows was higher, suggests that there is scope to determine the extent to which the genetic merit of indigenous cattle is a constraint to milk productivity in the Northern Areas. Milk yield of cows under similar environmental conditions in other mountain ecosystems suggest that the values recorded in the current study are fairly typical of mountain dairy production. Typical daily milk yields reported in the literature are 0.5 litres in the Punjab hills of India (Amble et al. 1964), 2.67 litres in Southern Zimbabwe (Scoones 1992), and 2.5 litres in Nepal (Alirol 1978). Lactation length, at 450 days, is similar to that recorded in other smallholder systems (e.g., 425 days in Kenya; Roderick, Stevenson, and Ndung'u 1999), although in Ghana lactation length was 210 to 240 days (Okantah 1992), possibly reflecting breed differences.

Data on reproductive performance was also collected during each visit to the study villages by interviewing farmers and recording which animals had produced offspring, and approximate dates of births, since the previous visit. Calving percentage was significantly higher ($p < 0.05$) in the KKH transect (82%) than in the GGR transect (53%; Table 2.5). The percentage of calves born to cows in the double cropping zone (75%) was significantly higher ($p < 0.05$) than in the transitional cropping (70%) and single cropping zones (56%). Kidding and lambing percentages of goats and sheep were also higher in the KKH transect than in the GGR transect (kidding percentages were 99% and 79%, respectively).

Table 2.5: Mean calving percentage per household during the period May 1999 to December 2000 in the study villages

Transect	SCZ	TCZ	DCZ	Transect mean	Transect ***p***-value
GGR	44.0 ± 0.04	51.0 ± 0.05	65.2 ± 0.05	53.0 ± 0.030	< 0.05
KKH	69.7 ± 0.10	90.2 ± 0.08	86.4 ± 0.08	82.1 ± 0.05	
Zone mean	56.3 ± 0.08	70.1 ± 0.07	75.3 ± 0.05		
Zone *p* -value		< 0.05			0.629*

SCZ = single cropping zone, TCZ = transitional cropping zone, DCZ = double cropping zone
GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, *p-value indicates the interaction between transects and cropping zones, values are mean ± S.E.M.

The lower reproductive performance in the GGR transect than in the KKH transect is most likely related to the relatively low levels of stored feed resources in this transect, although animal husbandry skills may also have had an influence. The higher numbers of animals per household in the GGR transect would have had the dual effect of reducing feed resources per animal and reducing the attention that farmers were able to pay to reproductive management.

Livestock and fodder trading

Information on animal and fodder trading practices was also collected during periodic visits by recording the fate of each animal in the herd since the previous visit. The percentage of cattle sold per household per year was four times higher in the GGR transect than in the KKH transect ($p < 0.01$; Table 2.6). Cattle trading decreased from the double cropping zone to the transitional cropping zone to the single cropping zone.

Table 2.6: Percentage of cattle sold per household in the selected study villages, November 1999 to December 2000

Transect	SCZ	TCZ	DCZ	Transect mean	Transect ***p***-value
GGR	6.5 ± 1.31	15.0 ± 2.20	17.1 ± 1.02	12.9 ± 1.12	< 0.01
KKH	1.7 ± 1.12	2.5 ± 0.62	5.1 ± 0.51	3.1 ± 0.75	
Zone mean	4.9 ± 1.25	8.7 ± 1.42	11.1 ± 0.55		
Zone *p* -value		< 0.01			< 0.01*

SCZ = single cropping zone, TCZ = transitional cropping zone, DCZ = double cropping zone
GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, *p-value indicates the interaction between transects and cropping zones, values are mean ± S.E.M.

The percentage of fodder sold per household in the GGR transect was double that in the KKH transect ($p < 0.05$; Table 2.7). The amount of fodder sold per household was higher in the double cropping zone and lower in the single cropping zone than in the transitional zone ($p < 0.05$).

Table 2.7: Percentage of fodder sold per household in the selected study villages, November 1999 to December 2000

Transect	SCZ	TCZ	DCZ	Transect mean	Transect ***p***-value
GGR	8.1 ± 1.70	13.0 ± 6.64	23.3 ± 4.40	16.5 ± 3.47	< 0.05
KKH	2.9 ± 0.82	5.9 ± 0.98	15.3 ± 2.44	8.5 ± 2.31	
Zone mean	6.3 ± 1.99	9.5 ± 3.38	20.6 ± 3.32		
Zone *p* -value		< 0.05			< 0.961*

SCZ = single cropping zone, TCZ = transitional cropping zone, DCZ = double cropping zone
GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, *p-value indicates the interaction between transects and cropping zones, values are mean ± S.E.M.

The higher levels of trading of cattle and fodder in the GGR transect occurred despite the poorer road infrastructure. This may reflect the greater economic reliance on livestock, as opportunities for other sources of income are limited (see Chapter 4). Herd sizes were also larger in the GGR transect, allowing larger numbers of animals to be traded. Furthermore, lucerne was grown on marginal land on a larger scale in the GGR transect for subsequent sale at market. However, the village in which fodder sales were highest (Bargo) was at the bottom end of the GGR transect and therefore only about 30 km from the main town of Gilgit.

Conclusions

This study provides detailed quantitative information on various aspects of the livestock enterprise in the Northern Areas of Pakistan. In some cases the effects of agro-ecological zone were not very systematic (e.g., Tables 2.1, 2.2, 2.5, and 2.7) and some of the variables measured did not follow trends associated with changing altitude and cropping pattern. Some of the expected agro-ecological zone effects may have been obscured by village-specific characteristics associated with the choice of the particular villages studied. For example, Gahkuch-Bala, the transitional cropping zone study village in the GGR transect, is an administrative centre, while the equivalent study village in the KKH transect, Minapin, has diversified into tourist-related activities. Given the limited number of villages studied this is perhaps not surprising. Nevertheless, some clear patterns emerge.

The results indicate a subsistence, mixed farming enterprise in flux. Seasonal measurements of feed use and livestock performance highlight the seasonal dynamics of this transhumance system and emphasise the findings of previous studies, which have pointed to a substantial shortage of winter fodder as being an important constraint within the system (Farman and Tetlay 1991; Dost 1995; Wardeh 1989).

Summer grazing at pasture plays an important nutritional role in renewing livestock body condition for the period of winter food scarcity; this has been highlighted and quantified. Furthermore, by recording livestock feed inputs and performance in transects differing in their degree of development, this study has allowed the impact of developmental change on the livestock enterprise to be assessed and future trends to be predicted. The efficiency of various livestock production and reproductive parameters was higher in the KKH transect than in the GGR transect, reflecting the more advanced stage of development found along the KKH. Better matching of feed resources with requirements led to greater output per animal. The reduced animal numbers in the KKH transect may relate to a decreased need to store capital in livestock due to more awareness of other ways of saving. Decreased availability of labour for tending livestock in both summer and winter may also have played a role. Finally, a reduced reliance on livestock as an income source, with the increasing prominence of cash crops such as potatoes (see Chapter 4), may also have diverted efforts away from livestock. Livestock are still regarded as an important component of the domestic subsistence economy in both transects. If livestock are to become a means of generating cash income, then the issue of marketing of livestock products and competition from external sources will need to be addressed.

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3

Pasture Productivity and Utilisation

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Introduction

This chapter describes the results of the pasture studies conducted within the Agri-Karakoram Project, with the broad aim of gaining information about the ecology of mountain pastures in the Northern Areas of Pakistan. The study had two main objectives. The first was to classify and characterise the vegetation communities present in the study area and their distribution. The second was to measure the biomass production, and utilisation of the vegetation, and identify the key differences in pasture use between the two geographical transects, determining where possible the causes of any differences found. This objective was approached using data from this and other components of the project. Full details of the study area are given in Chapter 1.

Pasture ownership and management

The pastures of northern Pakistan fall under communal, state, and private ownership (Buzdar 1988). The most common type of pasture ownership is communal, in which the pasture resources are owned by a defined group of users (a single village or cluster of hamlets). In the case of communal pastures, institutional arrangements (village committee, village pasture committee, pasture interest group, or herders group) exist to manage the use of the resource. For state pastures, the ownership of the pasture lies with the Northern Areas government, but a village or villages have grazing rights in the area. Khunjerab National Park is an example of such a state-owned pasture area. In the case of private pastures, individuals develop certain pasture areas (through personal inputs) for grazing or cutting, and hence establish secure claims to the future benefits from that pasture area.

Each village or cluster of villages has an institutional body for managing pastures, primarily consisting of experienced herders of the village. Such an institutional body makes various decisions based on consensus. Decisions made by the institutional body usually relate to: (a) grazing schedules (movement of livestock to and from the village); (b) distribution of pastures to different households, tribes, or clans; (c) grazing fees to be charged to other villages that wish to use the pasture resources of the village; and (d) penalties to be imposed on those who do not follow the mutual agreement.

Rangeland types and distribution in the Northern Areas

The only comprehensive information available on the land use of the Northern Areas (Table 3.1) is based on the interpretation of 54 Landsat Satellite Thematic Mapper images at a scale of 1:250,000 carried out in 1990/1991 by the Forest Sector Master Plan (ADB and UNDP 1992). There is, however, some doubt as to the accuracy of this information, since many of the images are impossible to interpret due to cloud cover and the rugged nature of the terrain. For this reason more than 65% of the total land area remained unclassified in this survey. Rangelands are described as predominant compared to other land types, but unfortunately much of the relevant land area for this land type is within the unclassified category.

In current literature for the Himalayan regions of Pakistan and India, three different range types are described for the Northern Areas of Pakistan (Khan 1985; Mohammed 1998). These are the foothill, dry temperate, and alpine range types, and they differ in altitudinal range and the type of vegetation supported. The foothill range type occupies the lowermost part of the mountains up to about 1,500m elevation. These ranges tend to be near to villages and are normally used

Table 3.1: Forest cover and land use classes in the Northern Areas of Pakistan, from ADB and UNDP (1992) Landsat image classification

Forest cover and land use class	Area ('000 ha)	Percentage
Forest/Trees/Scrub		
Conifer\scrub (natural)	660	
Farmland trees (planted)	6	
Total	666	9
Agricultural		
Irrigated	44	
Rainfed	4	
Total	48	0.6
Rangelands		
Degraded	896	
Alpine	705	
Total	1601	23
Barren Land		
Snow \ glacier	27	
Total	24	0.39
Water Bodies		
Lake	1	
Total	1	0.01
Unclassified		
Above 3,650 m	3161	
Below 3,650 m	1536	67
Total	4697	
All Land Classes	7040	100

by livestock during the winter season. The dry temperate range type lies between 1,500m and 3,000m elevation. Livestock graze this range type during the spring season while moving towards the alpine range type, and the autumn while returning to the villages. The alpine range type is above an elevation of approximately 3,000m and below the zone of perpetual snow cover. These pastures are grazed only during the summer season when free of snow.

An approximate estimation of the pasture area associated with each village was made at the start of the study. The total number of pastures available to each village and the approximate area per pasture available to livestock for grazing were used to estimate the total pasture area for each village (Table 3.2, Fig. 3.1).

Table 3.2: Number of pastures, mean area of each pasture (±SE) and total pasture area available to each of the study villages

Transect	Agro-ecological Zone	Village	Total number of pastures	Mean pasture area (ha)	Total pasture area (ha)
GGR	DCZ	Bargo-Bala	6	7.66 ± 1.00	45.96
	TCZ	Gahkuch-Bala	4	6.11 ± 1.05	24.44
	SCZ	Darkut	15	3.41 ± 0.41	51.15
KKH	DCZ	Bunji	10	7.65 ± 1.23	76.50
	TCZ	Minapin	9	5.20 ± 0.62	46.80
	SCZ	Morkhun	8	4.76 ± 1.04	38.08

GGR = Gilgit Ghizer transect, KKH = Karakoram Highway transect, DCZ = double cropping zone, TCZ = transitional cropping zone, SCZ = single cropping zone

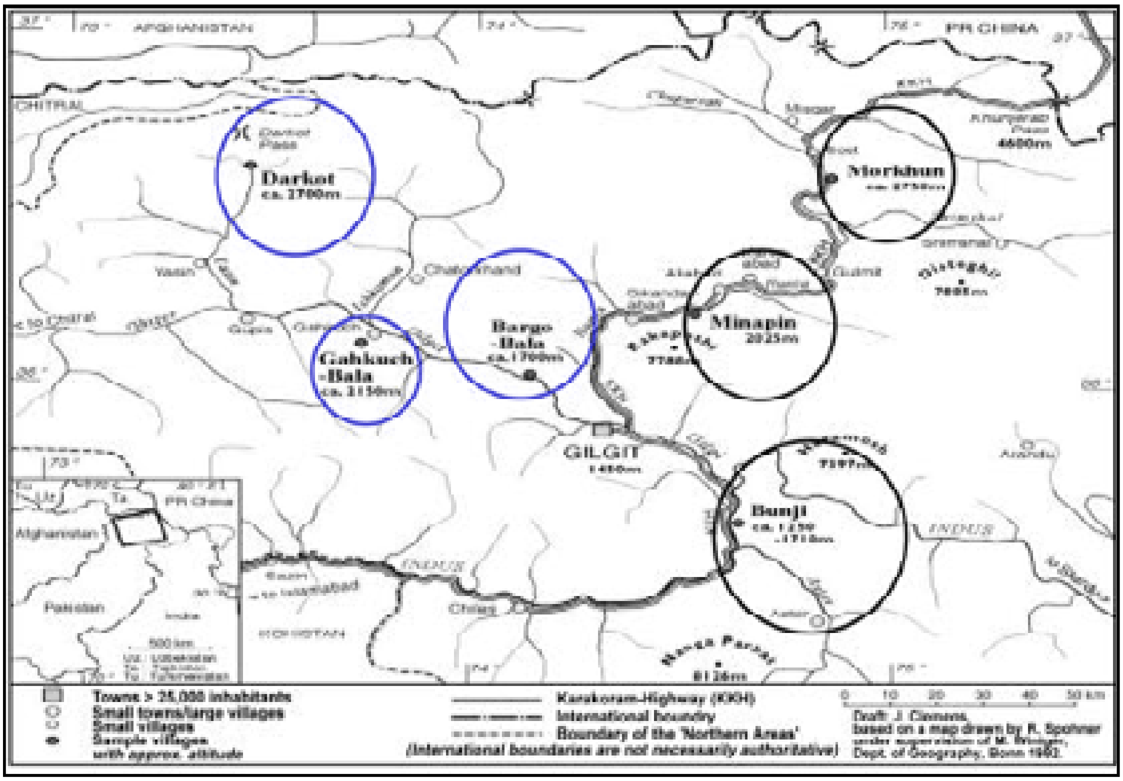

Figure 3.1: **Pasture area associated with the different study villages, area of circle indicates relative area of total available pasture**

Along the Gilgit-Ghizer (GGR) transect, Gahkuch-Bala village had a relatively small total pasture area, Bargo-Bala had a medium-sized area, and Darkot had a large total pasture area. On the Karakorum Highway (KKH) transect, Bunji had an extremely large total pasture area (the largest of the six villages), whereas Minapin and Morkhun had medium-sized pasture areas. Although total pasture areas varied among individual villages, the total area available in each transect was similar.

Preliminary pasture survey

At the start of the study, a preliminary survey was conducted to devise criteria for selecting study pastures. Information was gathered from herd owners and shepherds in the six study villages. In each village, all the pastures of the foothill and dry temperate range types were selected for study, as there were relatively few of these. However, some villages had large numbers of widely dispersed alpine pastures and in these villages a sub-sample of three alpine pastures per village was selected for study. This was done on the basis of any one or a combination of the 'main features', with the aim being to sample as wide a range of variation in key features and uses as possible. The main features considered were vegetation composition, stocking density, livestock species using the pasture, and altitude and/or aspect.

In Bargo-Bala, Gahkuch-Bala, and Morkhun, all pastures were selected for study, since these villages only had three or fewer pastures in the alpine range type. Sub-pastures were selected within the main pastures to cover the full range of vegetation types, uses, altitudes, and aspects present within each pasture area. These were used for the vegetation transects (see below). The main factors influencing the type and condition of the vegetation appeared to be aspect, altitude, extent of use of pastures by livestock (estimate from livestock trails), soil depth, degree of exposure to regular snow-melt each year, geological features, and degree of competition for grazing with wild herbivores (predicted from the faeces of wild goats, rabbits, and marmots).

Characterisation of vegetation communities

During summer 1999, transects of 30m were laid at random locations within the selected pastures and sub-pastures in each pasture area. They were laid across the contour, and quadrats were placed at 10m intervals starting from zero metres. Quadrats of 50 x 50 cm and 100 x 100 cm were used in the different alpine range types, and quadrats of 2m x 2m in the dry temperate and foothill range types, according to the scale of variation in the vegetation. Quadrats were divided into 100 equal segments (Figure 3.2), and these segments were used to estimate visually the percentage ground area covered by each species. Measurement of cover also included bare ground, rock, cryptogams, dung, and litter. Presence of any above-ground plant part in the quadrat – rather than the presence of roots – was used as the criterion for inclusion in the assessment of plant cover.

Figure 3.2: **Quadrat method for estimating surface material and vegetation cover**

Data were analysed using multi-variate techniques. Initially, the complete set of 70 species found was classified into three main plant groups – grasses, forbs, and shrubs – and their cover was described for each range type. A plant community classification was then carried out using Two Way Indicator Species Analysis (TWINSPAN; computer based, PC ORD program, version 3.19). Mean plant percentage cover data per transect was used to classify the samples (Castle 1976) into groups constituting the plant communities described later in this chapter.

Composition

Vegetation structure and composition varied among the different range types. The foothill range type was present only in Bunji village and constituted a flat area adjoining the village. The dominant plant species was *Ephedra gerardiana*. This shrub was sparsely distributed, and the area without vegetation, covered by bare ground and rock, was over 80% (Figure 3.3a).

In dry temperate pastures, shrubs were dominant (on a percentage cover basis), followed by grasses and forbs (Figure 3.3b). The main species were *Artemisia* spp. and *Aerva persica*. The vegetation was also quite sparse, with approximately 60% of the area being bare ground or rock.

In alpine pastures, forbs and grasses constituted over half of the total plant cover (Figure 3.3c), while shrubs had a small representation. The main plant species were *Antennaria nana, Potentilla* spp., and *Ranunculus* spp., and there was a sizable amount of litter. These pastures also had significant, although lesser, areas without vegetation cover (bare ground and rocks).

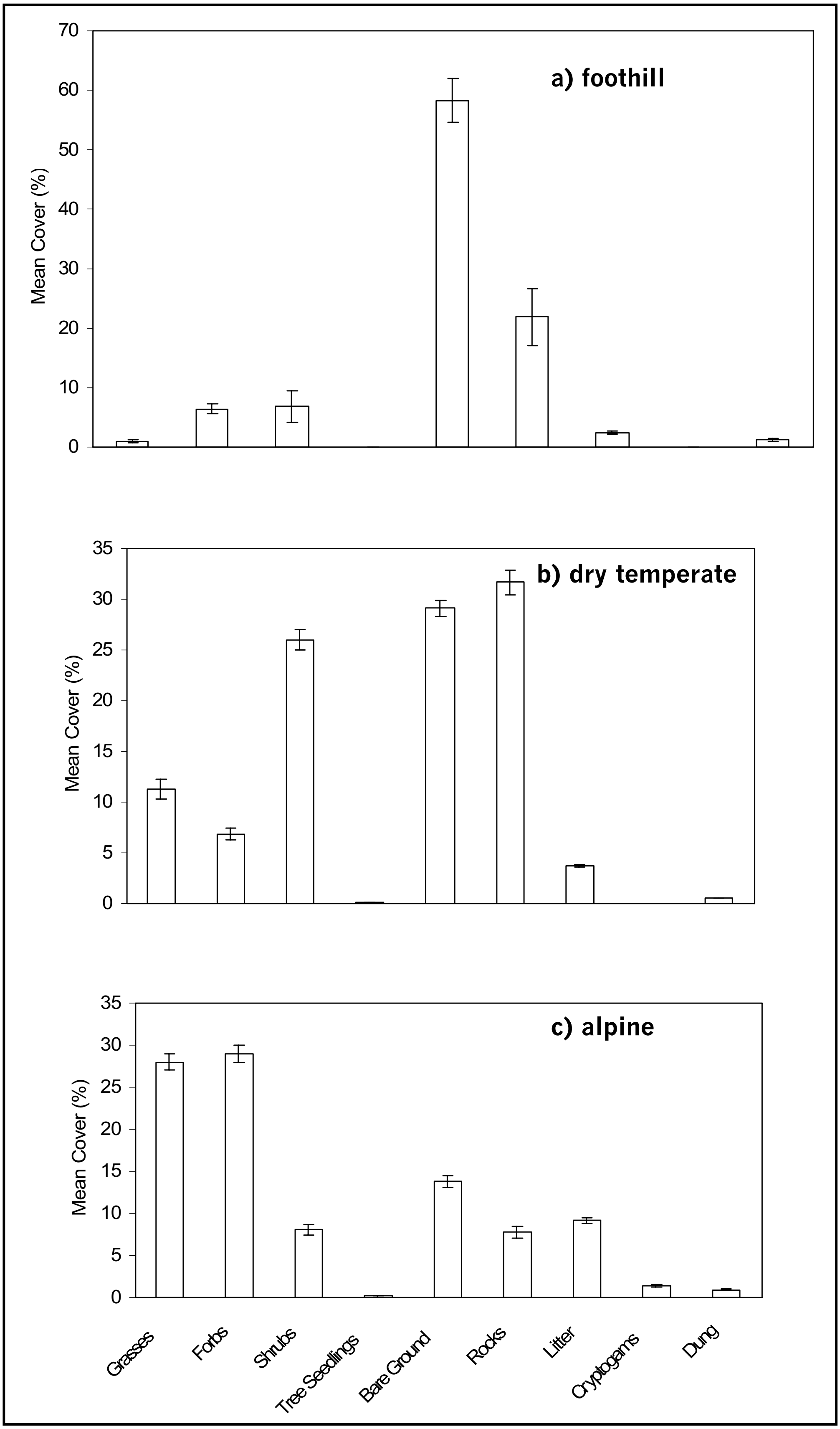

Figure 3.3: **Mean cover a) foothill range type, b) dry temperate range type, c) alpine range type**

In summary, plant cover increased from the foothill to the alpine range type. Vegetation consisted of very sparse shrubs in the foothill range type, less sparse shrubs in the temperate range type, and dominant grass and forbs in the alpine range type.

In the alpine pastures, the TWINSPAN analysis of plant cover data indicated that the *Antennaria nana-Potentilla* spp. community was the most extensive of all the alpine communities. It was generally found in areas that had been ponds, but were now empty due to changes in geographical features such as landslides. These areas were well drained at the time of the study. The *Polygonum affine-Ranunculus leatus* and *Potentilla sibbaldai-Polygonum affine* communities were of almost equal extent. The former was present either near wooded areas or in areas with sparse trees, whereas the latter was usually found on flat meadows close to ponds and at high altitudes. All of these plant communities were widely distributed in all of the alpine pastures available to the study villages.

In the temperate plant communities the *Artemisia* spp. community existed on gentle slopes and was mostly far from any water source. The *Aerva persica* community was present near rivers, streams, or irrigation channels but was never inundated by water. Both of these communities were widely distributed in all of the study villages. The *Festuca* spp.-*Carex* spp. community was relatively scarce and was found in areas within and surrounding pasture settlements. The *Peganum harmala* community existed only in the pastures of Morkhun village. It occupied an abandoned shepherd settlement.

In the foothill plant community, the *Pennesitum lacutum-Ephedra gerardiana* community was only found in the foothill pastures of Bunji village. *Ephedra gerardiana* bushes provided favourable conditions for the grass, *Pennesitum lacutum*, which grew in the shade of the former. The vegetation was sparse, with a mean plant density of 19 *Ephedra* plants per $25m^2$.

Production and utilisation of forage resources

Production, utilisation, and available biomass were measured during summer 2000 and winter 2000-01, using the paired cage plot method (Figure 3.4). In each sub-pasture area described above, cages were set up at six points. These were paired with uncaged plots of the same dimensions to allow combined quantification of herbage production and utilisation. Cages and their paired plots encompassed sample areas of 50 x 50 cm in the alpine range type and 2 x 2m in the dry temperate and foothill range types.

Grazing was allowed on the uncaged plots, whereas the caged plots remained ungrazed during each sampling period (Figure 3.4). Vegetation was clipped to ground level from both caged and uncaged plots simultaneously on each clipping date. Clipping dates were designed to encompass the main periods of livestock use, as well as the growing season. In foothill pastures, clipping was carried out in March, May, and October 2000 and again in January and March 2001. Dry

Figure 3.4: **Caged plot method for measuring forage production, utilisation, and available biomass**

temperate pastures were clipped during March, May/June, October/November and December 2000 and again in March/April 2001. Alpine pastures were clipped in late May, July/August, and October 2000. Caged and uncaged plots were moved to new locations after each clipping.

Plant material was sorted by species to obtain species composition and proportion of live and dead material as indications of both forage availability (by plant species) and changes in vegetation biomass and species composition due to grazing. Fresh plant material was oven-dried at 65°C for 48 hours and weighed to obtain the dry matter amount of each plant species. The dry matter obtained from each uncaged plot gave the total biomass at that date. The dry matter obtained from the corresponding caged plot, minus the dry matter clipped from the uncaged plot at the previous clipping/caging date, gave the seasonal production of forage during the period between those two clipping dates. The difference in dry matter obtained from the paired ungrazed and grazed plots on the same clipping date gave the utilisation during that time period.

Production, utilisation, and biomass data were examined for the different range types through the year. Relationships with environmental variables and geographical transects (GGR versus KKH) were examined using residual maximum likelihood (REML) analysis (GenStat version 4.2; Lawes Agricultural Trust 1998), a statistical method for analysing categorised data that is subject to variation at different levels or strata (Patterson and Thompson 1971).

The production and utilisation data presented here relate to the periods between clippings whereas the biomass data reflect the amount of herbage standing at the time of clipping. Mean production, utilisation, and biomass all increased with altitude, from foothill through dry temperate to alpine range types (Table 3.3). The overall trend in livestock use was that alpine pastures were more heavily used than were pastures in the dry temperate and foothill range types. We hypothesise that increased water from snowmelt led to the greater levels of production and biomass in the alpine pastures, which in turn enabled heavier levels of utilisation.

Production and utilisation were only measured during periods when livestock were using the pastures, but biomass was recorded periodically throughout the year. Table 3.3 shows seasonal summaries for the three range types. Available biomass in the foothill pasture area was greatest in October after a growing season and a period of rest from animal use (Table 3.3). March (spring) biomass was also relatively high, when new growth was accumulating, but biomass declined as animals consumed vegetation between March and May. The main reason for heavy use was the movement of livestock from the village towards the dry temperate and alpine range types. Utilisation was very light, however, when animals again used this area from December 2000 to March 2001, and relatively more biomass remained.

Table 3.3: Seasonal production, utilisation (g DM m^{-2} day^{-1}) and biomass (g DM m^{-2}) in different range types.

	Production	Utilisation	Biomass
Foothills			
March			5.09[ab]
March - May	0.09[ab]	0.07[a]	0.55[ab*]
May - October	0.20[ab]	-	7.81[ab*]
October - January	0.01[ab]	-	2.25[ab*]
January - March	0.12[ab]	0.01[a]	3.23[ab*]
Dry temperate			
March			5.02[a]
March - May/June	0.64[b]	0.27[a]	32.48[ab*]
May/June - October/November	-0.12[a]	-	38.01[b*]
October/November - December	0.05[a]	0.11[a]	28.06[ab*]
December - March/April	-0.08[a]	0.02[a]	13.57[ab*]
Alpine			
May			121.86c
May - July/August	0.82[b]	1.04[b]	111.95c*
July/August - October	0.50[ab]	0.15[a]	109.25c*

* Biomass at the end of the period.
Within columns, means with the same superscript are not significantly different ($P<0.05$).

In the dry temperate range type, production exceeded utilisation from March to June 2000 (Table 3.3). Biomass then accumulated further when livestock moved to the alpine range type between June and September, but it declined when animals returned to the dry temperate pastures in September. Sporadic use until March continued to reduce the remaining biomass. Negative values for production in the December-March period indicate winter die-back. Overall, there are indications of possible under-use of these pastures in the spring season, although because this study represents only one year of data, conclusions must remain tentative.

In the alpine range type, biomass remained relatively high during the whole growing season (Table 3.3). Production and utilisation were heaviest between May and August, the main period of both growth and animal use. Late in the season, both production and utilisation were lower when growth started to slow down and livestock started moving down towards the temperate range type.

As expected, mean levels of vegetation production did not vary significantly between the two transects, because most vegetation types were distributed across the whole study area and both transects contained similar ranges of altitude, aspect, and other important abiotic factors (Table 3.4). Mean utilisation, however, was significantly higher on the GGR compared to the KKH transect. The main difference in utilisation was in the alpine range type, where mean utilisation was three times higher in the GGR than in the KKH transect.

Table 3.4: Variation in production and utilisation along the GGR and KKH transects*

	Pasture type	Transect		Transect ***p***-value
		Gilgit Ghizar (GGR)	Karakoram Highway (KKH)	
Production ($g\ m^{-2}\ day^{-1}$)	Foothill	–	0.01 ± 0.23	
	Dry temperate	0.23 ± 0.18	0.19 ± 0.19	
	Alpine	0.32 ± 0.23	0.47 ± 0.22	
	Mean	0.26 ± 0.14	0.23 ± 0.12	n.s.
Utilisation ($g\ m^{-2}\ day^{-1}$)	Foothill	–	0.05 ± 0.19	
	Dry temperate	0.14 ± 0.15	0.11 ± 0.16	
	Alpine	0.83 ± 0.19	0.29 ± 0.18	
	Mean	0.40 ± 0.13	0.15 ± 0.11	0.002

* Values relate to the period of grazing only.

Conclusions

Vegetation changed from very sparse shrubs in foothill pastures to less sparse shrubs in dry temperate pastures to forb/grass dominance in the alpine range type. Production, utilisation, and biomass increased with increasing altitude, probably due to increased water through snowmelt. Water availability also governs the movement pattern of livestock in the transhumance grazing system under semi-arid conditions.

The two main conclusions from this study relate to patterns of use of two different range types. The data indicate two potential areas for modifying patterns of use to maximise benefit from the available forage resource. First, mean forage production of dry temperate pastures overall appeared to be higher than utilisation during the spring season. This indicates a potential for increased use of temperate range pastures in spring, which in turn would reduce pressure on the foothill and alpine range types, as well as allowing earlier movement of livestock from villages, sparing scarce stored food resources (Chapter 2). However, longer-term data are needed to establish whether this result was representative of typical patterns of use.

Second, the much heavier use of alpine pastures (three times higher than mean utilisation) in the GGR transect compared to the KKH transect raises two questions requiring investigation: (a) why is the use so much heavier? and (b) despite this heavier use, why does animal condition improve faster in the GGR transect? (see Chapter 2). These linked questions are explored further in Chapter 5.

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4

Human and Economic Issues Associated with Livestock Production

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Introduction

Livestock form an important component of rural livelihood strategies in the mountainous regions of northern Pakistan. Different spheres of the farm economy and their integrated cropping-livestock systems – 'mixed' (Rhoades and Thompson 1975), 'combined mountain agriculture' (Stöber and Herbers 2000), or 'mixed crop-livestock farming systems' (Tulachan 2000) – are linked interdependently with one another. The Farm Household Model developed by FAO (1993) provided the framework for this study. This model focuses on physical or monetary resource flows, such as draught power and dung as agricultural inputs, fodder crops or crop residues as feedstuffs, or animal products as outputs for consumption and income generation. It also stresses the interdependence of the ecological, socioeconomic, and social settings. A simplified model for the Himalayas also distinguishes between subsistence farming systems and easily accessible areas with higher degrees of commercialisation (Tulachan 2000).

This chapter reports the results of a study of farm household economics carried out as part of the Agri-Karakoram Project. The study analysed current and predicted changes in the livestock sub-sector resulting from improved transport infrastructure and subsequent external commodity supplies, as well as better opportunities for education and off-farm-employment. These changes are discussed within the wider socioeconomic framework.

The study focused particularly on farmers' perceptions of the livestock sub-sector, since the indigenous perception of the ecological, socioeconomic, and cultural framework of animal husbandry has been recognised as an important determinant of local management strategies. Understanding such indigenous perceptions also contributes to the success of rural development interventions (see Waters-Bayer and Bayer 1994; Tulachan and Neupane 1999). In combination with quantitative surveys, the integration of qualitative issues and participative tools provided additional insight for assessing the potential and constraints of the local livestock subsystem. The aim was to produce information that, in conjunction with the information presented in Chapters 2 and 3, would help to identify appropriate management interventions for forthcoming development

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activities in close co-operation with regional development institutions and the local communities.

Methods

The study involved several linked phases and methods. Existing secondary data, scientific literature, and consultancy reports were reviewed. An exploratory study was carried out in each of the six study villages (see Chapter 1 for details of the project design). This relied on rapid rural appraisal techniques such as interviewing key informants and transect walks. This was followed by a baseline survey of approximately 40-60 households in each of the study villages in which data were collected on household size, numbers and types of animals, land area, cropping patterns, and marketing of crop and animal products. A more detailed survey of approximately 20 households per village (sampled to be representative of herd size) was also carried out to collect information on farmer perceptions, and more detailed information on the economic importance of livestock within the farming system. These 20 households per village included those used in the study of livestock performance and fodder interactions (Chapter 2).

The livestock sub-sector – recent trends

Previous surveys of the livestock population in the Gilgit Region of the Northern Areas of Pakistan have mostly indicated decreasing herd sizes per household and an increasing total livestock population. Generally two major reasons are given for the total increase: the growth of the human population and the families' strategy of keeping a minimum number of animals for their own needs and as an asset for emergencies. Decreasing individual herd sizes are driven by the households' response to changes in the off-farm sectors, such as off-farm employment and education (Streefland et al. 1995).

However, recent information on the livestock population provides no clear impression of general trends for the last 25 years in the Gilgit region, and figures are not readily available from existing sources for the total livestock population. Only indirect estimates of the livestock population are possible, based on the trends of the rural population and individual livestock holdings. Table 4.1 shows data for the human population and estimates of the livestock population for the Gilgit region. The estimates of the livestock population for 1998 are calculated from the actual number of households in the human population census data, and information on the herd size per household taken either from the 1996 government livestock survey (Estimate 1) or from an economic survey for 1997 by the Aga Khan Rural Support Programme (AKRSP; Estimate 2). The alternative estimates of the total livestock population in 1998 indicate either an increase of 88% or a decline of 12% from 1980, against an increase of the rural population of 55%. The large differences in the estimates of the livestock population probably result from the fact that the different data sources use different definitions and methods of data processing. The government livestock census primarily presents data for households that rear particular kinds of animals and disregards households not reporting particular species; thus the animals per household value used for Estimate 1 is much higher than that used for Estimate 2. This means that it is difficult to get sound estimates of the total livestock population.

Table 4.1: Human and livestock populations in the Gilgit region (Gilgit and Ghizer districts), 1980 to 1998

	1980	1998	% change
Human population (rural areas)			
Total	197,775[1]	296,699[2]	+55.0
Number of households	25,380[1]	36,111[2]	+42.3
Livestock population			
Animals per household	23.4[3]	31.1[4] (Estimate 1)	+32.7
		14.5[5] (Estimate 2)	-38.0
Total animals	593,892[3]	1,114,859[4] (Estimate 1)	+87.7
		523,610[5] (Estimate 2)	-11.8

[1]1981 data; [2]census data; [3]GoP (1983) [4]based on 1996 government livestock survey data; [5]based on Aga Khan Rural Support Programme 1997 economic survey

Individual case studies have also been conducted. Kreutzmann (2000) gives an example of the general decline of individual herd sizes in Hunza in the context of socioeconomic changes. More case studies are given in Ehlers and Kreutzmann (2000). Case studies, however, do not cover a wider regional level, and indirect assessments and further empirical fieldwork are still needed.

The farmers' own perceptions of changes in their herd sizes were studied for the six study villages of the Agri-Karakoram project. The farmers' perceptions, however, also show great variation (Table 4.2).

Overall, most farmers surveyed in 2000, especially those living along the Gilgit Ghizer Region (GGR) transect, indicated that they had reduced or maintained their livestock numbers within the previous five years. However, the majority of farmers in the transitional cropping zones (Minapin and Gahkuch-Bala villages), with the potential to grow a second crop at least every second year, and in Morkhun, the single-cropping village of the Karakoram Highway (KKH) transect, reported increasing the number of animals they kept, although it is not possible to generalise about changes in the different cropping zones with only two villages surveyed per zone.

Table 4.2: Changes in herd size – farmers' perception[1], 1995-2000

Change in livestock numbers	Percentage of households	
	Overall	Range
Less	48.1	30.4 - 76.2
Same	12.4	4.6 - 21.7
More	38.8	9.5 - 59.1
No definite answer	0.8	0.0 - 4.8

[1] Based on the question: Does your household now own more or less animals than 5 years ago?

Labour availability was the most common reason given to explain decreases in livestock numbers. More than 20% of respondents attributed decreases mainly to the lack of people within their families for tending animals (rank 1); recent division of the father's joint household was another important factor (rank 7). Nüsser and Clemens (1996) and Kreutzmann (2000) also identified lack of labour as a factor related to keeping less livestock. Other important reasons for keeping fewer animals were disease (ca. 15%), lack of fodder and grazing areas (ca. 13%), sale of animals (ca. 12%), and slaughtering and natural death of animals (each ca. 10%). Respondents with increased livestock numbers generally attributed such increases to the animals' natural reproductive output (rank 1; 50% of all answers); about 13% of the respondents pointed to increased fodder supplies, supplemented by more awareness of, and personal interest in, livestock rearing (ca. 9%) both of which hint at a more rational farming approach. Increased needs of bigger families were of minor importance (ca. 7%).

At the regional level, existing data suggest that the percentage share of all cattle including yaks and yak-cattle crossbreeds (dzo and dzomo) in total livestock holdings nearly doubled between 1976 and the mid-1990s, and total livestock holdings also increased. The mean number of cattle per household was relatively stable, however, (with some variation among the different data sources) but there was a decrease in total herd sizes per household with fewer goats and an even more significant decline in the number and percentage share of sheep. Recent development activities have sought to change the latter trend and convince farmers to replace goats with sheep, since sheep are considered to have less grazing impact on natural pastures and forests.

The changes in favour of cattle are generally attributed to the higher labour demand of goats and sheep with regard to grazing and herding activities. At the same time, recent development activities have promoted the permanent keeping of smaller numbers of more productive dairy cows around the farmers' homesteads instead of sending animals to high pastures (see below). A similar situation of more livestock but fewer animals per household has been reported for the Nepali and Indian Himalayas recently, with a significant increase in the number of dairy animals, and especially improved Jersey crossbred cows, in those valleys with good access to markets (Tulachan and Neupane 1999).

A recent report on Gahkuch-Bala based on information given by local farmers also indicated an increase from 15 to 47% in the proportion of cattle, and decrease from 60 to 30% of goats in the overall livestock holdings (Ahmad et al. 1998).

The mean total herd size in the present study varied between 7 and 42 animals per household (Table 4.3). Livestock numbers did not show clear patterns between transects and zones. Cattle outnumbered goats and sheep in both the transitional zone villages Minapin and Gahkuch-Bala; goats were still dominant in three villages; and sheep holdings per household were generally lower than those of cattle with the exception of Morkhun, where sheep outnumbered both goats and cattle. Many households kept no sheep. The major extremes occurred along the KKH transect, which showed the largest and smallest herds as well as the highest and lowest shares of goats. However, 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.

Table 4.3: Mean numbers of livestock per household in the study villages (40-64 households per village)

	Double cropping zone	Transitional zone	Single cropping zone
GGR transect	Bargo-Bala	Gahkuch-Bala	Darkot
Cattle	4.3	7.8	4.9
Yaks and crossbreeds	0.0	0.0	0.1
Goats	8.7	5.4	9.5
Sheep	0.9	2.5	2.7
Total	13.9	15.7	17.2
KKH transect	Bunji	Minapin	Morkhun
Cattle	6.3	3.2	4.0
Yaks and crossbreeds	0.0	0.1	1.0
Goats	30.5	2.9	12.1
Sheep	5.1	0.9	13.2
Total	41.9	7.1	30.3

Farmers generally perceived cows and bulls to be their most important animals (Table 4.4), although they only comprised 13 to 40% of the total numbers. These perceptions relate directly to the reasons for keeping livestock (Table 4.5). By far the most important reasons for keeping livestock were the production of milk, butter, and dung. Keeping animals to provide transport was more important in the more remote GGR transect than in the KKH transect, which had a better road infrastructure.

Around half of farmers (52.7%) indicated they had a surplus of animal dung, while around 40% had insufficient supplies for their crop production. In some villages with easy access to summer field settlements and high pasture corrals, animal dung is even brought down to the cultivated land by tractor and trailer, jeeps, or donkeys. However, only a quarter of farmers in the survey sold or exchanged surplus dung, and only two (8.5% of those surveyed) bought animal dung from others (Table 4.6). Thus, there appears to be a very limited market for animal dung; additional fertiliser demands are generally met by purchasing chemical fertilisers. The percentage of fertiliser users was highest in those villages with the highest percentage of farmers who grew potatoes as a cash crop (Minapin, Morkhun, and Darkot) (Table 4.7). In general, wheat and potatoes received the highest fertiliser inputs, from either animal dung or chemical fertiliser.

Table 4.4: Farmers' perceptions of the most important livestock species (% of households in which each species is important – multiple answers possible)	Double cropping zone	Transitional zone	Single cropping zone	Overall
GGR transect				
Cows	91	91	67	83
Bulls	9	18	38	22
Goats	45	9	38	31
Sheep	5	9	19	11
Donkeys	41	45	43	43
Yaks/crossbreeds	0	0	0	0
All species	0	0	5	2
No species	5	0	5	3
KKH transect				
Cows	62	90	83	78
Bulls	10	0	0	3
Goats	57	20	13	30
Sheep	5	0	13	6
Donkeys	29	40	0	22
Yaks/crossbreeds	0	5	17	8
All species	0	0	4	2
No species	0	0	0	0
Both transects				
Cows	77	90	75	81
Bulls	9	10	18	12
Goats	51	14	25	30
Sheep	5	5	16	9
Donkeys	35	43	20	33
Yaks/crossbreeds	0	2	9	4
All species	0	0	5	2
No species	2	0	2	2

In addition to the irrigated land, all study villages had access to other productive areas, such as pastures, forests at different altitudes, and irrigated areas at higher altitude summer settlements. Donkeys were still the major means of transporting farming goods like seed, fertiliser, crops, residues, or fuelwood between these areas. Many households still relied on animals for transport to some extent. However, recent road construction projects to higher settlements, such as the Boibar Valley above Morkhun, have reduced the importance of animals for transport; none of the farmers surveyed in Morkhun kept animals for transport.

Table 4.5: Reasons for keeping livestock (% of households - multiple responses possible)				
	Double cropping zone	Transitional zone	Single cropping zone	Overall
GGR transect				
Milk	95	100	90	95
Butter	36	23	19	26
Meat	23	23	24	23
Draught power	0	9	24	11
Transport	9	18	33	20
Fibre	9	0	14	8
Dung	91	91	86	89
Income	0	0	0	0
Tradition	0	0	0	0
Other reasons	0	0	0	0
KKH transect				
Milk	95	80	61	78
Butter	48	20	9	25
Meat	14	5	22	14
Draught power	0	0	0	0
Transport	10	25	0	11
Fibre	5	0	13	6
Dung	62	85	87	78
Income	19	5	22	16
Tradition	0	15	17	11
Other reasons	0	10	4	5
Both transects				
Milk	95	90	75	87
Butter	42	21	14	26
Meat	19	14	23	19
Draught power	0	5	11	5
Transport	9	21	16	16
Fibre	7	0	14	7
Dung	77	88	86	84
Income	9	2	11	8
Tradition	0	7	9	5
Other reasons	0	5	2	2

Table 4.6: Percentage of households trading various agricultural and livestock products

	GGR Transect			KKH Transect		
	Double cropping Bargo	Transitional Gahkuch	Single cropping Darkot	Double cropping Bunji	Transitional Minapin	Single cropping Morkhun
Sold livestock	35	23	46	38	42	30
Bought livestock	17	36	21	25	15	11
Sold milk	0	0	0	0	0	0
Sold butter	6	12	18	15	12	11
Sold dung	8	0	16	10	0	0
Bought dung	4	0	5	0	2	2
Sold straw	10	0	14	5	15	13
Bought straw	12	16	33	3	12	11
Sold lucerne	62	17	6	15	15	13
Bought lucerne	17	17	17	23	12	11
Sold fruit	59	77	0	20	88	78
Sold vegetables	54	16	0	13	85	76
Sold potatoes	29	8	54	0	93	83

Table 4.7: Use of animals and tractors for draught power and use of chemical fertilisers (% of households)

	Double cropping zone	Transitional zone	Single cropping zone	Overall
GGR transect				
Animals used for ploughing	50	95	95	80
Tractor hired for ploughing	36	4	19	20
Tractor hired for threshing	82	86	62	77
Chemical fertiliser used	41	18	76	45
KKH transect				
Animals used for ploughing	71	30	9	36
Tractor hired for ploughing	33	85	100	73
Tractor hired for threshing	81	85	100	89
Chemical fertiliser used	46	95	100	81
Both transects				
Animals used for ploughing	60	64	50	58
Tractor hired for ploughing	34	43	61	46
Tractor hired for threshing	81	86	82	83
Chemical fertiliser used	44	55	89	77

Increased mechanisation has slowly replaced bulls and oxen for draught power over the last decades (Pilardeaux 1998). However, more than half of all households, and almost all households in the more remote parts of the GGR transect, still reported using animals for ploughing. Complete substitution of tractors for draught animals is unlikely even in villages with easy road access because the availability of tractors is not assured all year round. In remote parts of the villages, and at summer field settlements at higher altitudes, fields cannot be ploughed by tractors at all. Furthermore the cropping patterns often do not allow access for tractors – e.g., if the first crop of barley is already harvested and surrounding fields still have a standing crop of wheat or maize. However, mechanised threshers have substituted most of the animal power inputs during the post-harvest work, at least for wheat and barley at accessible sites (Table 4.7). Although draught power and transportation were still provided by bulls or donkeys in many cases, many households did not actually keep male animals, preferring to borrow those of neighbours or relatives for breeding and other purposes. Only in the most remote villages in the GGR transect was draught power given as a reason for keeping livestock (Table 4.5).

Land holdings and cropping patterns

In mixed mountain farming systems, both human livelihoods and livestock rely heavily on irrigated farming and integration with cropping. The size of individual landholdings is also important. The average size of landholdings in each of the six study villages is shown in Figure 4.1. Saunders (1983) estimated the area of land required for self-sufficiency in the double cropping zones of the Northern Areas of Pakistan to be 1.5 to 2 hectares, and in the single cropping zones to be 2.5 to 3 hectares, using some general assumptions such as a mean household

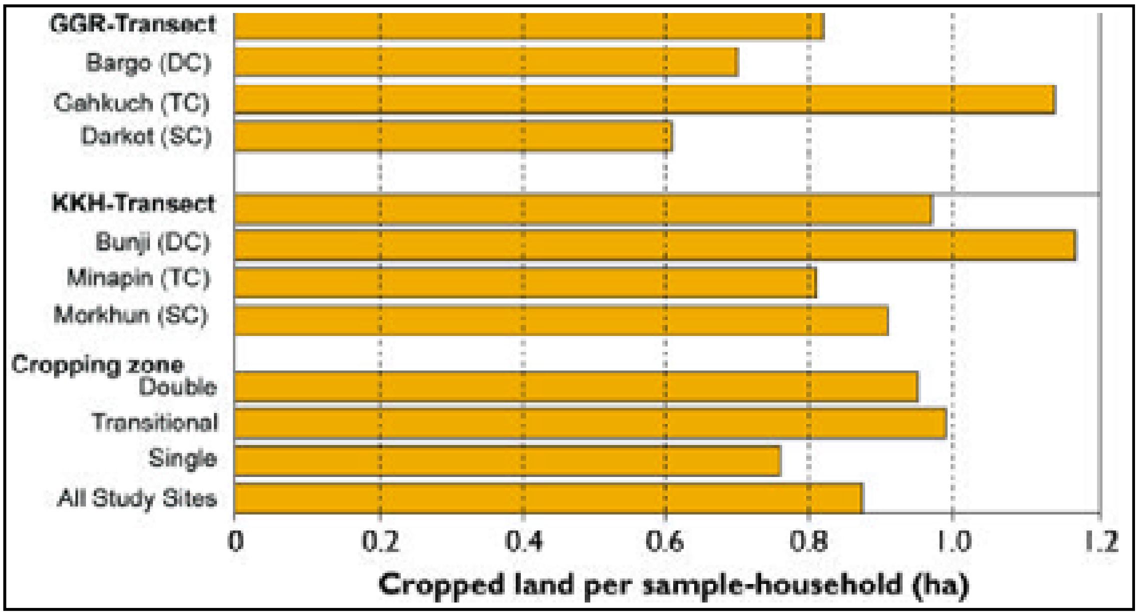

Figure 4.1: **Mean area of cropped land (first and second crop) per sample household (2000)** (DC = double cropping zone; TC = transitional zone; SC = single cropping zone)

size of seven to eight persons, careful intensive husbandry, reasonably fertile soil, current management practices, and a moderate living standard. In general, the average landholding per household did not reach those levels even in the double cropping zone. Only a few farming households had enough land to be self-sufficient, with most relying heavily on external supplies of staple foods such as wheat and wheat flour. These are provided by government supply structures at subsidised rates, at least to government warehouses at regional administrative centres. Not only are landholdings small, they are also frequently fragmented as a result of population growth and inheritance traditions.

The cropping patterns in the study villages reflected major changes from previous subsistence farming systems caused, among other reasons, by the assured supply systems for staple foods. For Darkot, Minapin, and especially Morkhun, the cultivation of potatoes as a cash crop has only been made possible through the improved road access that provides both subsidised food supplies and the marketing facilities for table and seed potatoes sold to the markets of 'down country' Pakistan. The increased cultivation of potatoes as opposed to cereals has, however, led to lower animal feed resources, as these are traditionally derived from crop residues – potato crops do not produce by-products suitable for animal feed. This was partly compensated for by development of previously barren land with new irrigation schemes providing a potential especially for growing leguminous fodder crops such as lucerne, as seen in the villages of Morkhun and Minapin (Figure 4.2).

Not all irrigated land was cropped, especially in the transitional zone villages Minapin and Gahkuch during the second crop season. Different reasons were

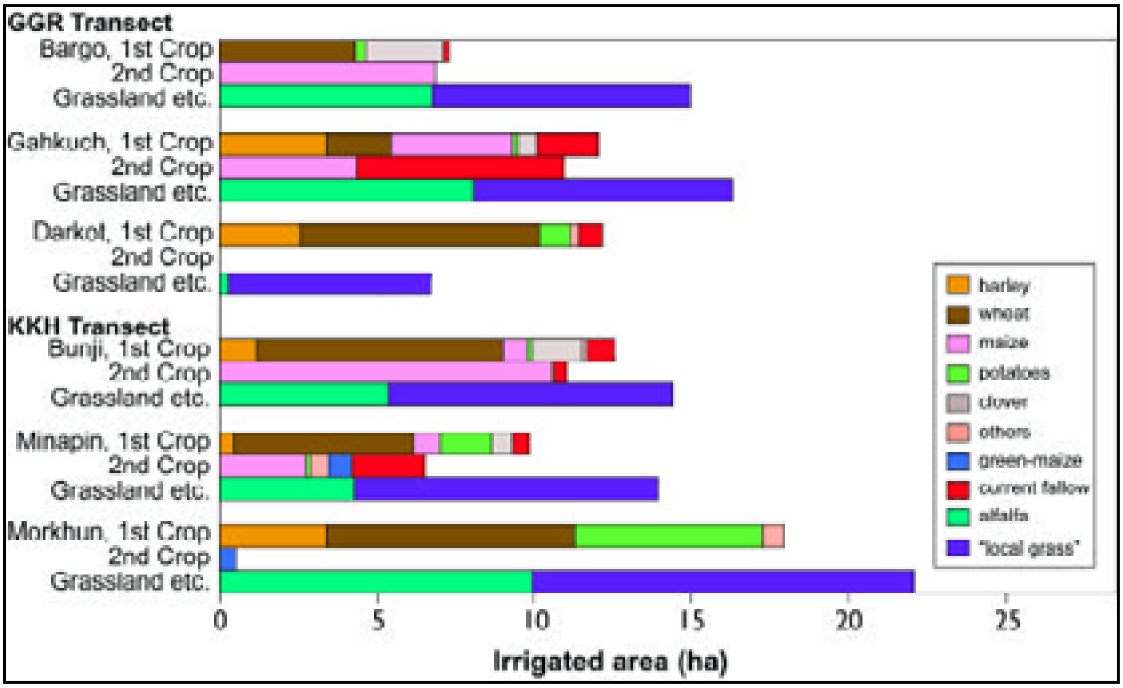

Figure 4.2: **Cropping patterns in the study sites (2000); areas reported are for 20 households**

given by farmers for leaving land fallow. These reflected crop rotation patterns and the availability of water for irrigation, as well as farmers' changing attitudes and preferences. In the transitional zones, a second crop of maize is only possible after a first crop of barley, which has a short growing period. If wheat or potatoes are the first crop, land must be left fallow for the rest of the growing season. Equally, the second-crop potential was often limited by the scarcity of irrigation water, for example in Gahkuch. Growing of buckwheat, at least as a catch crop, has been reduced drastically due to labour shortages and to the availability of year-round supplies of wheat, which is the primary bread-making cereal. Only a limited area of green-maize, which is often sown as a catch crop for animal feed, is grown (Figure 4.2).

These patterns of land use are generally similar to those found in several other studies of the changing farming systems in the Northern Areas of Pakistan (Khan and Khan 1992; Kreutzmann 1993; Nüsser and Clemens 1996; Streefland, Khan, and Lieshout 1995).

The economics of the livestock sub-sector

The farmers' perceptions of the importance of livestock to household income are shown in Figure 4.3. Respondents considered farming in general, and in the upper parts of the KKH transect the marketing of potatoes in particular, as their most important source of income. This reflects the direct cash income, for example, from potatoes, as well as the important production of staple crops, such as wheat and maize for human consumption and crop residues for the winter feeding of animals. The second most important source of income was cash income from off-farm employment. Income from livestock was ranked third, followed by seasonal labour, running a business (e.g., a general store), and income from pensions. Most of the households sold animals and animal products only occasionally (see below). The survey probably underestimates the indirect income, in kind, from livestock.

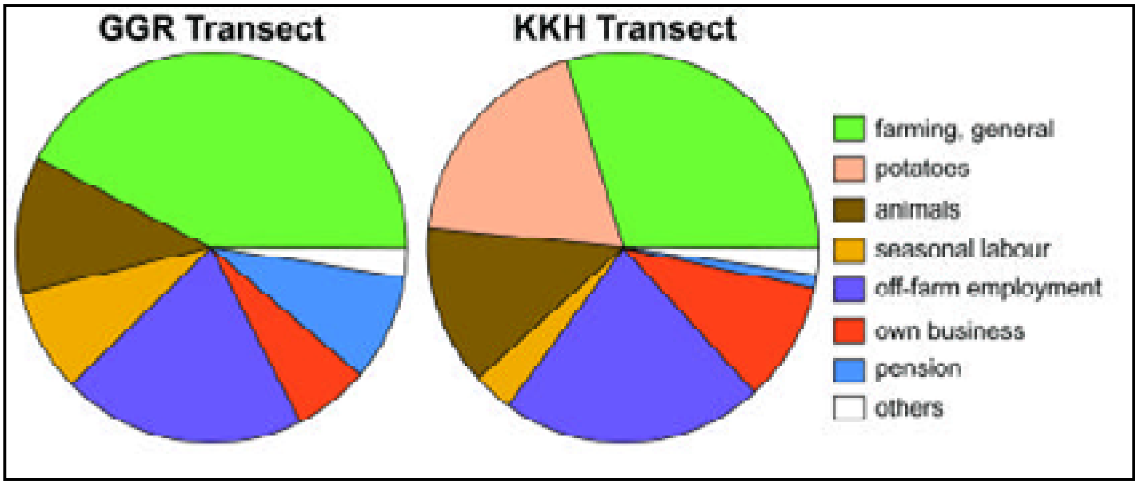

Figure 4.3: **Farmers' perceptions of important sources of income. Based on the question: Which source of income (cash or kind) is the most important to your household? Multiple answers possible.**

The data from AKRSP's Farm Household Income and Expenditure Survey for 1997 indicate that when assessed both in cash and in kind, the biggest contribution to total farm income in the Northern Areas is actually from livestock. Livestock's share of the total farm income ranged at the regional level from 37 to 43%, compared to crops and vegetables with 32 to 36% (AKRSP 2000). The income from livestock had increased from 22 to 33% of gross farm outputs and from 7 to 29% of net farm income compared to earlier surveys (Bhatti et al. 1994, data from 1991; Malik 1996b, data for 1994). The data from the 1997 survey did not show large differences between socioeconomic groups in terms of main source of income. Wealthier groups earned about 43% of total farm income from livestock, compared to 36% for the bottom quintile (AKRSP 2000). The AKRSP data also showed that most animal products and services remain within the individual farm economies: only 10% or less of these products were sold (Malik 1996b).

Between 23 and 46% of farmers in the villages in the present study sold at least one animal in 1998/99 (Table 4.6). Most goats and sheep were sold in late summer after fattening, during winter, or in cases of financial crisis (Figure 4.4). The percentage of households selling livestock was not related to the ease of access to markets or road infrastructure (Table 4.6). The lowest percentage of farmers selling livestock was in Gahkuch, close to Gahkuch Pain, the administrative headquarters of Ghizer district, while the highest percentage was in Darkot, the most remote village in the study.

Fewer households sold livestock products than sold animals; butter was only sold regularly by 12% of the sample households. Most butter is kept for fresh consumption or stored (for several years) for family ceremonies such as marriages and funerals. None of the surveyed households sold fresh milk; milk is sold in other villages, but fresh milk sales are insignificant at the regional level.

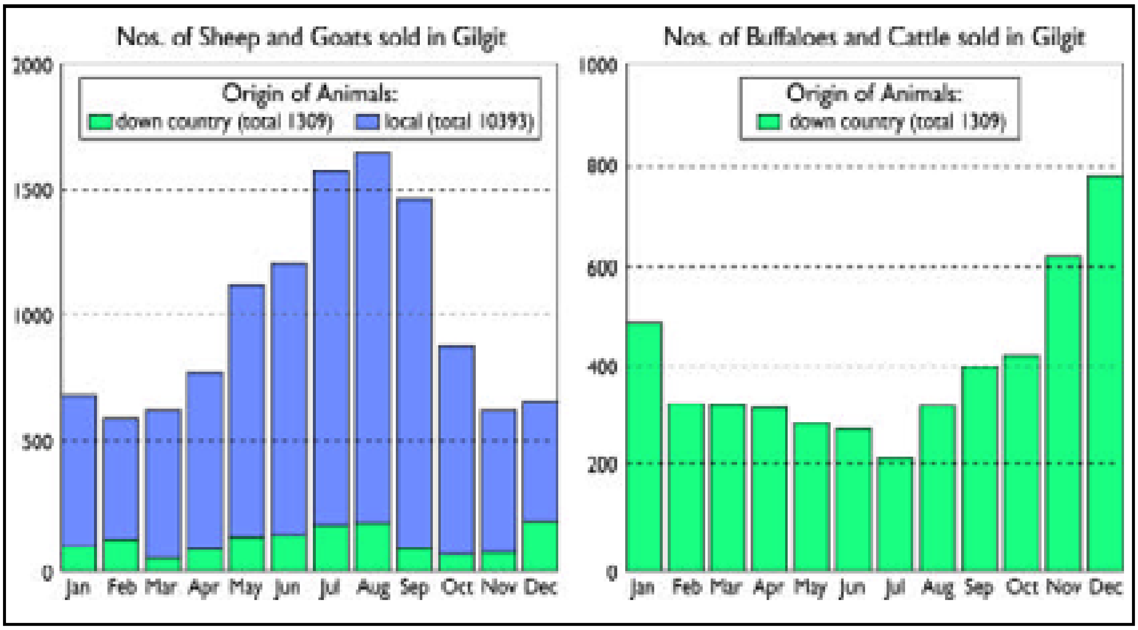

Figure 4.4: **Livestock sales and external inflow of animals to Gilgit town (1998). Source: Malik (undated). Down country = Pakistani lowlands**

Many households fill supply gaps (quantitative or seasonal) by purchasing UHT milk packs or milk powder brought to the Northern Areas from the Pakistani lowlands (Dietrich 1998).

Meat supplies at the local and regional levels are important triggers of livestock economics and the individual households' economies. Meat is not a regular component of family diet in the villages (Herbers 2000). It is mostly consumed during autumn and winter after slaughtering some of the households' own animals or as dried meat over winter. The tradition of 'nasalo', slaughtering before the winter and preserving the meat, is common all over northern Pakistan (Snoy 1993; Nüsser and Clemens 1996; Herbers 2000). Meat is also eaten at family ceremonies such as marriages or funerals; small ruminants, preferably goats, are kept for this purpose.

Despite the generally low demand, there are still gaps in the meat supply in the Northern Areas which might be explained by the demand from the army, the increasing human population, or (until 1990) increasing numbers of tourists. The number of slaughtering places for buffaloes in the Gilgit bazaar increased from 2 in 1985 to 15 in 1990 (Kreutzmann 1993). But as a result of the lack of marketing structures for locally produced livestock, most of the meat demands are met by imports of live animals from 'down country' as well as by animals smuggled from Afghanistan (this study; Kreutzmann 1996 for Chitral) or China. Overall, the policies and structures at different levels discourage marketing of local livestock. From 1974, the national government's subsidy policies for grain and fuel encouraged the transport of live animals and animal products towards the mountains and not vice versa (World Bank 1990); animal products accounted for around one-third of all goods arriving in Gilgit at the beginning of the 1990s (Khan and Khan 1992). Cull water buffaloes from 'down country' are brought to market places of the Northern Areas by traders, especially from the North-West Frontier Province of Pakistan and the imported animals are slaughtered by local butchers. The meat prices are generally fixed by the local administration in favour of urban customers, the fixed beef prices (50-60 Rupees per kg in 2000) undercut those of locally produced meat, especially mutton (90-100 Rupees per kg). In 1998, nearly 4,800 water buffaloes and lowland cattle were sold in Gilgit Town (Malik undated). Imports are highest in winter, when the meat consumption of the local population (but also the availability of locally produced animals) is traditionally the highest (see Figure 4.4). Imports of live animals are also common in other parts of northern Pakistan, for example in Baltistan (Allan 1998) and Chitral (Dittmann and Nüsser 2002).

Constraints to livestock productivity

Farmers were asked for their views on the major problems of keeping livestock. Lack of fodder, especially for overwintering of animals, was perceived as an important constraint to livestock production and productivity (Figure 4.5). However, traditional management strategies had been developed to adjust herd size according to the available fodder supplies, such as the sale of animals during

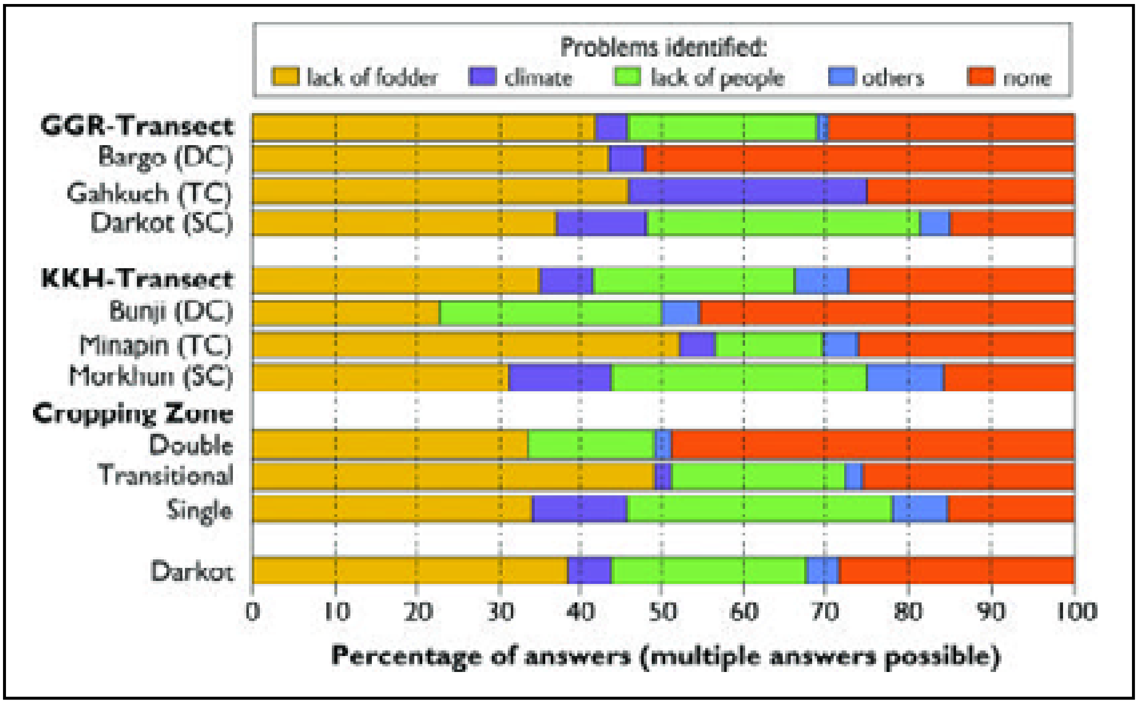

Figure 4.5: **Farmers' identification of major problems of keeping animals. Based on the question: What are the major problems of keeping animals according to your own experience? Lack of fodder includes insufficient grazing areas; other includes losses through predators** (DC = double cropping zone; TC = transitional zone; SC = single cropping zone)

autumn or slaughtering at the beginning of the winter (the 'nasalo' tradition, see above).

The quantitative measurement of fodder supplies and requirements in this project (Chapter 2) supports this view and agrees with previous findings of quantitative and qualitative fodder gaps in the Northern Areas, especially during winter and spring (e.g., Wardeh 1989).

Even so, almost 60% of the farmers in the six study villages actually assessed their fodder resources as being in surplus (Table 4.8). However, there are only limited sales of locally produced fodder, so that farmers with insufficient fodder cannot readily supplement their resources by additional purchases. Within this study, regular purchases, especially of alfalfa hay or feed concentrates, were more prominent along the GGR transect and in villages at higher altitudes.

In areas close to regional market centres, livestock are increasingly kept for income rather than family use. Farmers in Bargo benefited both from the agro-ecological potential of the double cropping zone and from their proximity to Gilgit. The milk animals kept to meet the demands of the urban population place high demands on fodder and thus the prices of lucerne hay reach high levels, especially during winter and spring. Lucerne can be cut at least three times per year in Bargo and clover up to five times, and sale of lucerne and clover seed is common. This example indicates an awareness among a small sector of the

Table 4.8: Percentage of households with surplus and deficit of fodder (farmers' perception based on 129 sampled households)			
	Fodder supplies from own resources		
	Surplus	Barely sufficient	Deficit
% of households	58.7	28.5	12.7

population of the income generating potential of agriculture, an awareness that is still not widespread in the Northern Areas. Although the leguminous crop lucerne has been an important component of the crop rotation for quite a long time (Singh 1917), it has only recently become widely cultivated, and this as a part of recent land development schemes. Lucerne serves to improve soil fertility and overcome local fodder shortages, which have been exacerbated by changing cropping patterns such as the intensified cultivation of potatoes instead of cereals (for example in Minapin and Morkhun).

The next most important constraint to keeping livestock that farmers identified was the lack of labour and time for herding animals, especially for the movement of animals to higher altitude pastures in summer and their subsequent herding. In three of the six study villages – Bunji, Morkhun, and Darkot – this issue was perceived to be as severe as the lack of fodder resources (Figure 4.5). Two major reasons were given for the labour shortage: the increasing absence of men from the villages due to off-farm activities and permanent employment, and the growing number of children attending school.

The problem of labour shortage is met by reducing the herd size, by keeping more animals permanently near the farmsteads, and/or by several households jointly managing their livestock. These trends have been observed within the Northern Areas in other studies (Nüsser and Clemens 1996; Kreutzmann 1993, 2000; Stöber and Herbers 2000). Within the project's study villages, several households have recently not only engaged relatives to tend livestock but also hired semi-professional herders for payment either in kind or in cash, for example in Gahkuch-Bala. In other villages, labourers were hired for payment on a seasonal basis for agricultural work, including grazing, for example in Morkhun, or loan defaulters were engaged for this work until the loan was repaid, for example in Bunji. The issue of labour availability at the individual household level is one of the major driving forces affecting utilisation of pastures at a community-wide level (see below).

Other reported problems included weather (heavy rain or snow during summer) and losses due to predators, which were generally of minor importance but more relevant in the single-cropping, higher altitude areas. The proportion of householders that reported no problems in keeping livestock was much higher in the villages in the double cropping zones.

Utilisation of pastures

Strategies of rangeland management by agro-pastoral communities in northern Pakistan have been perceived repeatedly as exploitative and unsustainable, especially in documents related to conservation programmes. For example, “In this region, pastoralism is an important land use and economic pursuit. Most of the rangelands are common village or tribal property and are not subject to regulated grazing. Coupled with nomadic grazing, the alpine pastures and other grazing grounds have been ruthlessly exploited” (Ahmad 2000). These statements are, however, not supported by empirical evidence. Surveys of the grazing potentials of alpine pastures so far conclude that in many of these pastures the potential has not yet been fully utilised (Chapter 3; Klötzli et al. 1990; Nüsser 1998). However, differences have to be considered in terms of the seasonality of pastoral migration cycles and the pastures’ altitudes. For example, as stated by Khan (2000), “although winter rangelands are highly over-grazed in Northern Pakistan, summer pastures in the upper montane and the alpine zones are not fully used”.

The vast majority of farmers thought that the winter pastures of their village could not maintain more animals (Table 4.9), but the results for the summer pastures were more variable. In all the villages apart from Gahkuch, more than half of the farmers thought that the summer pastures could maintain more livestock. These perceptions generally reflect the observed levels of utilisation reported in Chapter 3, where the estimates of utilisation rate suggest that many mountain (summer) pastures could be used to a greater extent for grazing livestock.

Table 4.9: Percentage of farmers who thought that their village pastures could carry more animals[1]

	GGR Transect						KKH Transect					
	Bargo DC		Gahkuch TC		Darkot SC		Bunji DC		Minapin TC		Morkhum SC	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Summer pastures	64	36	32	68	52	48	62	38	86	14	57	43
Winter pastures	10	90	5	95	0	100	5	95	30	70	49	51

[1] Based on the question: Do you think that the summer/winter pastures of your village can sustain more animals? DC = double cropping zone; TC = transitional zone; SC = single cropping zone

The mountain summer pastures in northern Pakistan are still used as part of the agro-pastoral land-use system, and village communities traditionally enforced this by banning all animals, except one milking animal per household, from the cropped area during summer. This tradition, however, is currently undergoing significant changes. Although many continue to send their animals to the mountain pastures (often tended by a relative or hired shepherd), others keep more of, or even all, their animals within the villages year round and graze them on a daily basis along field boundaries and on uncultivated land (Figure 4.6).

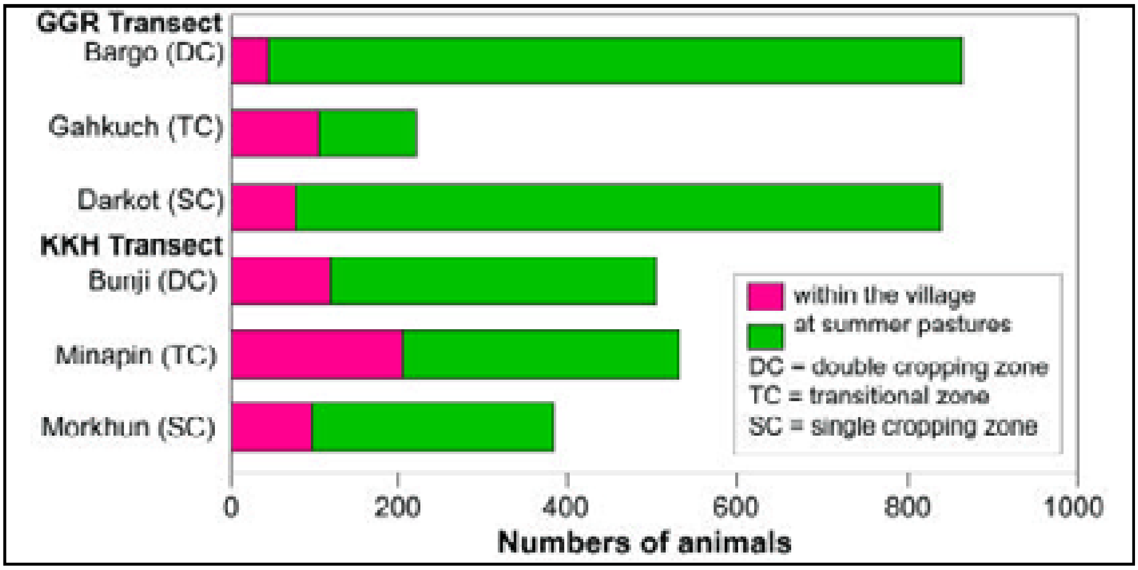

Figure 4.6: **Number of animals sent to pastures or retained around the homestead during the summer**

In Minapin, 12 of the 20 households surveyed kept most of their animals close to the homestead throughout the year, and five households did not send any animals to summer pastures. In Bargo and Gahkuch, 15 and 13 households, respectively, out of the 22 surveyed in each village, kept most animals close to the homestead throughout the year. Nearly one-third of households in Bargo did not send any animals to the summer pastures at all (8 of 22).

The differences between villages that sent or did not send animals to summer pastures could not be explained on the basis of agro-ecological zone, accessibility to the road network, local facilities for education, or off-farm employment. Where the traditional agro-pastoral grazing cycles were maintained, it appeared to be mainly by using labour inputs external to the household or through joint family systems. The substitution of joint systems for single household systems is increasingly common in northern Pakistan (Nüsser and Clemens 1996; Stöber and Herbers 2000). Often, this is also driven by the direct and indirect impacts of the increased tourist treks, which mostly lead to alpine pasture areas and give them a new economic value. Changes in Minapin, the major base for treks to the Rakaposhi range, even led to the abandonment of one pasture settlement in 1999 due to local labour constraints. At the time of the study, individual livestock owners in Minapin were herding livestock on mountain pastures on a rotational basis for only a few days per summer, and could thus spend more time on off-farm activities.

Conclusions

The overall trends in livestock numbers in the Northern Areas of Pakistan are not clear; there are conflicting estimates of livestock numbers. There are also considerable gaps in knowledge regarding the contribution of animal husbandry to overall farm and household incomes.

Changes in external socioeconomic driving forces, especially off-farm employment and education, have been considerable and have had indirect effects on the livestock sub-sector and the agro-pastoral grazing system. Many individual households are decreasing their household labour inputs at summer pastures through several strategies such as reduced herd sizes, permanent summer grazing of animals around their farmsteads, joint management systems, and paid external labour.

At present, there are few marketing incentives for local livestock owners, and several policies discourage commercialisation in the livestock sector. Thus, livestock and animal products still remain overwhelmingly within the household economies, irrespective of ease of access to road infrastructure.

In general, agro-pastoral livelihood conditions are limited significantly by scarce resources of cultivated land and consequently by shortages of fodder for winter feeding. Recent changes in the cropping patterns in favour of selected cash crops, especially potatoes, have increased the local fodder gaps, and traditions of inheritance will cause further land fragmentation. At present, gaps in the food supply for people can be overcome by purchasing subsidised staple food supplies such as wheat. But only a small market has developed for animal fodder. There is a marked need to increase the cropping potential within the Northern Areas to fulfil both human and animal demands. Possible strategies include the development and irrigation of additional land, changing cropping patterns in favour of increasing the net area sown – for example, with the wider introduction of winter cereals; selection of more location-specific cereals and fodder crops (even as catch crops); and planting of multipurpose trees. Development projects and government institutions have taken up selected issues since the 1980s (Whiteman 1985). However, farming communities still have reservations against these specific interventions. More holistic approaches with a special focus on farmers' perceptions, participation, and capacity building, such as on-farm trials, are still needed. Farmers must also be integrated into the decision-making process. This also holds true for the sustainable use of rangeland resources. Local communities are the major stakeholders of these natural resources, and their direct integration into the identification of priorities and the implementation of management strategies is a prerequisite for successful development activities. Further recommendations for increasing rural incomes in northern Pakistan must be based on the identification of economically and ecologically feasible management interventions, and take into consideration the farmers' own priorities and capabilities.

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5 A Systems Approach to Understanding Constraints and Opportunities

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Introduction

Classical scientific research methods are based on reductionism – they reduce systems to their basic components and seek to understand the mechanisms in terms of cause and effect. The systems approach recognises that objects and events are part of a larger whole – a set of interrelated parts – and that the functioning of one part can affect the functioning of another. In other words, a system is more than the simple sum of its parts. There is a common misconception that systems research means that every conceivable process or event that could influence the functioning of the system must be studied. This is not the case, since this would lead to the inevitable conclusion that one would have to study the whole universe in order to advance understanding. The systems approach to research necessitates defining the boundaries of the system of interest. This can be at a range of spatial and temporal scales and it can be applied to physical, biological, economic, or social systems. One of the great strengths of the approach is that it can be used to cross traditional disciplinary boundaries, and is therefore an extremely powerful tool when dealing with systems that comprise, for example, biological, economic, and social components.

There is also a distinction to be drawn between systems research and systems development. Systems research leads to new knowledge and analysis about the way in which a system functions. Systems development then synthesises that knowledge to modify the system to create a new or modified system (Figure 5.1). This chapter gives an example of how a systems approach to research can be used to identify constraints to a system and how that system might then be modified to overcome some of those constraints. It does not deal with the testing or validation of any modifications to the system.

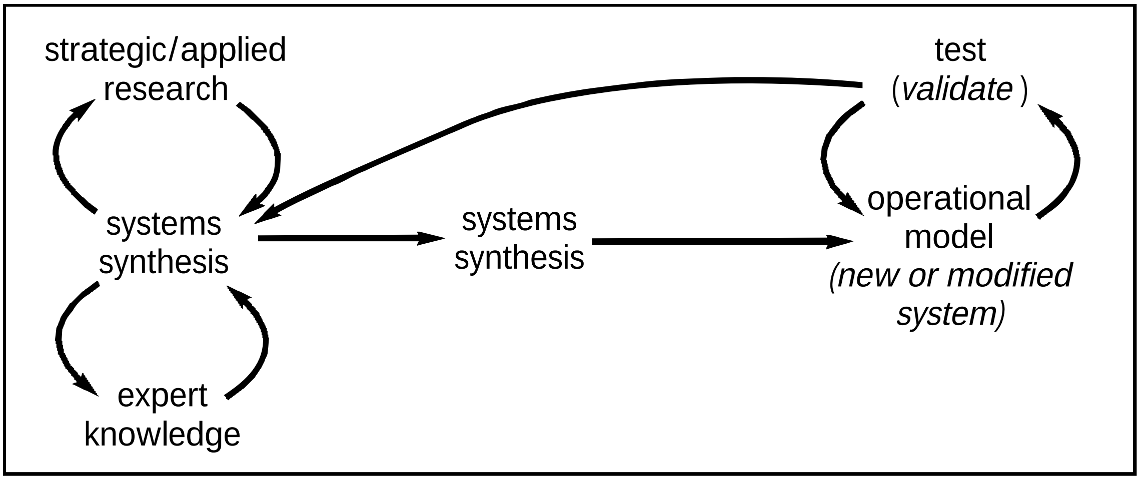

Figure 5.1: **Systems research and systems development**

There are four key steps in a systems approach to research (Pearson and Ison, 1997):

- define the boundaries of the system of interest,
- define the objectives of the system (these can be thought of as the outputs),
- describe the resources (these can be thought of as the inputs), and
- describe the components and their interactions.

Chapter 1 described the objectives of this study in the Northern Area of Pakistan, which were to:

- examine constraints to increasing productivity from livestock,
- measure botanical composition, pasture productivity, and biomass offtake by grazing livestock, and
- understand the socioeconomic context of livestock production, including labour, marketing, and traditions.

Thus three principal components of the system were identified and studied in a way that allowed the linkages between the components to be described and analysed. Livestock production depends on grazing mountain pastures in summer (Chapter 3) and stall feeding of a variety of fodder types in winter (Chapter 2). At one level, animal production can be considered as a process by which feed is converted to animal products by the animal. However, this ignores the fact that livestock production is an economic activity that takes place within the context of a more complex farming system managed by a household. Thus, livestock production competes for resources with other household activities. It is therefore important to take account of the household's or farmer's objectives for keeping livestock. The household itself sits within a wider village system. However, for the purposes of this chapter the system will be defined as the livestock within the household. Linkages to other parts of the farming system and the wider socioeconomic context can be thought of as inputs to and outputs from the system (Figure 5.2).

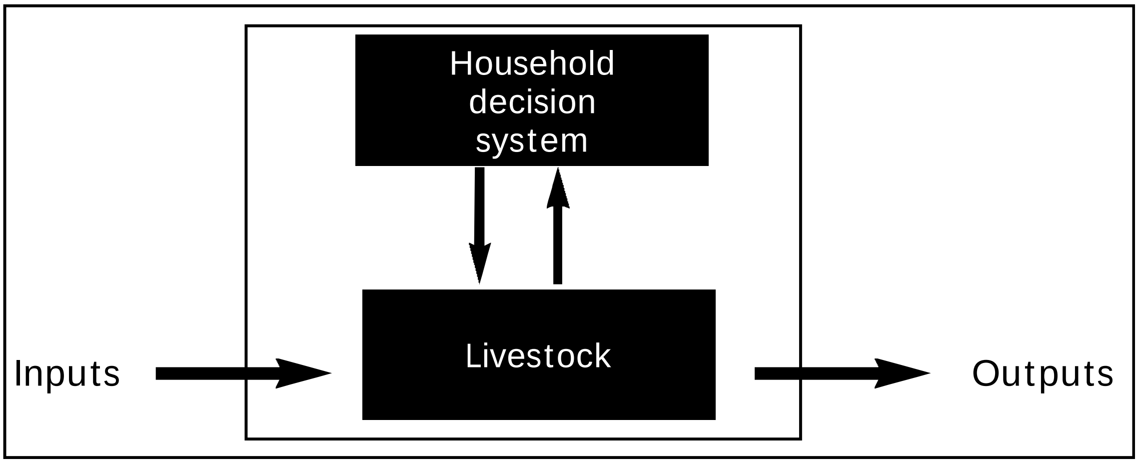

Figure 5.2: **A simple model of a livestock system**

Outputs from the livestock system

Now that the boundaries of the system have been defined, we need to define the outputs from the system. The socioeconomic survey (Chapter 4) asked farmers why they kept livestock. In approximate order of importance the responses were: milk, dung, butter, meat, transport, income, fibre, draught power, and tradition. Although tradition did not feature strongly in the responses, it was clear that tradition pervaded many of the other reasons for livestock keeping.

There were some differences in the importance attributed to various outputs among villages and the two transects of the study (see Chapter 1 for a description of the two transects). For example, although none of the farmers in the Karakoram Highway transect (KKH) mentioned draught power as a reason for keeping animals, 25% of farmers in the most remote village in the Gilgit Ghizer transect (GGR) did. The most important output was milk, mentioned by nearly every household. The second most important output was dung, which immediately identifies a link to another system, the cropping system.

Inputs to livestock systems

During the course of the study the key inputs to the livestock system were identified as feed (Chapter 2) and labour (Chapter 4). In winter, the animals are kept in the village and stall fed conserved fodder, crop residues, leaves, and household waste. They also scavenge around the village and may be taken out to graze on pastures close to the village. In summer, most animals graze mountain pastures, where pasture is the sole source of feed. However, increasingly some households keep animals close to the homesteads in summer too. These animals are mostly fed fresh cut fodder or graze waste land and field boundaries. Chapter 4 identifies the way in which households allocated labour to different activities, including off-farm labour.

Livestock feeding and productivity

The results in Chapter 2 showed that the overall levels of animal performance were higher in the Karakoram Highway transect than in the Gilgit-Ghizer transect. Two examples of this are shown in Table 5.1 – both milk yield in cows and kidding percentage (the number of kids born per year per 100 does) were higher in the Karakoram Highway transect. This was related to higher levels of winter fodder supply (Table 5.1). Overall, the animals lost considerable amounts of live weight and body condition during the winter feeding period in the villages. The average body condition score of mature cattle was 3.2 in September, but this had dropped to 1.8 by March (see Chapter 2). There is therefore a considerable shortage of feed for livestock during the winter.

Table 5.1: Winter feed sufficiency, cow milk yield, and goat kidding percentage in the Gilgit Ghizer (GGR) and Karakoram Highway (KKH) transects

Transect	Winter feed sufficiency index	Cow milk yield (l/day)	Kidding (%)
GGR	0.8	2.3	0.79
KKH	1.2	2.9	0.99

Summer grazing

When animals are moved to pastures in spring, initially to the dry temperate pastures, they start to gain live weight and body condition immediately. This improvement in condition continues during the period when they are moved to the high alpine pastures. From a body condition score of 1.8 in March, mature cows, for example, increased their body condition score to 3.5 by October. It is noteworthy that the animals in the Gilgit-Ghizer transect achieved higher levels of body condition than those on the Karakoram Highway transect (3.7 vs. 3.3).

The levels of pasture productivity and utilisation were generally much lower in the dry temperate pastures, which are at intermediate altitudes and are grazed by livestock in spring before they are moved to the higher alpine pastures, than they were in the alpine pastures (Figure 5.3). There were two other striking features. First, the levels of utilisation of the dry temperate pastures are lower than the levels of biomass production in spring. This indicates that the pastures might be able to sustain higher use at that time, perhaps by moving animals to them earlier than is current practice. However, since these data relate to one year only, this conclusion must be regarded as tentative until further data are gathered. Second, the levels of utilisation of the alpine pastures on the KKH transect were considerably lower than those on the GGH transect. Although the levels of pasture utilisation in summer were higher in the GGR pastures, the animal performance was also slightly higher, suggesting that from a livestock perspective they were not over-utilised.

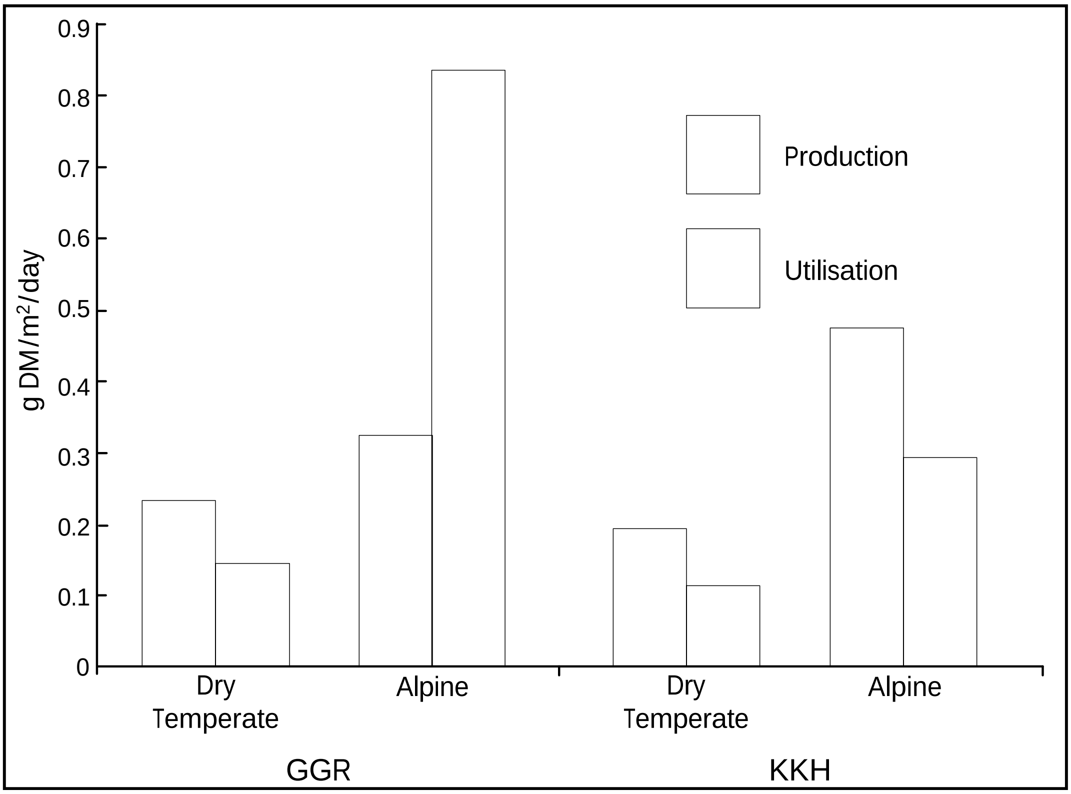

Figure 5.3: **Pasture production and utilisation in dry temperate and alpine pastures in Gilgit Ghizer (GGR) and Karakoram Highway (KKH) transects**
(from Chapter 2, Table 3.4, values relate to the period of grazing only)

Interestingly, when householders were questioned as to their perceptions about the carrying capacity of the summer pastures, 57% thought that the KKH pastures could carry more animals, but only 49% of households in the GGR transect thought that their summer pastures could support more livestock. Thus, the measurements of pasture productivity and utilisation support the perceptions of the householders.

Labour inputs to livestock husbandry

Clemens (Chapter 4) collected data on labour deployment in the sample households and found that in the GGR transect the mean amount of labour spent on each animal per year was 109 hours, while the equivalent figure for the KKH area was only 76 hours. This is a reflection of the greater opportunities for cash cropping in the more readily accessible KKH transect (19% of household income comes from growing potatoes in the KKH transect, but growing potatoes for sale is not a feature of agriculture in the GGR area) and the improved opportunities for running businesses other than agriculture.

By allocating a score to the level of education of each member of the household over 10 years old, a mean education index was calculated for each household. The level of education was higher in the households in the KKH transect (with a mean education index of 3.0 in the KKH transect and 2.5 in the GGR transect). This has two important effects. First, the amount of labour available for tending animals is reduced because children, who are traditionally involved in livestock tending, spend more years at school. Second, the higher level of education raises expectations, particularly among young people who may not be content to stay at home and become involved in traditional activities such as agriculture, but may prefer to move from the area to seek alternative employment opportunities.

Generally, most of the farmers in the survey had reduced the size of their herds and flocks over the previous five years, although there were differences among villages, with labour availability being cited as one of the main reasons (Chapter 4).

Village workshops

After the main phase of data collection had been conducted and some preliminary analyses of the data undertaken, three workshops were held, to which representatives of the six study villages were invited. At these workshops the objectives, methods, and preliminary findings of the project were explained. These were then discussed from the perspectives of the local population. The conclusions from these workshops are shown in Box 5.1. The options for improving livestock productivity given in this chapter include suggestions and recommendations made at these workshops.

Options for improving livestock productivity

The above analysis, based on the integration of research on different components of the livestock sector in the Northern Areas of Pakistan, identified four principle means of improving livestock productivity:

- increase winter fodder production,
- improve the utilisation of some pastures in some areas,
- reduce animal numbers, and
- improve commercial aspects.

Increase winter fodder production

There is a considerable shortage of winter feed, as indicated both by livestock performance over winter and by direct measurement of fodder availability in relation to livestock requirements (Chapter 2). The farmers themselves identified scarcity of winter fodder as a major problem in keeping livestock (Chapter 4). Other studies have also indicated a shortage of winter fodder. For example, Wardeh (1989) estimated that only 52-74% of the requirements of livestock were being met. While the present study indicates that the amount of winter feed available varies with the location, there is clearly a need to increase the supply of winter fodder if livestock productivity is to be improved.

One way to increase the supply of fodder is to increase the area of irrigated land. Each household has, on average, only about 1 ha of irrigated land on which to grow crops and fodder. Increasing the area of land under irrigation would allow more fodder, such as lucerne, to be grown.

Box 5.1: **Outcomes of three workshops held with representatives from the study villages to discuss preliminary results**

Livestock/fodder issues

- Increased fodder production is required. This may be achieved by land development, although water shortage is often a constraint as are changes to cropping patterns.
- Villagers stressed the need for relevant and accessible training on livestock issues on a household basis, as training of village specialists did not necessarily lead to further training of householders (e.g., on manger construction). There was a need to foster participation.
- There was a need to keep costs low and to use locally available materials.
- They wanted to know how to improve feed quality, feed storage practices, and feeding conditions.
- They wanted to know how best to tackle diseases such as liver fluke, foot rot, and tick infestation. Vaccination following disease outbreaks was currently slow.

Pasture ecology issues

- There was a need to raise awareness of pasture issues at the village level.
- Villagers requested training on how to assess pasture production and quality from local institutions and experts.
- The creation of pasture committees was a strong common theme. These would be responsible for organising a village pasture management strategy and liaison with local institutions.
- Pasture Management Plans should include issues such as: commercialisation of pasture resources (excess pasture could be leased to earn cash), means of distributing animals more effectively, and reseeding of pastures.

Socioeconomic issues

- Villagers considered risk-aversive strategies important. For example, if herd sizes are reduced, risks are concentrated among fewer animals, but can be reduced by better management practices such as vaccination against disease.
- Cultural and religious traditions are important (e.g., herd size reduction could interfere with requirements for animals for these purposes).
- Householders need to prioritise their requirements for livestock. The rationale for keeping livestock must be considered.
- Long-term thinking is required, e.g., if children are attending school then labour for herding animals will be reduced.

General issues

- The village representatives were grateful that the project team had returned to discuss the preliminary results with them.
- Training and follow-up from this project is needed.

Crop residues are a major source of winter fodder. In the study villages, wheat straw accounted for 48% of the dry matter offered to livestock over winter, and 36% of the metabolisable energy. Most of the cereals grown are spring cereals. A switch to winter cereals would have two possible advantages: winter cereals would provide a higher yield of straw and therefore increase the supply of fodder, and it may be possible to graze winter cereals lightly in spring without affecting grain yield. This would provide a valuable source of grazing at a time of year when fodder supplies are almost exhausted. This would, however, require a mechanism to control the timing and extent of grazing to ensure that unacceptably high levels of grazing were avoided. Furthermore, those who first adopt winter cereals in a village may face problems because their earlier-ripening crops could be subject to increased damage from insects or birds that have limited feed available to them from surrounding fields. Thus, some sort of coordinated community action may be required. Also, winter cropping requires that the field be prepared for the next crop quickly after harvest, putting pressure on both labour and mechanised equipment where it is used. However, growing of winter cereals is practised in some of the villages in the double-cropping zone and to a limited extent in the transitional zone.

New crops may also have a potential role. There may be potential to introduce catch crops such as triticale, vetch, or other leguminous crops sown immediately after the major crop to produce more green fodder and also to improve soil fertility. However, this may put pressure on available labour, and not all households may have this capacity. One possible solution could be the leasing of land on a share basis. Households with land resources may lease land to households with excess labour capacity and share the crop on perhaps a 50:50 basis. This share cropping already happens in the Northern Areas.

However, before introducing new crops or cropping patterns the utilisation of the existing fodder supplies should be optimised. Many farmers supply fodder to stall-fed animals by placing it on the floor. Inevitably this leads to a proportion of the fodder being trampled and contaminated with urine and faeces, and thus rejected by the animals. This wastage of fodder could be reduced by providing fodder in simple mangers made from locally available materials, such as wood.

Improved utilisation of pastures

Traditionally, the response to a shortage of winter feed in the Northern Areas has been to suggest ways of increasing the supply of winter fodder (e.g., Wardeh 1989). While this is clearly one option, this study suggests that there may be other alternative or complimentary strategies for improving livestock productivity. The measurements made on the dry temperate pastures that are grazed in spring, before the animals are moved to the high alpine pastures, indicate that there may be scope for increasing the utilisation of these pastures (Figure 5.2). However, as noted above, these measurements were made in one year only and need to be confirmed over a longer period of time. If they can be confirmed it may be possible to move livestock from the villages to these pastures earlier in spring than is current practice. This will have two benefits. First, the length of the winter feeding period will be reduced and with it the reliance on winter fodder and second the time during which livestock are at pasture will be increased and therefore the opportunities for recovery of liveweight and body condition increased. Pasture management committees need to consider how more flexible arrangements might be put in place to allow livestock to move to these pastures at the appropriate time to make better use of their potential.

Some studies have suggested that the high alpine pastures may be over-grazed (e.g., Ahmad 2000). This study indicates that there is considerable variation in the level of utilisation of these pastures. Those grazed by animals from villages along the Karakoram Highway have considerably lower rates of herbage utilisation than those in the Gilgit Ghizer area (Figure 5.2). This coincides with the perceptions of the villagers themselves, more of whom on the KKH transect than the GGR transect thought that their high mountain pastures could sustain more livestock. Thus, in some areas, notably along the KKH, there appears to be scope for sending more of the livestock to the alpine pastures in summer, although insufficient labour to tend the animals when they are away from the village may be a problem. The options for cash cropping, especially growing seed potatoes, and the higher general levels of education in the KKH transect may mitigate against people being willing to spend long periods of time in the alpine areas tending livestock.

Reducing animal numbers

One option to increase the feed availability to animals, especially in winter, is to reduce the number of animals kept per household. The reduction in numbers could be offset by higher production per animal as a lower proportion of the total feed requirements for the herd/flock would be used for maintenance. Such a reduction would also reduce the labour required for animal husbandry. On the other hand, reducing livestock numbers may conflict with traditional or cultural requirements. Social obligations when family members die, at ceremonies, and at religious festivals often require the slaughter of an animal to provide meat. It is regarded as easier to slaughter a sheep or goat than a cow. This, combined with a general preference for mutton rather than beef, may be one reason for keeping so many sheep and goats. However, recently some households have begun to buy meat for such occasions, where such meat is available on the market.

Reducing animal numbers also has the potential disadvantage of exposing households to greater risk of losses from the herd/flock. As pointed out by one villager, “If one of your four cows dies, you lose a quarter of your herd, but if you only have two cows and one dies, you have lost half your herd”. However, another villager pointed out that having fewer animals may lead to better management that would reduce the risks to each individual animal.

Improving commercial aspects

In most cases keeping livestock is a subsistence activity. The most important single reason for keeping animals was to provide milk, and most of this was consumed within the household (Chapter 4); only 12% of the sample households regularly sold butter. Improved marketing of livestock products locally and regionally is likely to lead to better returns from the livestock sector. The transaction costs of marketing livestock products are not inconsiderable, especially in the more remote areas where the travel time to market must be considered. However, a pre-requisite for informed decision making about the costs and benefits of more commercially focused livestock production is accurate information on market prices, which is not readily available to farmers at present.

Conclusions

Although this study focused on the Northern Areas of Pakistan, many features of the system are common to mixed crop-livestock farming systems across the Hindu Kush-Himalayan – Karakoram region, and indeed in other mountainous regions of the world (Tulachan et al., 2000). This study has clearly identified some of the key constraints that operate on livestock in these systems. There are also considerable opportunities for improving livestock production and for a greater contribution of livestock to the livelihoods of these households.

This project has highlighted the power of interdisciplinary systems research in identifying these constraints and opportunities. Without such a systems approach, it would not have been possible to identify the complex interrelationships among the biological, economic, and social components of livestock production. Further adaptive participatory action research is needed to develop some of the options identified in this chapter. There is little doubt that given appropriate assistance, the determination and resourcefulness shown by the people of the Northern Areas of Pakistan will ensure that they can develop their livestock systems to meet their needs.

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