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Livestock Feeding and Production

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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.

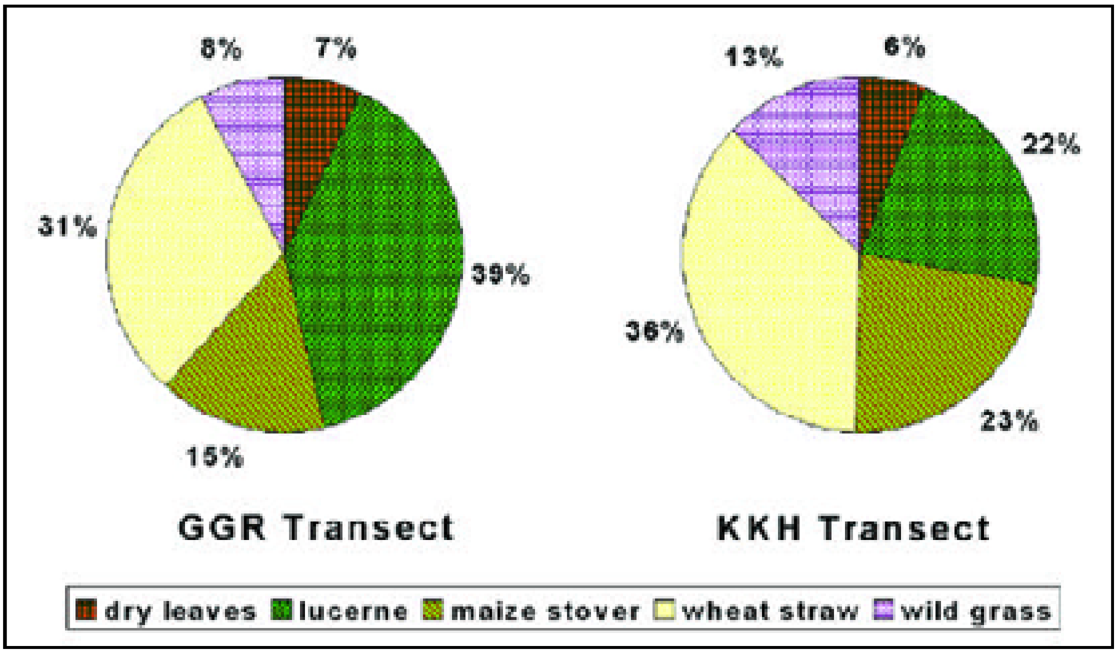

Figure 2.1: **Mean percentage of roughage storage (dry matter) per household at the start of winter in the two transects**

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).

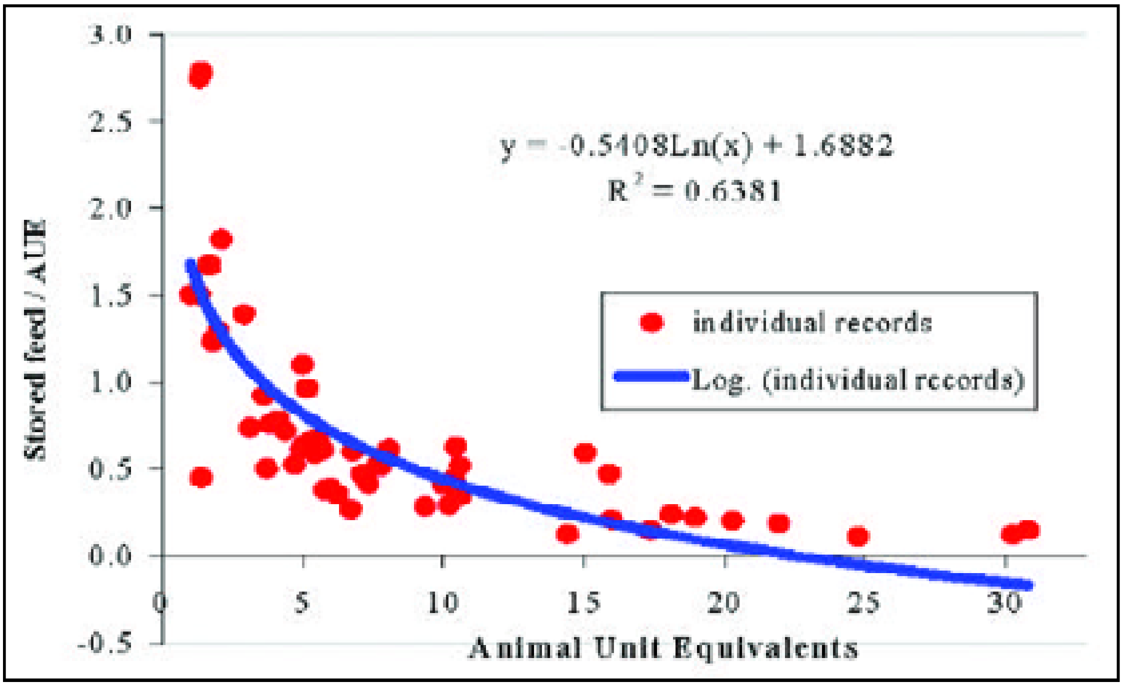

Figure 2.2: **Impact of herd size on stored fodder for winter per animal unit equivalent (AUE) in the study villages**

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.

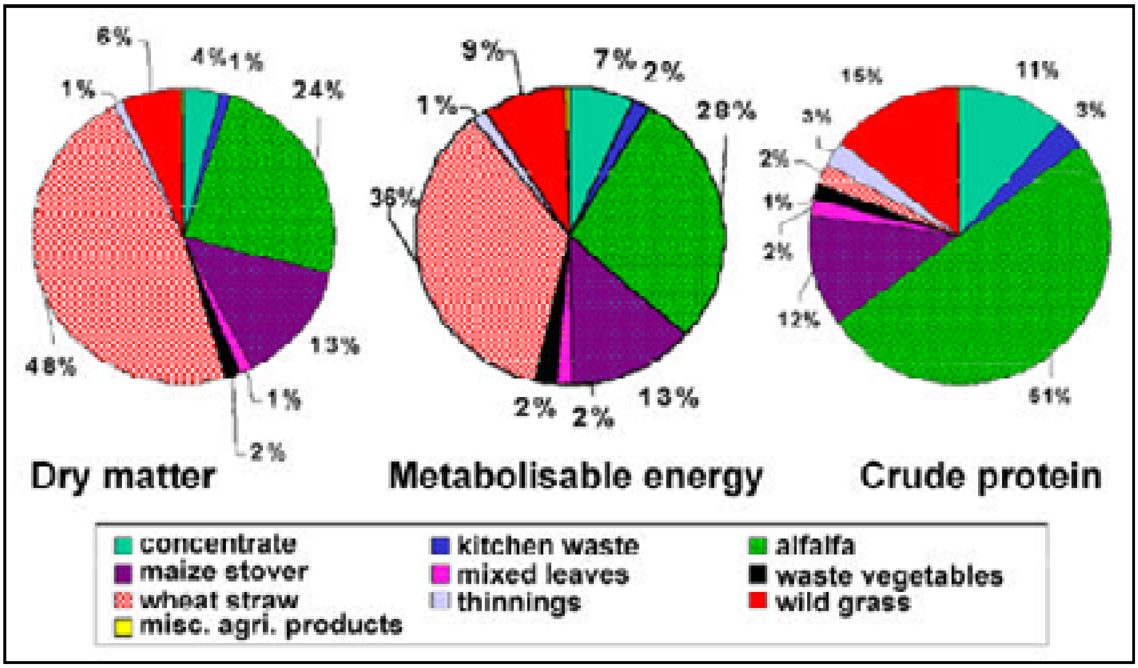

Figure 2.3: **Percentage of overall dry matter, metabolisable energy, and crude protein supplied by different components of the livestock diet**

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.

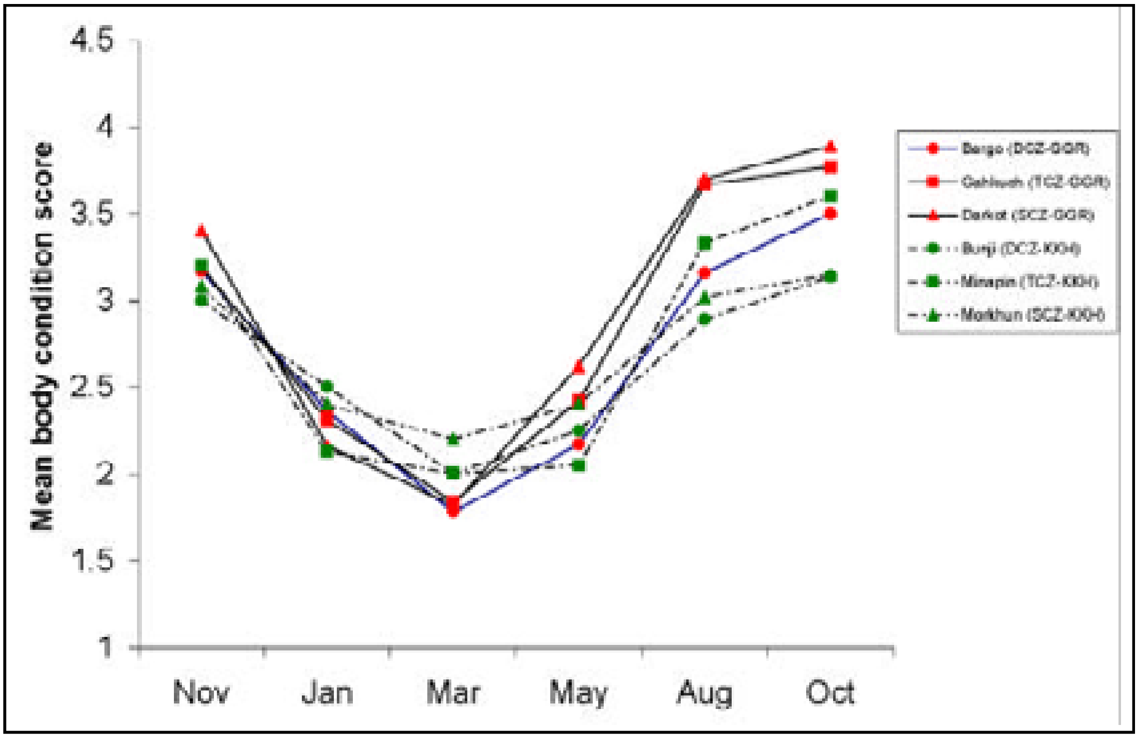

Figure 2.4: **Temporal changes in the body condition score (BCS) of mature cattle in the study villages of the Northern Areas. Solid lines represent GGR transect villages, broken lines KKH transect villages; circles represent the double cropping zone, squares the transitional cropping zone, and triangles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

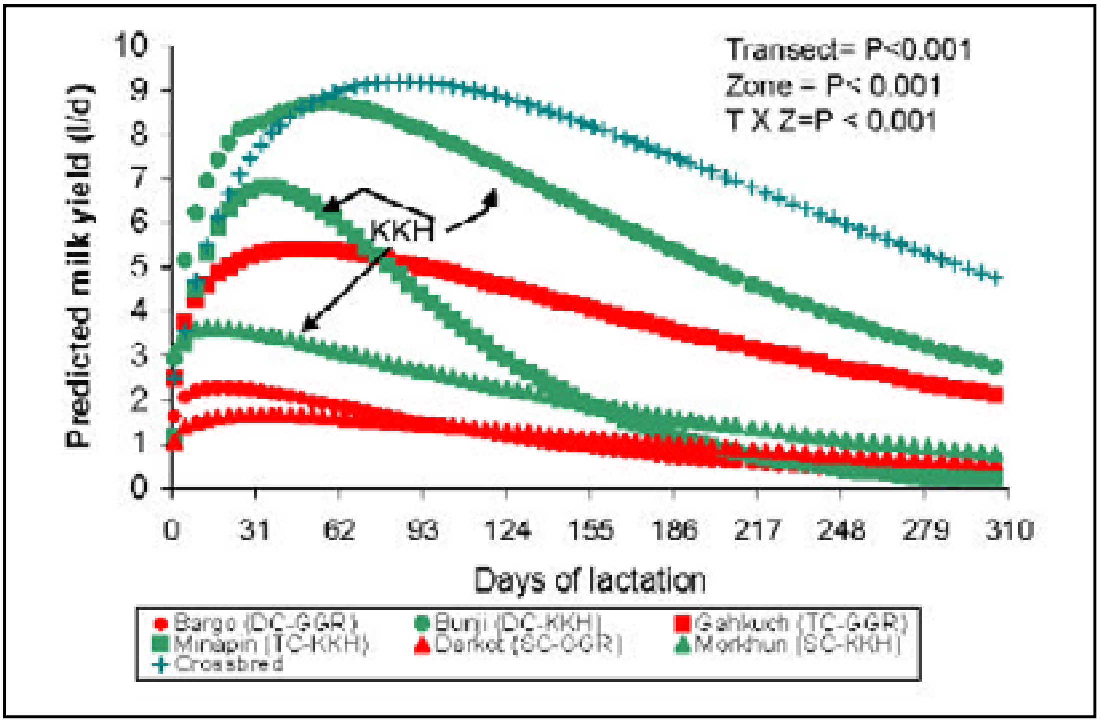

Figure 2.5: **Predicted 305-day lactation curves for local and crossbred cattle of the study villages**

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.

Bibliography (not necessarily cited in text)

AFRC (1993) *Energy and Protein Requirements of Ruminants: An Advisory Manual Prepared by the AFRC Technical Committee on Responses to Nutrients*. Wallingford: CAB International

AOAC (1999). *Official Methods of Analysis of the Association of Official Agricultural Chemists, 16th ed. (5th rev.)*. Gaithersburg (MD, USA): AOAC International

Alirol, P.H. (1978) *Transhumance Animal Husbandry System in the Kalingchowk Region (Central Nepal): A Comprehensive Study of Animal Husbandry in Southern Slopes of the Himalayas*. Kathmandu: Integrated Hill Development Project, Swiss Association for Technical Assistance

Amble, V.N.; Murty, V.R.; Sathe, K.V.; Goel, P.S. (1964) 'Milk Production of Bovines in India and Their Feed Availability'. In *Indian Journal of Veterinary Science*, 35: 221-238

Chowdhury, S.A. (1989) *Energy and Protein Metabolism During Undernutrition*. MSc Thesis; Department of Agriculture, University of Aberdeen, UK

Dost, M. (1995) *Fodder Production in Northern Areas*, pak/86/027. Islamabad: National Agriculture Research Council

Duncan, A.J.; Omer, R.; Clemens, J.; Rahman, A.; Wright, I.A.; Hester, A.J.; Gordon, I.J.; Rehman, Atiq-ur, Rafique, S.M.; Frutos, P. (2001) *Rangeland Management and Livestock Feeding Strategies, Karakoram Region, Pakistan*. Kathmandu: ICIMOD

Farman, A.; Tetlay, K.A. (1991) *Dynamics of Livestock Development in Northern Areas of Pakistan*, Aga Khan Rural Support Programme Gilgit, Conference and Workshop Papers No. 20, pp 1-25. Gilgit: AKRSP

Iqbal, S.S. (1994) *Animal Husbandry*. Islamabad: National Book Foundation

Lawes Agricultural Trust (1998). *Genstat 5 Committee of the Statistics Department, Rothamstead Experimental Station*. Oxford: Oxford University Press

Lowman, B.G.; Scott, N.A.; Somerville, S.H. (1976) *Condition Scoring of Cattle, Bulletin No 6 (rev. ed.)*. Edinburgh: East of Scotland College of Agriculture

Mansuri, M.N.; Dave, A. D. (1990) 'Study on the Lactation Curve and the Rate of Decline in Milk Yield in Crossbred Cattle'. In *Indian Veterinary Journal*, 67: 127-129

McCullagh, P.; Nelder, J.A. (1989) *Generalised Linear Models*. London: Chapman and Hall

Okantah, S.A. (1992) 'Partial Milking of Cattle in Smallholder Herds on the Accra Plains: Some Factors Affecting Daily Milk Yield and Milk Composition'. In *Animal Production*, 54: 15-21

Ørskov, E.R. (1999) 'Research Priorities for Animal Production in Many Developing Countries in the Tropics'. Conference Proceedings of 2nd International Seminar on Tropical Animal Production held at Gadjah, Mada University, Yogyakarta, Indonesia

Ørskov, E.R. (2000) 'Why has Animal Research had Minimal Impact on Rural Poverty Alleviation in Asia?'. In *Asian-Australian Journal of Animal Science*, 13: 350-351

Ørskov, E.R.; Hovell, F.D. DeB; Mould, F. (1980) 'The Use of the Nylon Bag Technique for the Evaluation of Feed Stuffs'. In *Tropical Animal Production*, 5: 195-213

Parkes, P. (1987) 'Livestock Symbolism and Pastoral Ideology among the Kafirs of the Hindu Kush'. In *Man*, 22: 637-660

Patterson, H.D.; Thompson, R. (1971) 'Recovery of Inter-block Information when Block Sizes are Unequal'. In *Biometrika*, 58: 545-554

Robinson, D.L. (1987) 'Estimation and Use of Variance Components'. In *The Statistician*, 36: 3-14

Roderick, S.; Stevenson, P.; Ndung'u, J. (1999) 'Factors Influencing the Production of Milk from Pastoral Cattle Herds in Kenya'. In *Journal of Animal Science*, 68: 201-209

Russel, A.J.F.; Doney, J.M.; Glenn, R.G. (1969) 'Subjective Assessment of Body Fat in Live Sheep'. In *Journal of Agricultural Science* (Cambridge), 72: 451-454

Scoones, I. (1992) 'The Economic Value of Livestock in the Communal Areas of Southern Zimbabwe'. In *Agricultural Systems*, 39: 339-359

Syed, M.; Abdur R.A.; Farooq, M.; Ali, M. (1996) 'Production Performance of Sahiwal and Various Grades of Crossbred Cattle'. In *Sarhad Journal of Agriculture*, 12: 601-610

Wardeh, M.F. (1989) 'Livestock Production and Feed Resources in Gilgit District of the Northern Areas of Pakistan'. In *Livestock Paper No. 4*, pp 1-19. Gilgit: AKRSP

Wood, P.D.P. (1965) 'Algebraic Model of the Lactating Curve in Cattle'. In *Nature*, 216: 164-165

Wood, P.D.P. (1976) 'Algebraic Models of the Lactation Curve for Milk, Fat and Protein Production, with Estimates of Seasonal Variation'. In *Animal Feed Science and Technology*, 22: 35-40