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.

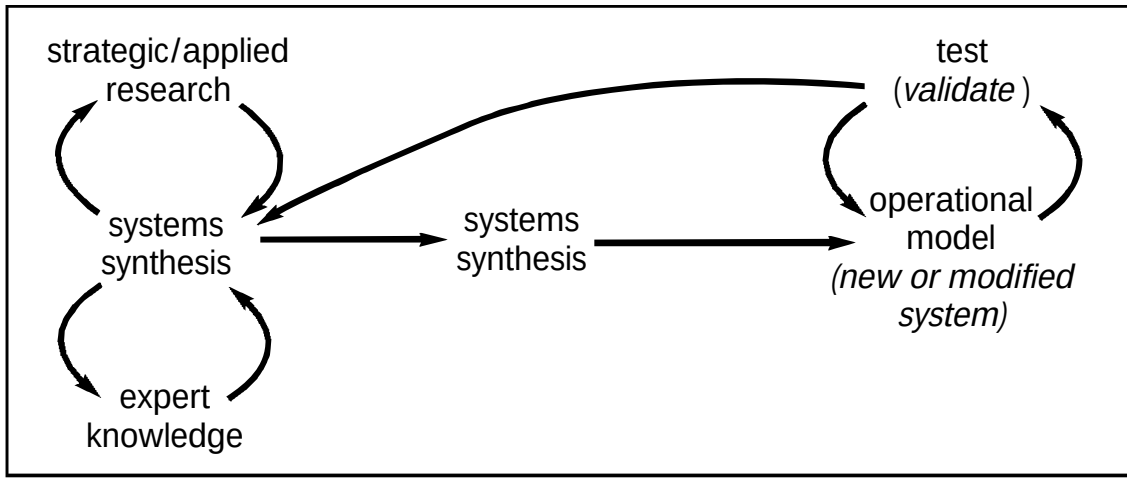

Figure 5.1: **Systems research and systems development**

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).

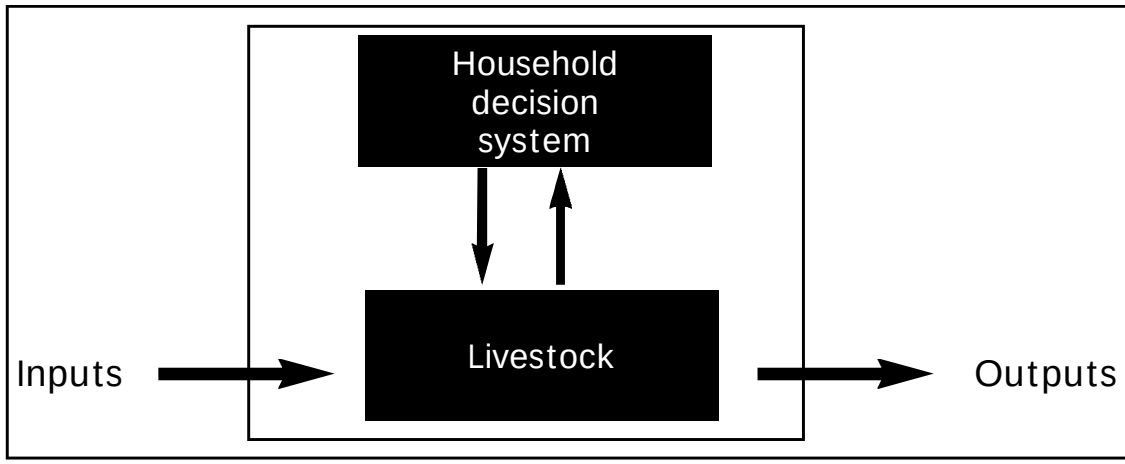

Figure 5.2: **A simple model of a livestock system**

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.

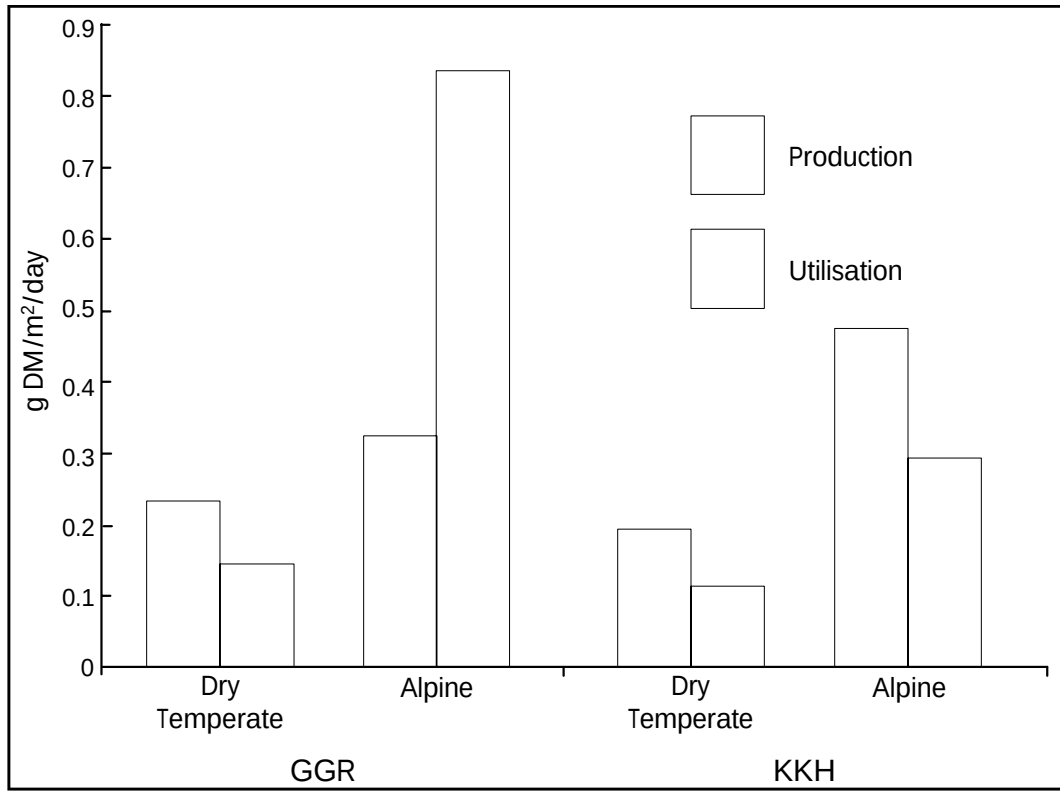

Figure 5.3: **Pasture production and utilisation in dry temperate and alpine pastures in Gilgit Ghizer (GGR) and Karakoram Highway (KKH) transects**
(from Chapter 2, Table 3.4, values relate to the period of grazing only)

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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