chapter four

Sustainable Management of Livestock, Feed Resources and Soil Fertility

In the mixed crop-livestock farming systems of the HKH, livestock production and food production systems are closely integrated. Crops provide feed and fodder, while in return livestock supply draught power and manure, as well as milk and meat as a source of cash income. A close link also exists between livestock and common property resources (CPRs). Nutrients from forests, support lands, and crop residues fed to animals are recycled back to the cropland as manure. This complex inter-relationship between forests, grasslands, livestock, and crops in mountain farming systems has contributed to the sustainability of mountain agriculture for generations.

Soil fertility and agricultural productivity are receiving both positive and negative impacts from the declining population of livestock and changing practices of livestock management. A declining availability of fodder resources is a common phenomenon in the mountain areas where a large number of animals must depend on limited supplies of fodder, grass, and leaf litter. Fewer feed resources result in fewer animals, further reducing the amount of farmyard manure. There have been some studies carried out on the relationship between fodder supply and decline in soil fertility. These are summarised in the following sections.

Inter- relationship between Livestock, Soil and Plants

Based on various studies in Nepal, Bajracharya (1999) has identified the following relationship between livestock, soil fertility, and natural resources.

- Livestock convert crop residues and fodder/forage to soil nutrients through manure. Application of manure helps to improve soil texture and decompose litter more easily. It also contributes to increased productivity.
- Using the traditional feeding system and farm yard manure (FYM) preparation method, a large adult ruminant provides approximately 1,140 kg of FYM and potentially approximately 29 kg of nitrogen (N) per year.
- About 50 per cent of leaf litter is removed from the mid-hill forests annually for composting purposes.
- About 30–50 per cent of total animal feed is derived from forests and grasslands.
- Approximately three to seven hectares of forest land (depending upon the type of forest, forest productivity, types of trees available, etc) is needed to maintain one hectare of arable land with livestock without causing deterioration of forest and livestock and in the amount of compost produced.

It is clear that trees, crops, animals, and soil are all interdependent components of mountain farming. None of these should be ignored if the farming system in the hills is to remain sustainable.

Fertility Maintenance Measures

Mountain farmers have developed a number of approaches for managing soil fertility. These approaches are discussed below.

Farmyard Manure (FYM)

Livestock manure is a critical component of hill farming. Farmers indicate that two adult buffaloes give enough manure to fertilize approximately 0.25 hectares of land. According to the farmers, the application of manure is mandatory for the

maintenance of crop productivity. Output of manure varies between cows and buffaloes. Buffaloes give 75 per cent more manure than cows. Farmers, in general, apply more FYM on lowland parcels than on uplands.

In the hills, bedding materials, (crop residues, leaf litter, left over forage, and feed) are spread in the animal shed and are mixed with dung and urine. New bedding materials are added at various intervals, generally once a week, to keep the shed dry. In this system, the whole process of FYM preparation takes place within the animal shed itself. In some areas, it is allowed to remain within the animal shed almost for one year; while in others the compost is carried to the field during winter when it is well decomposed.

The use of raw materials for bedding varies from place to place depending on forest species, forest condition, and socioeconomic circumstances. Compost used in crop production is at the moderate- to well-decomposed stage, with the majority of it being applied from December to February on maize crops.

However, decrease in supplies of bedding materials due to degradation of forest resources and the decreasing number of livestock affects sufficient production of FYM.

- One adult cow or buffalo excretes about 29 kg of nitrogen (N) per annum. Up to 90 per cent of this may be lost in the stall if too little bedding material is used. If urine is not collected in closed pits, rain and sun cause leaching and volatilisation of N from the urine, which contains 65 per cent of the nitrogen excreted. Dung contains 35 per cent N, so loss of nitrogen through uncollected urine is greater.
- If bedding material is not sufficient or is of low quality, it will not absorb moisture from dung and urine efficiently and will not prevent nitrogen loss.
- N volatilisation, denitrification, and leaching occur in open manure pits that render FYM exposed to sun and rain.

FYM is often only partially decomposed. This reduces the amount of humified organic matter and can lead to the immobilisation of FYM when it is applied to the soil.

Green Manure

Applying green manure is one of the traditional methods of maintaining soil fertility employed by hill farmers. Leaves and twigs of various trees and shrubs are collected and incorporated into the soil. The other uses of these green manure species are as live fences, hedge plants, insect repellents, and for better use of marginal land. Maintaining such plants as fences and planting them on marginal land and on river banks improve the landscape and control soil erosion. Conservation, evaluation, and utilisation of green manure species available locally should be encouraged to provide a sustainable supply of nutrients to the soil. However, such species are restricted to specific altitudes and some are threatened by over-exploitation.

Mulching

Mulching is a common method adopted by farmers for moisture conservation, weed control, and for maintaining soil fertility after decomposition. Mulching materials, such as weeds, fallen leaves, crop residues, fodder leftovers, and decomposed twigs, supply the soil with plant nutrients. The moisture conserved in the soil as a result helps to decompose the mulch.

In Situ Manuring

In situ manuring is an important form of soil fertility management, particularly in the high mountains where cultivation of forage and application of manure are difficult. In this practice, during winter animals are kept on fallow land and dung and urine are used directly on the field. Farmers believe this system makes the best use of urine. The animals are also moved from one terrace to another, particularly in the uplands, and migratory sheep and goats graze on stubble on arable land. This practice has been declining in recent years due to the fall in livestock population and the intensification of crops.

Soil Fertility Decline and Livestock Management Practices

There has been a general decline of livestock numbers, particularly in areas of the middle hills that are under intense pressure and where the decline per household is most prominent

(Sharma 1996). A decline in the number of draught animals is also well documented (Singh 1997). This is due to the decreased size of holdings, reduced livestock feed resources, increasing population pressure, and a deepening shortage of human labour. Reduced livestock numbers result in reduced FYM. It is clear that the increasing inability of smallholders to keep a large number of animals because of feed constraints has had an indirect impact on soil fertility. During field investigations in Nepal, farmers stated that their rationale for keeping at least one or two head of local cattle (otherwise unproductive) was mainly to provide manure.

Along with a trend of declining numbers of livestock, there have also been changes in livestock management practices. The most important change is the increase in stall feeding. This has been brought about by both the shrinkage in grazing resources and incentives to rear high-yielding animals such as improved buffaloes and cattle. These improved and cross-bred animals require better management and nutrition as well as stall feeding. Control by the Village Forest Development Committee on grazing and cutting forage has contributed to reducing animal numbers since reduced feed forces farmers to remove unproductive animals.

These factors have encouraged fodder planting on private land, better regeneration of existing forests, and more efficient collection of urine and dung for composting. There is a theory that livestock numbers do not determine soil fertility, but rather the way in which manure is managed does. Since stall feeding, as opposed to grazing, has a greater manure retrieval rate, stall-fed systems can produce more FYM per animal than more extensive systems (Vaidya *et al.* 1995).

The use of chemical fertilizer is increasing in some areas of the middle hills, especially the lower altitude areas with better access[2]. Crop intensification, the decrease in livestock population, and consequent reduction in the output of dung, labour shortages, and a depleting natural resource base have all prompted farmers to use fertilizers to maintain soil fertility. All this is occuring despite the apparent greater efficiency of the stall-fed system over the open

[2] Accessibility and market availability are closely linked to altitude since much of the recent infrastructural development has taken place in the low middle hills.

grazing system. A suitable market and accessibility to infrastructure both have a significant effect on soil fertility trends. Chemical fertilizer has become a major source of plant nutrition in accessible areas. Its use is particularly prevalent in the production of commercial vegetables and other high-value crops.

In Himachal Pradesh, the average rate of inorganic fertilizer used increased ten-fold from 1.7 to 18.6 kg N/ha from 1966/67 to 1985/86, with similar increases in other nutrients. Inorganic fertilizer supplies and transport are subsidised by between 30 and 40 per cent to the farm gate and are supplied widely throughout the state. Some supplies even reach accessible, high altitude locations, although in general these still rely heavily on manure. These areas are likely to be most vulnerable to a reduction in livestock populations.

In their study, Vaidya *et al.* (1995) mention that a large proportion of farmers reports an increase in soil fertility on both *khet* (irrigated lowland) and *bari* (dry upland) in the roadside villages. This could be related to the intensive use of chemical fertilizers here. In these villages, over 80 per cent of farmers use chemical fertilizer, and there has been a commensurate rise in FYM/compost applications.

The key issue is farmers' ability to use FYM/compost application and chemical fertilizers in order to adjust their fertility management strategies to cope with the increased demand on the soils' nutrient reserve.

Biogas Generation and Livestock-Environment Relationships

Biogas generation is emerging as a promising role for livestock to alleviate the burden on resources in the high pressure areas of the low hills of Nepal. Biogas, as a supplement to fuelwood for household energy needs, has great potential in the low hills.

At a site in Kaski District, information was gathered regarding the level of biogas use and the favourable impact on the local natural resource base. In one of the accessible villages in Kaski District, approximately 30 per cent of the households were reported to have biogas plants. The general opinion was that biogas had

increased the importance of livestock at the farm level, but it had not replaced firewood altogether as a source of fuel. The use of biogas is mainly limited to cooking food for the family, and fuelwood is still used for cooking animal feed as well as for heating milk to make ghee.

Nevertheless, farmers indicated that biogas had reduced the total use of fuelwood by 20–25 per cent, and labour and time have been saved from collecting firewood in the forest, thus contributing to conservation of forest and support lands. Households keeping biogas plants were generally more inclined towards smallholder dairy farming and kept at least two buffaloes in the herd. Buffaloes have greater manure output than local cattle. It was reported that two buffaloes give enough manure to generate cooking gas for a family of four to six.

Declining Sources of Fodder and Farmers' Responses

There are various sources of fodder — public forest, agricultural residue, shrubland, pasture and grazing land, terrace risers, and private fodder trees. The most significant source of fodder and leaf litter (leaf litter is used as bedding material for livestock and forms the bulk of FYM) is the public forests for the large majority of households. Fodder from the forests of Nepal contribute about 50 per cent of the Total Digestible Nutrients (TDN). A study in western Nepal indicated that, according to present agricultural and forestry management practices, 3.5 ha of forest land (for fodder) was needed to sustain the productivity of one ha of agricultural land (Wyatt-Smith 1982). However, the gross per capita availability of forest land is only 0.14 ha (FAO 1979). General degradation of forests in the high-pressure mid-hills has reduced the amount of fodder and leaf litter, with implications both for livestock productivity and productivity of agricultural lands.

In the middle hills of Nepal, only about 64 per cent of the livestock's total feed requirements are met (APROSC 1986). Good quality green fodder in adequate quantities is generally available only from June to November (the wet season). Thus the major problem is the lack of green fodder during the long dry season from December to May. The past norms were for farmers to overcome this problem by growing fodder trees on their farms and extracting

tree fodder from the forests. However, due to increasing population pressure, this source is shrinking.

Stall feeding of livestock is recommended as a solution, as is the production of more fodder on individual farm holdings and the creation of more community forests composed of multipurpose tree species. Since there are biological and physical limitations to planting significant numbers of additional trees (particularly on private farms), a more viable alternative is to improve the management of existing as well as future tree resources and to increase their productivity (Rusten and Gold 1991).

Feed Resources from Private Land and Implications for CPRs

Many areas in the hills have already started to respond to the challenges of managing livestock feed in the face of dwindling fodder and leaf litter. Changed livestock management systems, e.g., stall feeding and planting of fodder trees close to the homestead, are especially visible in areas with increased market integration. Interlinkages with the environment are also changing in these areas.

According to farmers, straw makes the largest contribution towards livestock feed and comes largely from rice, finger millet, and maize. In Nepal as a whole, agricultural residue makes up 36 per cent of the total fodder supply (Giri 1990). Ground grass makes an additional contribution to livestock feed and is mostly available during the rainy season. This can usually be collected from waste land, private land, and other public land. Farmers have been managing the scarcity of fodder from public forests by planting fodder trees (Table 4.1) and cultivating grass on private land that is otherwise unsuitable for growing food crops or vegetables.

During the winter months, corn stalks and '*badhar*' (*Artocarpus lakoocha*) are fed to livestock. Farmers also save dry fodder (paddy and wheat straw, maize, stover, etc) during this period to feed large ruminants. Dry fodder production is minimal and would last only a few months if fed to the animals on a regular basis.

In some villages, farmers have adapted to winter fodder shortages by cultivating exotic oats, cultivated after the rice harvest

Table 4.1: **Commonly Cultivated Fodder Trees in the Middle Hills of Nepal**

Local name	Scientific Name
Tote	*Ficus hispida L.*
Gidagi	*Ginderi premna*
Berula	*Ficus clavata*
Kutmiro	*Litsea polyantha*
Badahar	*Artocarpus lakoocha*
Dabdabe (ramsing)	*Garuga pinnata Roxb.*
Khanayo	*Ficus cunia*
Pakhuri	*Ficus glaberrima Bl.*
Kabro	*Ficus lacor*
Koiralo	*Bahunia variegata L.*
Aankhapakuwa	*Ficus clavata Wall. ex. Miq.*
Dhungre	*Ficus sp.*
Barro	*Terminalia belerica C.B. Clarke*

Source: Adapted from Tulachan (1985)

sometimes, replacing wheat. One of the villages even exported about 1.5 tonnes of oat grass to other districts. This conscious effort to tackle the shortage has paid off in abundant milk supplies in this village.

Some resource poor farmers have responded to the lack of fodder from private land by making arrangements to harness fodder from the private land of resource-rich farmers. Box 4.1 below illustrates such a case.

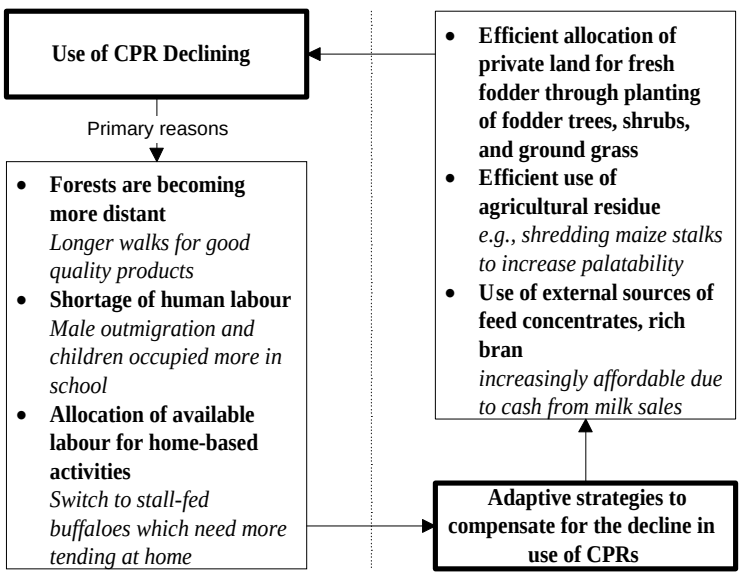
The following figure (Figure 4.1) adapted from a village case study (Neupane 1994) summarises the shifting scenario of livestock-CPR interaction in an accessible village where smallholder dairy farming has advanced well. According to the study, stall-feeding of buffaloes has become the norm in the village, meaning less grazing.

Another aspect of change in this village is the constant reduction in human labour. This shortage has reduced activities that take labour and time, e.g., taking animals out for grazing and grass and fodder collection from distant public forests. Planting fodder trees is also very common. Fodder planting is not only limited to trees but also to shrub species on terrace risers. When fodder from land-based resources is in short supply, substitution is

Box 4.1
Labour for Fodder: A Case of resource poor Farmers of marginal – lands Adaptation to Fodder Needs

Farmers with marginal farm land are generally thought to be more dependent on CPRs (public forests) because they do not own enough land to grow fodder. However, there was an interesting case in one village in Parbat. A poor farmer was found to be working on a large farm in a 'labour for fodder' arrangement, whereby the fodder produced on private land was exchanged for labour. There were also cases where fodder (in this case, particular fodder trees) were paid for in a 'lease' arrangement, in which the purchaser could harvest the tree for the season for a certain sum of money. Even farmers with just 2 to 3 *ropani* (0.1–0.15 ha) of homestead – hardly any extra land apart from the house and animal shed – were found to be keeping at least one milch buffalo, maintaining the animals through buying grasses/ fodder from others sufficient to last for a single season.

Figure 4.1
Changing Pattern of CPR Use and Livestock Management in a Transforming Village



made by buying feed and concentrates, and agricultural residues (shredding of maize stalks for example) are used more efficiently. Farmers' increased income from milk sales has increased the affordability of external inputs. All of these changes related to livestock management imply a decreasing dependence on CPRs (Annex 6) .

Perceptions of the Role of Community Forestry

Mixed reactions were heard from farmers regarding the impact of community forestry. Some felt that community forestry had a positive impact on the fodder and leaf litter supply from marginal lands because of natural growth as a result of protection from harvesting.

Meanwhile, others felt that community forest management decreased the availability of fodder and litter resources as the forest is closed to free grazing and there is control on collection of fodder/ litter. Although minimum fees on a monthly basis can be paid to acquire fodder grass from community owned lands, poor farmers do not find this acceptable.

With the growing scarcity of fodder and leaf litter, farmers are searching for alternatives. A greater number of farmers is addressing the fodder scarcity through use of their own lands. In some villages, about 30–40 per cent of the land-rich farmers have private support land. *Kharbari*(s) (marginal sloping land) on which normally grass and fodder trees are grown are now being used more intensively. Increased fodder shortages and the high cost of feed provide incentives for the increased cultivation of trees on farms. There has also been an increase in the trend of growing leguminous fodder trees on the field bunds of cultivated terraces.

In recognition of the degraded state of the forests, communities and policy-makers are turning to community forestry as a potential solution. Over the past decade, communities have formed groups with the help of district forestry officers to manage their forests according to their needs. The impact of community forestry is being seen in fodder, leaf litter, and timber supplies.