3. Dynamics of Resource Utilisation

Two basic issues of development in Bhardeo lie both within and outside its system. On the one hand, the deterioration of the local natural resource base and, on the other, the weak national institutional response to the community's needs are both crucial for sustainable development. The resulting constraint is naturally felt by local institutions, hindering development and hindering the expansion of necessary services and economic opportunities. The potential of Bhardeo's human resources has not been fully utilised. Their varied skills, however, are intact.

Human Resources

Family Size and Economically Active Members (EAM)

In 1988, the average household size was 6.5 persons. The family size was not uniform among different ethnic households. The Newar community, which accounted for 12.4 per cent of the total households, had fewer family members (<5.4 members/household), well below the average.

More than eight per cent of the households had three family members and 4.5 per cent had only two members. There was a single person household too. Most households were headed by males, but 11 per cent of the households were headed by females by virtue of age and seniority.

Most Bhardeo households (67%) contained members from two generations and in 29 per cent of the households there were members from three generations. Approximately four per cent of the families had members from a single generation.

Although 11 per cent of boys and girls between the ages of 11 and 15 years were actively contributing to household work, such as fetching water, fodder, dry leaves, or firewood from the forests, or taking care of livestock, the estimation of labour availability was carried out, however, on the basis of adults between 16 to 60 years. This was not quite relevant to Bhardeo's condition because, due to a degraded resource base, the community had to engage every able family member. Over 52 per cent of the population (916 persons) was economically active and, on average, households contained 3.44 EAM, of which at least one EAM had to be totally occupied with the livestock. The balance of 2.44 EAM had to cope with on-farm and off-farm activities. The dependency ratio of children under 10 years of age and older people above 60 years (4% of the population) upon the economically active population was over 55, which means that almost every second man had to feed and clothe another person.

Education and Skills

The literacy rate for Bhardeo was 40 per cent. Twenty-nine per cent of the population above the age of five years could generally either read only or read and write Nepali.

The number of persons that attended school, either wholly or partially, or who were still in primary school, was 160. Of these, 55 per cent were at primary school level. Seventy-one persons were in middle and high school while 415 were self taught, barely literate. There was only one local school that ran primary and middle level classes. The local school also catered to the neighbouring villages. Bhardeo shared only 38 per cent of the population of the school. Two boys had completed high school and one of them was attending college.

The local people were skilled and experienced in making charcoal from different kinds of wood. There were masons and carpenters, basket-makers, ghee-makers, and collectors of wild mushrooms, ferns, vegetables, and medicinal plants. Their invaluable skills were yet to be used for development.

Women's Literacy

The overall literacy rate for women (including girls above the age of five) was only 15.6 per cent. In both the primary and middle level classes, girls from Bhardeo formed a small minority of 11.7 per cent. The total attendance of girls in school was 22 per cent in the primary and 44 per cent in the middle level. There had been a rise in the enrolment of girls

by 16 per cent during the previous academic year. Only one lady above the age of 60 could read a simple Nepali text and only one girl above the age of 16 had completed lower secondary schooling. This is an important parameter for planning local development support activities, especially those involving women.

About 38 per cent of the households had no family member above the age of 10 years with either formal or informal education. It is significant to note, however, that, in three per cent of mixed households (containing both male and female members), the only literate members were female. These women could read or, in some cases, were able to write simple Nepali.

Farmland Resource Management

In 1978/79 the Land Resources' Mapping Project (LRMP) estimates (based on aerial photographs) showed that the area of Bhardeo was around 806ha of which 34 per cent (274.3 ha) was privately owned and cultivated, whereas the Cadastral Survey of 2022 (1965/66) recorded that Bhardeo had 265.78ha of private land. However, the District Revenue Office Record of 1991 showed a normal revenue area of only 175.6ha for which a regular revenue of Rs 3007.94 was paid. According to information collected from individual households, in April 1988 the total area of land under private use was less than the 1991 figure (166ha, Table 6, Figure 6). The percentage of households cultivating one or several types of land was 98.5.

Table 6: Types of Private Land Used in Bhardeo - 1988

	Area (ha)	User (#)	HH (7) (%)	Holding Size (ha)	(range)
Shrubland	23.64	150	56.4	0.157	250sq.m.-1ha*
Fallowland	1.42	7	2.6	0.202	250sq.m.-0.55ha
Rainfed *Bari*	140.31	262	98.5	0.535	500sq.m.-3ha
Flatland	1.27	7	2.6	0.181	375sq.m.-0.1ha
Total	166.64				

* (four households < 125sq.m.)

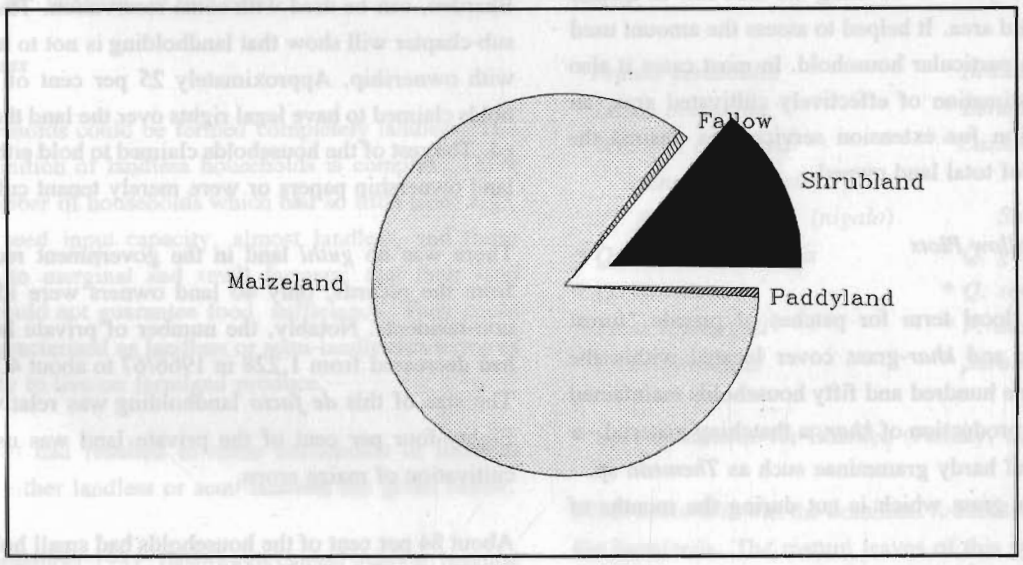

Figure 6: Types of Landholding in the Year 1987/88

The people had recorded flat land, used for growing rice, as 1.27ha, whereas the Revenue Office had a record of 1.6ha a loss of 0.33ha. Of the land resources under private use, about 56 per cent of the households maintained larger or smaller plots of *kharbari*[2]. Seven households owned plots of fallow land (normally under grass) which remained untilled for a variety of reasons; either the land was unproductive for cereal growing, or it was too steep for regular use, or it was

2. *Kharbari* is a category of land normally maintained for the production of thatch grass (*khar*). A kind of silvipastoral (more of a shrubland) type of land in local use for diverse resources such as grasses, non-fruit trees, etc.

prone to slides, or there was a need for grassland. The area of land under paddy cultivation was small. Only seven households owned rice cropped land in this mountain valley. The most important type of land in Bhardeo was dry land, especially suitable for the cultivation of maize, millet, unirrigated wheat, and barley crops.

Rainfed Land (Maize Cropped)

About 141ha of rainfed land, which accounted for 84.2 per cent of the total land under various uses, or 99 per cent of the land under cultivation, was assumed to be available for the cultivation of maize. In fact an amount of 3.829MT of maize seed was sown in 1988 which would have sufficed, according to local seed rate practices[3], for approximately 118ha only.

The difference of about 22ha (15%) of cultivable land or equivalent area, for 714kg of maize seed inputs, was yet to be reclaimed from the land damaged by the 1981 floods. Initially over 30ha of farmland were estimated to have been damaged.

There were two objectives for using the seed rate as a basis for estimating land area. It helped to assess the amount used for farming by a particular household. In most cases it also facilitated the estimation of effectively cultivated area, an important criterion for extension services, as against the general concept of total land owned.

Kharbari and Fallow Plots

Kharbari is the local term for patches of private "forest land" under tree and *khar*-grass cover located within the farming area. One hundred and fifty households maintained *kharbari* for the production of *khar*, a thatching material - a mixture of several hardy gramminae such as *Themeda* sp. - and some fodder grass which is cut during the months of July/August.

Land lying fallow (*bajho*) amounted to about one and a half hectares. The private lands which were being used as shrubland had potential for improvement.

Flat Terraces

Located in the temperate region, rice farming in Bhardeo was carried out on the valley floor, a narrow ecological area above 1,700masl which is a fairly marginal area for rice. There was a tendency to turn the valley into flat terraces by levelling off the slopes. The productivity of this new land, however, was generally low.

Land areas earmarked as being suitable for rice cultivation were small. Earlier, only 1.27ha of flat land on the valley bottom were used for paddy cultivation. Since the 1981 floods, over 80 per cent of the paddy land still needed to be cleared of debris and boulders. Only about 0.15ha was cultivated by three households. One local variety of rice (*bhaimale*) seemed to have adapted to the harsh conditions of Bhardeo.

Many flat paddy terraces along the valley, and semi-terraced maize fields on the hill slopes, were destroyed in 1981 during the catastrophic floods. The people had made several efforts to convert this damaged land into acceptable gradients and to increase the soil fertility, but with little success.

Land Tenure

The ownership of cultivated land was tenuous for the majority of households. The term landholding, in the case of Bhardeo, can be used with some reservation. The following sub-chapter will show that landholding is not to be confused with ownership. Approximately 25 per cent of the households claimed to have legal rights over the land they cultivated. The rest of the households claimed to hold either dubious land ownership papers or were merely tenant cultivators.

There was no *guthi* land in the government records, but, from the records, only 40 land owners were identified as non-residents. Notably, the number of private land owners had decreased from 1,228 in 1966/67 to about 400 in 1991. The size of this *de facto* landholding was relatively small. Eighty-four per cent of the private land was used for the cultivation of maize crops.

About 84 per cent of the households had small holdings with an area below one hectare. Ownership data, therefore, did not give a realistic picture of effectively cultivated lands. This was the major reason for considering the total seed input applied by local farmers to the summer crops of maize and rice as a basis for estimating land area.

Table 7 illustrates the situation in the year 1987/88 and clearly shows that the majority (55%) of the population cultivated less than 0.5ha per farming household.

3. This is around four *mana* of maize seed (equivalent to 1.625kg) per *ropani* or about 32.5kg/ha of maize cropped land.

Table 7: *De Facto* Landholding Situation in Bhardeo

	Size of Land (ha)							
	<0.25	<0.5	<0.75	<1.0	<1.25	>1.25	Landless	Total
HH	56	88	54	21	14	29	4	266
%	21	33	20.3	8.0	5.2	10.9	1.5	100

The size of individual farms was small in Bhardeo with over 80 per cent of tenant households cultivating, on average, an area less than one hectare of land. The size of such holdings ranged from 0.05 to 4.75ha.

Following the floods in 1981, two households had "officially" encroached upon forested slopes for cultivation and had constructed dwelling huts with the tacit agreement of the community and of government officials. One house-hold lost its cultivation rights to the Agricultural Development Bank of Nepal because of bankruptcy. One household, having lost all its cultivable lands during the floods of 1981, was still trying to reclaim them and had successfully reclaimed an area of about one hectare only. These cases have not been registered as "landless" in this study.

Landlessness

Four households could be termed completely landless. The whole definition of landless households is complex. There were a number of households which had so little land; e.g., very low seed input capacity, almost landless, and those belonging to marginal and small farmers; that their land earnings could not guarantee food sufficiency. They could also be characterised as landless or semi-landless in terms of their ability to live on farmland produce.

Factors that had resulted in some households in Bhardeo becoming either landless or semi-landless are given below.

i. In September 1981, flashfloods caused many to become landless or semi-landless within hours. Ms. Bisnumaya Rambo and Thuli Maya of Ward Nos. two and five lost all their cultivable land. Ms. Rambo was later allotted a plot of forest land within her ward.

ii. A number of tenant farmers were cultivating land owned by others and were paying a high rent, exploited by so called *de jure* landlords. Not even a receipt for rent paid was given to the tillers. They were not even recognised as tenants and could be evicted any time if the owner so wished.

iii. The construction of the 50km Lele-Chandanpur road under the Food-for-Work Programme, undertaken on the assumption that people would voluntarily contribute their lands for the road, created a new category of partially landless households. One household, for example, had become virtually landless having lost most of its productive land to the road. No compensation had been paid for the land.

Tree Planting and Cropping System

Tree Plants in Use. Some farmers had planted fruit trees, but more for ornamental purposes than for fruit production. Most of the trees were yet to bear fruit. One or two households had started small orchards with 20 to 30 fruit trees of oranges, apples, limes, plums, peaches, guavas, pomeloes, walnuts, and pomegranates.

Out of 4,855 or more fodder trees on the farmlands and *kharbari*, approximately 50 per cent yielded fodder materials totalling 120MT of leaves, while the other half were expected to yield in another five years' time. Saplings of certain species were in demand. They have been listed below.

Prunus cerasoides
* *Litsea polyantha*
* *Michelia champaka*
Alnus nepalensis
Arundinaria sp. (*nigalo*)
* *Quercus lanuginosa*
* *Q. lamellosa*
* *Ficus roxburghii*
* *Ficus nemoralis*
* *Brassaiopsis hainla*
* *Betula alnoides*
* *Castanopsis tribuloides*
Salix babylonica
* *Q. glauca*
* *Q. semecarpifolia*
* *F. auriculata*
* *Sarauia nepalensis*

* Species suitable for Bhardeo (Panday, 1982 and 1991).

Ficus nemoralis was the dominant fodder tree species around the farmlands. The mature leaves of this species can be fed to livestock until mid-June, following the season of forest species such as *Quercus glauca*. The species of *Alnus nepalensis* was planted more for the protection of steep farmlands. Apart from fodder trees there was a local demand for the fodder grasses which were planted on terrace benches. There had been no previous experience of grass planting in Bhardeo, except for local species of *babiyo* (*Pollinidium angustifolia*), etc. Vegetable production, however, was virtually non-existent during the months of April and May. Only one or two households maintained kitchen gardens. Potatoes and radishes were grown by most

farmers. Remarkably, the farmers grew major hill crops in a locally-developed, elaborate cropping pattern.

Cropping System

The climate of Bhardeo is temperate, starting from the warm temperate area of the valley bottom (1,750m) in the west, to cooler temperate areas (2,600m) in the east. Infrequent snowfall, which occurs during the months of December and January, limits the cropping pattern to some extent.

Bhardeo is agriculturally an upland area where the climate permits only one major crop. Maize is a major summer crop, together with potatoes and beans. The growing period for maize is longer on the upper slopes (by one to two months) than in the valley bottom.

Growing potato crops during winter, as practised in Kathmandu Valley, is out of the question in Bhardeo. Potatoes are grown in summer (May-August) as practised at high altitudes. Maintaining seed potatoes (during the winter for summer crops) is not a common practice here (Table 8), apart from in the case of a few households. Part of the potato harvest (harvest leftovers) is left in the soil to provide seeds for the next season.

Potatoes perform surprisingly well even as an inter-crop. The autumn months are good for mustard crops and, in the winter and spring months, wheat and barley grow on middle slopes and in the valley bottom (Figure 7). Potato productivity was generally low but farmers claimed that, in terms of the low input required, production could be considered to be high.

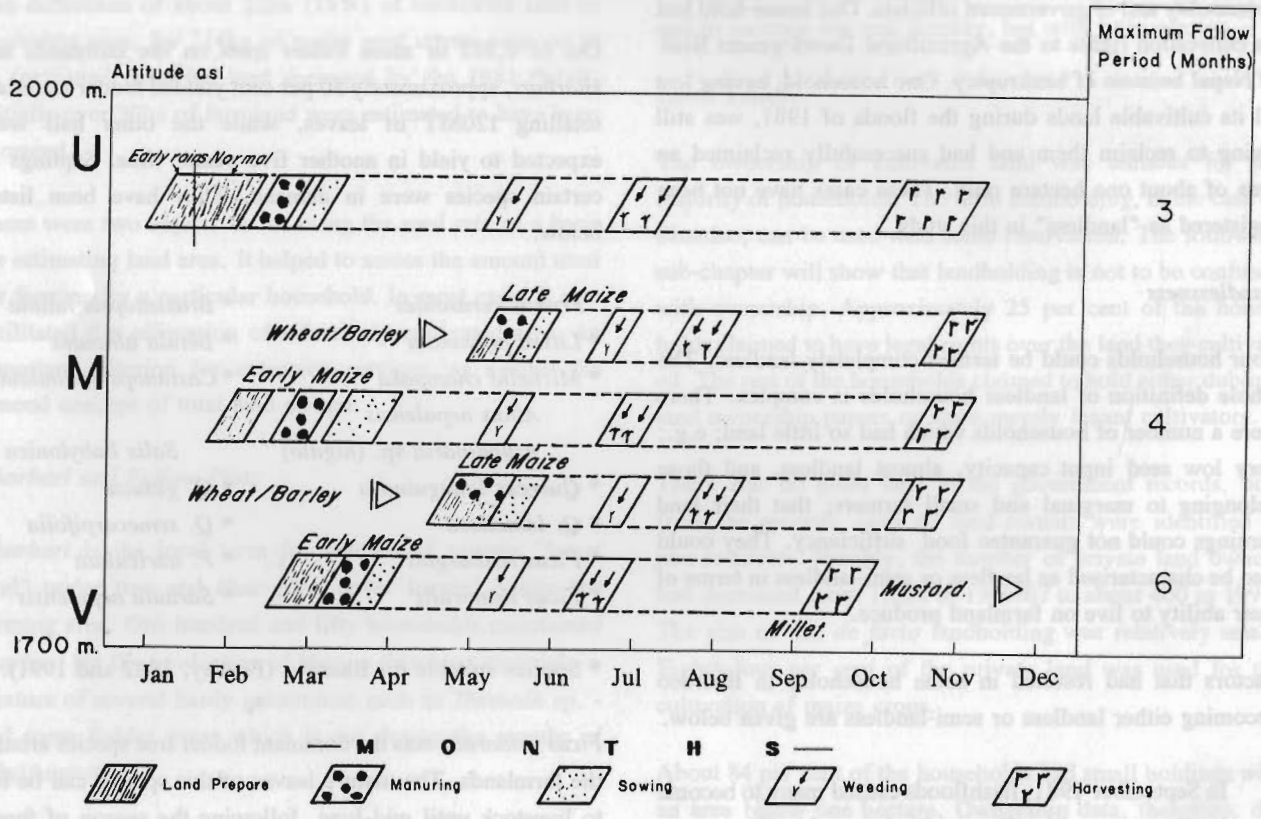

Figure 7: Cropping Pattern of Bhardeo

Farm Inputs

Seed Inputs

Table 8 gives an idea of seed inputs required by households for normal crop yields in the Bhardeo area.

The required quantity of maize seed (a major crop) indirectly reflects the economic conditions of individual households (Figure 8).

A normal household in Bhardeo with 6.5 members in the family requires 30 to 35kg of maize seed inputs to guarantee minimum staple grain production.

Table 8: Seed Inputs of Crops - 1988

Crops	Seed Inputs (kg)	Cost (Rs)	Households (%)
Maize	3829	22974	98.5
Wheat	1047	4188	40.9
Mustard	240	2400	12.4
Barley	54	204	4.1
Beans	22.5	130	6.4
Soyabeans	14.5	49	3.0
Millet	13	41	1.5
Paddy	8.5	1.1	-
Potatoes	?	11.6	-
Peas	?	0.75	-

Only 6.7 per cent of the households could afford adequate seed inputs. In an area where there is as chronic a food deficit as in Bhardeo, maintaining even an adequate quantity of seeds becomes a difficult proposition. Many farmers in Bhardeo could not afford to store seeds at home and had therefore to rely on the market for seeds. This influenced seed prices in Bhardeo and the surrounding areas, ultimately affecting grain prices during the late dry season. The price of maize seeds was normally higher than the maize grain used for food. The rise in price was continuous from October (Rs 3.10/kg or Rs 10/*pathi*) through April (Rs 5.50/kg or Rs 18/*pathi*).

Labour

Farming in Bhardeo can be considered to be labour efficient. This is due to the fact that there is one major summer crop which forms part of a multi-species, inter-cropping system with potatoes and beans, planted as inter-crops, followed by millet as a relay crop. The major labour force required was for maize cultivation, at the rate of 7.8 mandays per kilogramme of seed input, from the soil preparation (inclusive of 0.6 mandays [bullock driver]) to harvesting.

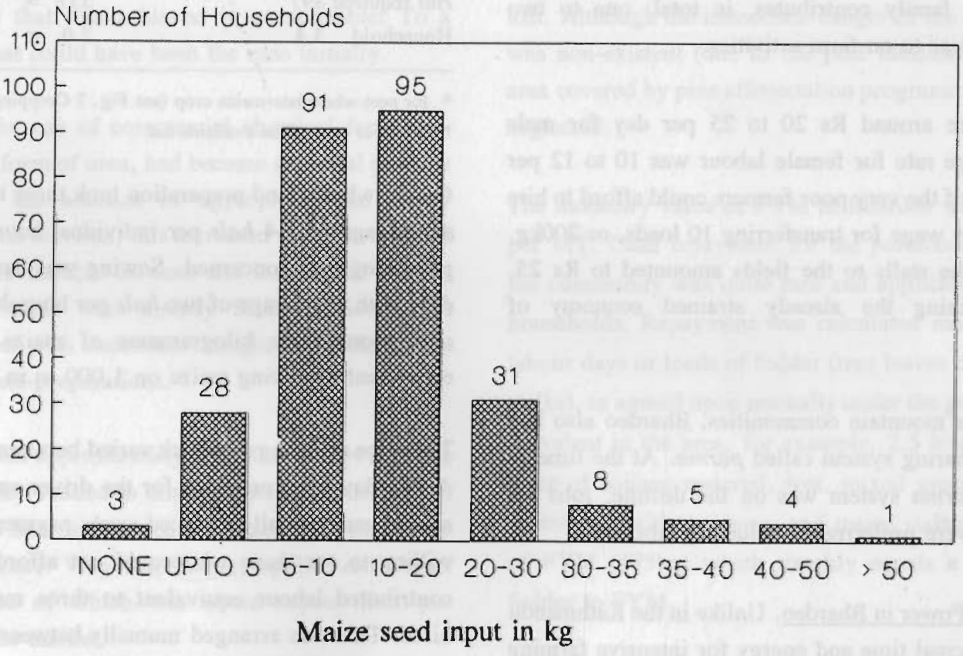

Figure 8: Classification of Households by Maize Seed Inputs

About 18 per cent of the labour was required only for the transfer of farmyard manure (FYM) from the stalls to the fields and spreading operations were mostly carried out in the months of February and March. Table 9 illustrates the labour distribution needed for maize crop production.

Similarly, the labour requirements[4] for minor crops such as wheat and barley might be slightly lower than for maize cultivation. Minor crops were normally of a single species. The labour requirement was roughly equivalent to four man months for maize (plus inter/intra crops) cultivation-which

4. Based on the Bhardeo system, a factor of 0.75 is to be multiplied by a kilogramme of seed of minor crops (wheat, barley, mustard, peas) to calculate the labour requirements for minor crops.

Table 9: Farm Labour Requirements for Cultivation of Major and Minor Crops (mandays)

For maize crop only	Mandays/kg seed	Crops	Mandays
Field Preparation 1	1.8	Maize	29866
Manuring/fertilising 2	1.5	Wheat	6449
Sowing 3	0.9	Barley	399
Weeding 1st	1.5	Mustard	1201
Hoeing 2nd	1.0	Millet	85
Harvesting	1.1	Peas/beans	111
Total	7.8		38111

1) 0.4 mandays bullock driver, 2) 0.3 mandays for transportation, 3) 0.2 mandays bullock driver

takes place only during the months of January to early October. The total farm labour requirement was approximately 1,254 man months or 20.5 per cent of the labour used. This would imply that each economically active member of the family contributes, in total, one to two months labour/year to on-farm activities.

Wage rates were around Rs 20 to 25 per day for male labour. The wage rate for female labour was 10 to 12 per cent less. None of the very poor farmers could afford to hire labour. The daily wage for transferring 10 loads, or 200kg, of FYM from the stalls to the fields amounted to Rs 25, further constraining the already strained economy of Bhardeo.

Like many other mountain communities, Bhardeo also had a local labour-sharing system called *parma*. At the time of the study the *parma* system was on the decline, jobs for monetary gain were preferred to voluntary labour.

Use of Draught Power in Bhardeo. Unlike in the Kathmandu Valley, the principal time and energy for intensive farming operations, such as soil preparation and sowing, were conducted through the use of draught power. The demand for draught power was high from the month of December to the beginning of May when most of the able-bodied persons were away in search of job opportunities. Plantation on farmlands located at higher altitudes took place in February, whereas in the lower areas of the valley it was carried out in March.

The draught power requirement per household was more or less positively related to the amount of seed input involved and the land area brought under cultivation. The average use of 0.37 *hal*[5] per kilogramme of maize seed sown was the norm. Altogether such operations last for a total of about 40 days per annum (Table 10). The main draught power requirement was for soil preparation. The use of draught power was not equally intensive in all the wards.

Table 10: Seasonal Requirement of Draught Power (*Hal*) in Bhardeo

Area	Soil preparation	Sowing operations	
Upper	December	February	(2nd half)
Middle	January	March	(1st week)
Valley	February	March	(2nd half)
	April*	May	(1st week)*
Hal required	897	537 =	1434**
Household	3.4	2.0 =	5.4

* for post-wheat late-maize crop (see Fig. 7 Cropping Pattern)
** 87.5 per cent of the available *hal*

On the whole, land preparation took three to four days with an average of 3.4 *hals* per individual household, as far as ploughing was concerned. Sowing was carried out in two days with an average of two *hals* per household. A *hal* could sow about three kilogrammes of maize seed per day, equivalent to sowing maize on 1,000 sq.m. of land.

The price of hiring a bullock varied between Rs 40 to Rs 70. A mid-day meal provided for the driver and fodder for the animal substantially reduced cash payment. Those either willing to, or those who could not afford cash payment, contributed labour equivalent to three mandays to a *hal* hired. This was arranged mutually between bullock owners and the households hiring the *hal*.

Soil Nutrients

The quantity of soil nutrients, particularly N, P, and K, for the level of productivity found in Bhardeo, was agronomically acceptable. Per hectare use of N, P, and K in 1988 was estimated to be around 94, 115, and 325kg, respective-

5. *Hal* = one day's labour from a pair of oxen with a driver = *Hali*.

ly. However, taking into consideration the slope gradients of the cultivated land, nutrient inputs, even at this level, were insufficient to prevent soil erosion and loss of soil nutrients.

Of the total amount of nitrogen fertiliser available, 18.5 per cent (2.08MT N) was available in the form of urea (46% N). People in Bhardeo used commercial chemical fertilisers increasingly, partly due to the heavy loss of soil, on one hand, and partly due to aggressive agricultural information that promoted the use of commercial chemical fertilisers. The local people had only recently become aware of the negative implications of commercial fertilisers, and previously chemical fertilisers had been assumed to have only positive qualities.

Commercial Chemical Fertiliser. In Bhardeo, the use of chemical fertilisers increased following the catastrophic floods of 1981 as an instant response to the sudden and massive loss of farmlands and soils, causing drastic reduction in cultivable land. Since no food aid was supplied from outside Bhardeo, the pressure to increase productivity was strong. Whether that was achieved is questionable! To a certain degree that could have been the case initially.

As elsewhere, the use of commercial chemical fertilisers, especially in the form of urea, had become a normal practice in Bhardeo. In the absence of appropriate and timely technical extension services, this increased use of urea could lead to more unfavourable harvests and loss of soil fertility in the future. People were already facing difficulties in breaking soil clods with traditional draught power during the post-monsoon field preparations.

A sack of urea cost approximately Rs 200 to 215 (4% of the household income). Added to this was the additional cost of transportation to Bhardeo, which amounted to about Rs 40 per sack of fertiliser. Very few farmers applied muriate of potash, the price of which was about rupees four per kilogramme in the market.

In 1987/88, 34 per cent of the farming households in Bhardeo used 90.5 sacks of urea worth Rs 22,000; equivalent to almost three per cent of their cash incomes from the farmlands. Because of dwindling forestry resources the use of chemical fertilisers was expected to rise substantially. For longer term maintenance of soil fertility, organic fertilisers such as FYM play a crucial role.

Farmyard Manure (FYM). The total FYM available for the area was about 1,305MT which is equivalent to 11MT of FYM/ha of effectively cultivated land. The estimated NPK content of the local FYM was estimated to be around 9.1, 13.7, and 38.7MT respectively (LAC 1991).

The amount of FYM in terms of its value in NPK contents should not be the way the importance of FYM is judged. It is the organic nature of FYM that is essential for the soil structure, plant nutrition, and water absorption capacity of the soil. Some households had started collecting pine needles as bedding materials from the degraded pine plantations of Ward numbers one, two, and six, and this would have ultimately ended up as FYM. About 4.9 per cent of the farm households in Bhardeo did not keep any ruminant animals and about 1.9 per cent did not have any animals (including poultry) at all. These households faced the problem of insufficient soil nutrients and organic matter for their farmlands. The amount of FYM available for Bhardeo soils would have been adequate for most households, provided the gradient of cultivated lands had been good and soil erosion at a minimum. However, this had not been the case since the 1981 floods when terraces were damaged and topsoil was lost. Although the immediate danger of the Ph level sinking was non-existent (due to the pine needles), the increasing area covered by pine afforestation programmes should not be neglected.

The monetary value of FYM in Bhardeo was around Rs 70 per MT. Cash repayment for the purchase of FYM within the community was quite rare and applicable to only a few households. Repayment was calculated mostly in terms of labour days or loads of fodder (tree leaves or loads of maize stalks), as agreed upon mutually under the general conditions prevalent in the area, for example, 2.5 loads of fodder (ca 60kg of soilage material, wet, mixed green-cut during the monsoon, fodder grasses, and maize stalks) to seven loads of FYM (175kg) which roughly equals a ratio of 1:3 of fodder to FYM.

Cost of Maize Production. The cost of maize production, which can be relatively high in the mountains, was about Rs 5.45 per kilogramme of maize. But the effective cost to the farmer in terms of cash expenditure for chemical fertilisers and tax payment was less than Rs 0.40, and this covered the cost of seed, chemical fertilisers, and land taxes. Table 11 shows the cost-benefit ratio of maize production in Bhardeo. This is inclusive of the cost for the production of potatoes, beans, and soyabeans, as they form part of the maize cultivation system.

Table 11: Cost of Maize Cultivation in Bhardeo

	Rs	Rate
Labour	597324	Rs 20/day wage
Manure	104385	Rs 2/bag of 25 kg
Land tax	3330	Rs 20/ha
Urea fertiliser	21700	Rs 4.80/kg urea
Seed	22974	Rs 4/kg
Total Cost	734463	

Major Contributions of Farmland Resources

Foodgrains

A major contribution to the local farmland resources came from maize which provided 89 per cent of the foodstuff produced.

More than 60 per cent of the households harvested less than 0.5MT of maize grains (Figure 9). The second important, crop was wheat which accounted for 6.4 per cent of the total crop production, whereas rice was insignificant.

Fodder and Feed

As elsewhere in the mountains, the farmlands in Bhardeo were used for producing fodder in numerous ways. The contribution from the local farmland, of fodder and bedding materials for the management of livestock, was substantial. It was estimated to be around 80 per cent of the total fodder from multiple sources.

The maize grain used as feed accounted for approximately 11 per cent (13.4MT) of the total maize production. For ruminant animals it was used as *khole* (salt and flour boiled in water), especially for feeding draught animals.

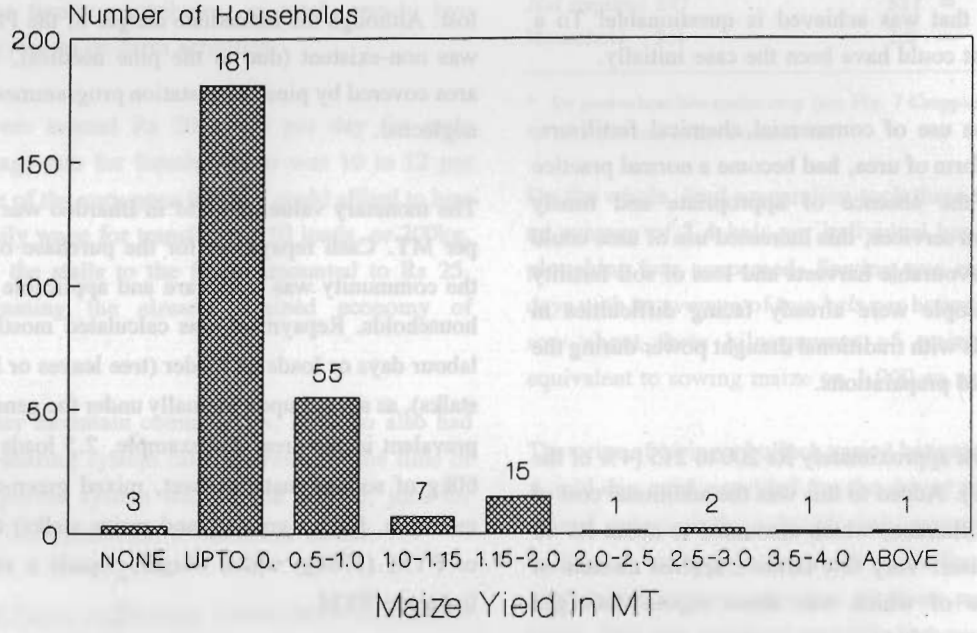

Figure 9: Classification of Households by Maize Yields

The crop residues were used as fodder during the dry season. This was an important investment on the part of the community as it still faced a food deficit for six months of the year. Mustard straw (*gatte)*, paddy straw (*paral*), wheat straw (*chhwali*), and millet straw (*nal*) were also fed to ruminants, although the low volume of production was hardly significant. Miscellaneous plants collected as green soilage fodder from the farmlands amounted to about two to three basket-loads per household daily and they were collected mainly during the monsoon season.

Cooking Fuel and other Materials

The most important by-products of maize are dry cobs which are used solely for cooking and heating purposes. About 31MT of cobs were available in Bhardeo as fuel. It was estimated that an increase in maize production by 10 per cent could increase the availability of cobs by over three metric tonnes, which was equivalent to the firewood needs of two households in Bhardeo or five households in warmer areas.

The farmlands also produced *babiyo* (*Pollinidium angustifolia*) and *amriso* (*Thysanolaena maxima*) plants which are used for making brooms. About 25 per cent of the households produced their own *amriso* plants whereas *babiyo* was not available in abundance, although the area was suitable for both species. A bush of *amriso* or *babiyo* of average size could be used for making four brooms. They were planted for home use only and were sufficient to meet local household needs.

Production and Productivity

Maize, which is the principal crop and requires the most inputs, was the staple foodgrain for the local community and had an output rate of 134.8MT with a productivity rate of about 1.2 metric tonnes per hectare. The quantity of foodgrains (including soyabeans, beans, and peas) produced in the area exceeded 146MT. Potato production was about 3.2MT and mustard output amounted to about 2.1MT or equivalent to 390 litres of edible oil. Minor crops, such as wheat, provided only a month's supply of staple food. Winter wheat was becoming the most important crop after maize. Over 40 per cent of the households cultivated wheat.

There was a potential to produce a further 25MT on an estimated area of 22ha of farmland which were still under debris cover. The average yield of maize was much below the national average and even 35 per cent below the district's average yield of 1.836MT/ha (Agricultural Census 1977).

Even if productivity had increased by 10 to 15 per cent (as it had in 1971 according to the farmers), the total production would have been only around 185MT of maize grains from a total of 140ha, giving, on average, a per capita maize availability of about 120kg per year, implying the existence of a serious food deficit even before the catastrophic soil loss and damage to the farmlands in the 1981 floods.

Livestock Resource Management

Livestock are one of the most important resources of mountain communities. They contribute directly and indirectly to nutrition and rare cash incomes, draught power, and crucial farmland nutrients. Regular investments in terms of fodder and forage materials, building of stalls, and addition of new animals to augment or replace the stock were important elements in the Bhardeo farming system.

Ruminants

As of mid-1988, there were 1,892 ruminants in Bhardeo (Table 12)

Table 12: Ruminant Animals from 253 Households in Bhardeo

Ruminant Animals		#	(%)	Household Owners	Holdings
Buffaloes					
	male	70	(63)	59	
	female	294	(60)	180	
		364	(44)		1.4
Cattle					
	oxen	21	(29)	63	
	cow	169	(29)	91	
		190	(29)		1.1
Goats					
	males	314	(67)	155	
	female	924	(28)	220	
		1238	(38)		4.7
Total		1892	(38)	253	

(Figures in parenthesis = % very young animals)

What is worth noting from Table 12 is the complete absence of pigs and sheep, an uncommon occurrance in a temperate area like Bhardeo. Pig rearing might not be viable in Bhardeo, where food shortages are chronic, and the absence of sheep might be mainly due to the lack of proper pastures.

The mean size of the ruminant holdings of the community varied between 5.97 to 8.37 head per household. Taking into consideration the special dependence of Bhardeo ruminants on forestry biomass for fodder and bedding materials, particularly over the dry periods, an unconventional basis for the estimation of Livestock Units (LSU) was used. The farmers in Bhardeo had an interesting practice: the amount of fresh leaves of *Quercus* sp. fed to the adult ruminants varied according to the type of adult animal. On this basis, it was found that approximately 10kg were fed to buffaloes, eight to cattle, and three to goats daily during the dry season. Hence, to calculate livestock units for the area, an adult buffalo was considered as one LSU, adult cattle 0.8 LSU, and an adult goat 0.3 LSU. This was applicable only

for Bhardeo. Fifty per cent of the population in any one of the above categories were counted as one-half adult units. The estimated total number of Bhardeo LSU was around 700.

Poultry

The importance, especially of male birds, is high due to their sacrificial value in the area where five big religious festivals are held every year. Poultry holdings were rather small: 9.64 birds per household among 266 Bhardeo households (Table 13).

Table 13: Poultry Population in Bhardeo

Population	F	M	Chicks	Total No. of Birds
Total	742	608	1215	2565
Households	246	205	173	255

Most of the birds belonged to the local breed (*sakini*) which is not very productive (in the context of egg laying). However, the quality of the meat (in terms of taste) from this breed is much better than that from new breeds of poultry such as the Leghorn, New Hampshire, Astrolop, or their crossbreeds. In fact, the price of *sakini* meat was higher, even in Bhardeo, than the meat from new breeds.

In Bhardeo, normally, *sakini* hens followed three cycles of egg production per year, laying 10 to 20 days in each cycle. This hardly gave 50 eggs per annum. *Sakini* hens lay eggs for about three years or more.

Resource Dynamics

The animal population was quite dynamic, as shown in Table 14.

The mortality of ruminant animals for the year 1987/88 was over 80 LSU, worth at least Rs 200 to 300 thousand at the prevailing market price. Mortality of the poultry, found to be highest amongst young chicks, was registered as incurring a loss of Rs 25 to 30 thousand. These figures imply substantial loss of animal resources for farmers who are compelled to search for off-farm opportunities for half the year. The factors that were responsible for the high mortality rate are given below.

Table 14: Animal Population Changes in 1987/88

Population	Buffalo	Cattle	Goats	Poultry
April 1987	318	288	930	2299
Mortality	41	33	139	814
Sales	17	1	40	56
Consumption	1	-	4	770
Purchases	25	8	21	212
Birth	80	28	470	1694
Population April 1988	364 (44.2%)	290 (29.6%)	1238 (37.9%)	2565 (47.4%)
Growth 1987/88	+ 14.4%	+ <1%	+ 33 %	+ 11.5%

(Figures in parentheses = percentage of young animals)

The lack of adequate veterinary services and absence of breeding and brooding programmes were among these factors in terms of lack of inputs. Other factors included the existence of predators such as wild cats, leopards, and jackals which posed a danger to poultry, goats, and cattle, and sometimes also to young buffaloes. The situation could become acutely self-defeating, as the people protect and promote the forests, thereby providing a sanctuary for the carnivores. At the time of the study the danger lay within the farmlands, especially during the monsoon.

The loss of livestock had an important bearing on the production of soil nutrients and direct cash income. In Bhardeo seventeen per cent of the cash incomes were generated by livestock. Much of the loss could have been avoided with the help of timely veterinary services. Despite these losses affecting consumption or sales, the livestock population growth recorded for the year 1987/8 was 14 per cent for buffaloes, 33 per cent for goats, and 11 per cent for poultry, not only through birth but also through purchases from outside. According to the people, the ruminant holdings were one-third of what they had been two decades previously.

Resource Productivity

Although the transformation of crop residues, other roughage, and forestry biomass into FYM by ruminants is a crucial contribution of livestock in maintaining soil fertility, the economic contribution of livestock to the local farming system as a source of milk, meat, manure, and draught power is a very important one also.

Milk Production

The total milk produced in 1987/88 was about 27,000 litres (equivalent to Rs 189,830 calculated at 6% fat content) and was used for home consumption with few exceptions.

Eighty-eight per cent of the milk was from buffaloes. Of the total number of female buffaloes and cows only 18 per cent of the female buffaloes and five per cent of the cows were lactating.

The milk yield of the animals rises gradually in the early monsoon and is monitored by local farmers. The early stage of lactation and rising milk yield is known as *laino*, the second stage is known as *thito* phase and it indicates the yield constancy, and the last stage or *tharo* phase indicates the drying up of lactation.

The maximum daily performance of a buffalo was 2.3 litres of milk (1987/88). April to June were lean months and milk production was low. This period is also one of stress for farmers due to the scarcity of fresh, green materials for feed. Figure 10 illustrates the annual milk production in Bhardeo.

In terms of the average percentage of lactating animals and the amount of average daily milk yield per animal, buffaloes performed the best. The minimum percentage of lactating buffaloes for the 1987/88 period was over two per cent, while that of cows was just over 0.5 per cent.

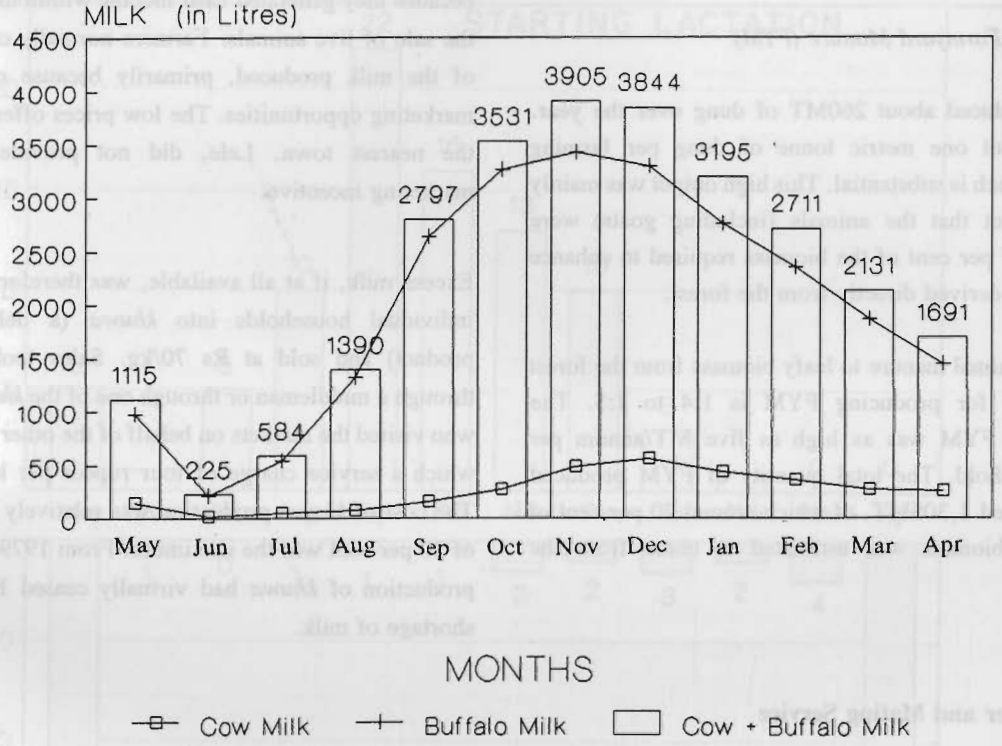

Figure 10: Monthly Milk Production

The lactation season begins in May which is normally the hottest and a relatively dry month. A maximum percentage of buffaloes (22%) lactate in *Poush* and *Magh* (December-February) during a relatively dry period and the highest percentage of cows lactating in any one month is eight per cent (Table 15).

Meat Production

Only one buffalo and four goats (hardly 1.04 LSU) were slaughtered in 1987/88 for home consumption. This was equivalent to roughly one kilogramme of meat per household per year or Rs 8,000 worth of meat.

Table 15: Lactation Differences between Cows and Buffaloes

Animals	% Animals Lactating	Daily Milk Yield	Fat Content %
Buffaloes :	15%	1.5 litre	6
Cows :	4-5%	1.0 litre	NA

The Bhardeo people are poultry eaters. About 770 birds were killed for home consumption, equivalent to 1,500kg of meat (equivalent to Rs 75,000). On the average 5.6kg of poultry was consumed by each household per annum. The per capita meat consumption was only 11 per cent of the national average (Livestock Strategy Vol.I).

Production of Farmyard Manure (FYM)

Livestock produced about 260MT of dung over the year. This was about one metric tonne of dung per farming household, which is substantial. This high output was mainly due to the fact that the animals (including goats) were stalled. Eighty per cent of the biomass required to enhance the FYM was derived directly from the forest.

The ratio of animal manure to leafy biomass from the forest (*patkar/sottar*) for producing FYM is 1:4 to 1:5. The production of FYM was as high as five MT/annum per farming household. The total quantity of FYM produced annually reached 1,305MT, of which around 20 per cent of the required biomass was estimated to come from the farmlands.

Draught Power and Mating Service

Oxen were maintained for draught power as well as for normal mating services for which owners charged Rs 10 to 30 per conception. Buffalo bulls cost more than cattle bulls.

The draught power requirement and its generation within the area were very high. It was found that 41 pairs of bullocks were used for draught power within the households of the community, generating about 1,640 *hal* (bullock days) of which 87 per cent were utilised (Table 10). The draught power available was adequate for both types of labour used, namely, soil preparation and sowing operations. Seasonal imports of draught power were not observed.

Soil preparation which takes place in the beginning of the dry period, between November and December, requires approximately double the draught power required for sowing operations. However, during the labour season (November to May), bullock pairs are maintained on a special diet. At the time of the study, fodder shortages were not critical. Animal feed was supplemented with eggs at intervals of seven to 14 days, and about 500 grammes of maize flour were provided daily with salt water. Roughage fodder was provided *ad lib*.

Livestock as a Source of Direct Incomes

Livestock were important to the local farming system because they generated cash income within the area through the sale of live animals. Farmers normally consumed most of the milk produced, primarily because of the lack of marketing opportunities. The low prices offered for milk in the nearest town, Lele, did not provide an adequate marketing incentive.

Excess milk, if at all available, was therefore processed in individual households into *khuwa* (a dehydrated milk product) and sold at Rs 70/kg. Sales took place either through a middleman or through one of the *khuwa* producers who visited the markets on behalf of the other producers (for which a service charge of four rupees per kg was made). The cost of *khuwa* production was relatively high. A profit of 20 per cent was the maximum. From 1979, however, the production of *khuwa* had virtually ceased because of the shortage of milk.

Qualitative Indicators of Livestock Resource Management

Visual Condition of Livestock

The visual condition of the animals indicated a low level of nutrition. The general practices of rearing and maintenance were satisfactory. The animals were normally stall fed. The condition of the stalls was good and the structures protected the animals against rain, cold, heat, and carnivores. The farmers kept almost all animals inside the stalls overnight to avoid the cold. In the coldest period, animals were allowed outside for a maximum of three days.

Planning for Lactation and Milk Production

The management strategies for sustaining ruminant livestock resources showed how a small mountain community, without outside intervention, had tried to maximise gain and minimise risks. The farmers were aware of how high temperatures, fodder availability, and labour availability affected the quality and quantity of milk production. Eighty-two per cent of the lactation started during July and lasted until November when the fodder was relatively adequate. Twenty-five per cent of all lactation took place between August and September. The lactation period coincided with seven to eight months of monsoon flush when tree fodder was available for the lactating animals. The highest amount of milk was produced from July (heavy rains) to March (relatively cooler). Fifty-seven per cent of the milk produced in Bhardeo was thus available between July and November.

The three months from April to June were lean months when milk production was at its lowest, when dependence on forest fodder resources increased, and when there were labour shortages. The labour shortage was aggravated by the winter harvesting season, the first hoeing of early maize, and the sowing of late maize which coincided with frequent dry spells.

Servicing and lactation should be timed to avoid lactation during periods of the year when fodder availability is low and milk conservation and the marketing of milk products becomes difficult. Figure 11 illustrates the Bhardeo farmers' planning skills as far as livestock management is concerned.

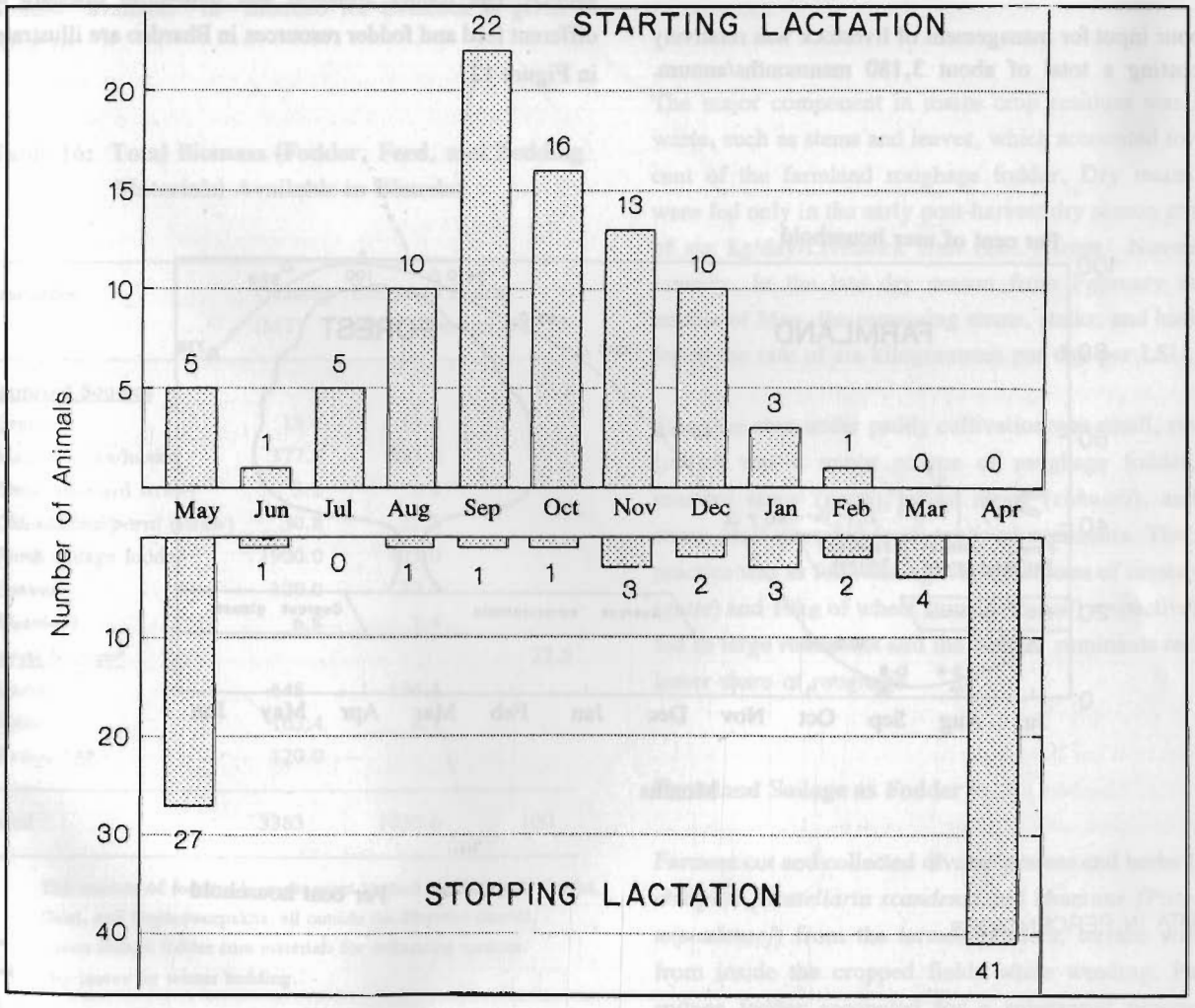

Figure 11: Number of Animals Commencing and Completing Lactation Periods over a One-year Period

Coinciding with lactation, 57 per cent of the total amount of milk produced in Bhardeo was available from July to November (five months). The quantity of milk fell during the four months from August to December to over 3,600

litres per month. The increase in total milk production cannot be wholly attributed to the availability of fresh fodder.

It was not surprising to find that 79 per cent of the lactating animals stopped lactating during the three driest months of March, April, and May. The farmers were aware of the implications of fodder shortages and the problems of high temperatures (during the dry period from March to early June) on milk production. Accordingly, the servicing of female animals was arranged in such a way that the lactation period coincided with the flushing season from August to November. This was one of the few good examples of farmers adapting to the prevailing situation. The farmers managed in such a way that they derived maximum benefit from their natural resources.

Labour Input for Livestock Management

The labour input for management of livestock was relatively high, costing a total of about 3,180 manmonths/annum. Shifting animals to stalls and farmyards and bringing water to the animals, or even taking the buffaloes for a walk, however, did not require much effort. The ruminants were all stall fed, requiring on an average one extra labourer daily for fodder collection. The time required to collect a load of fodder/forestry biomass had increased by over two hours and the households delegated one member of the family to collect the same each day.

Fodder Resource Management

The major sources of feed and fodder/forage for the ruminant livestock in the area were, primarily, farmland and surrounding forests. Even during the monsoon period, the farmlands could not sustain 100 per cent of the fodder supply. The fodder situation and household pressure on different feed and fodder resources in Bhardeo are illustrated in Figure 12.

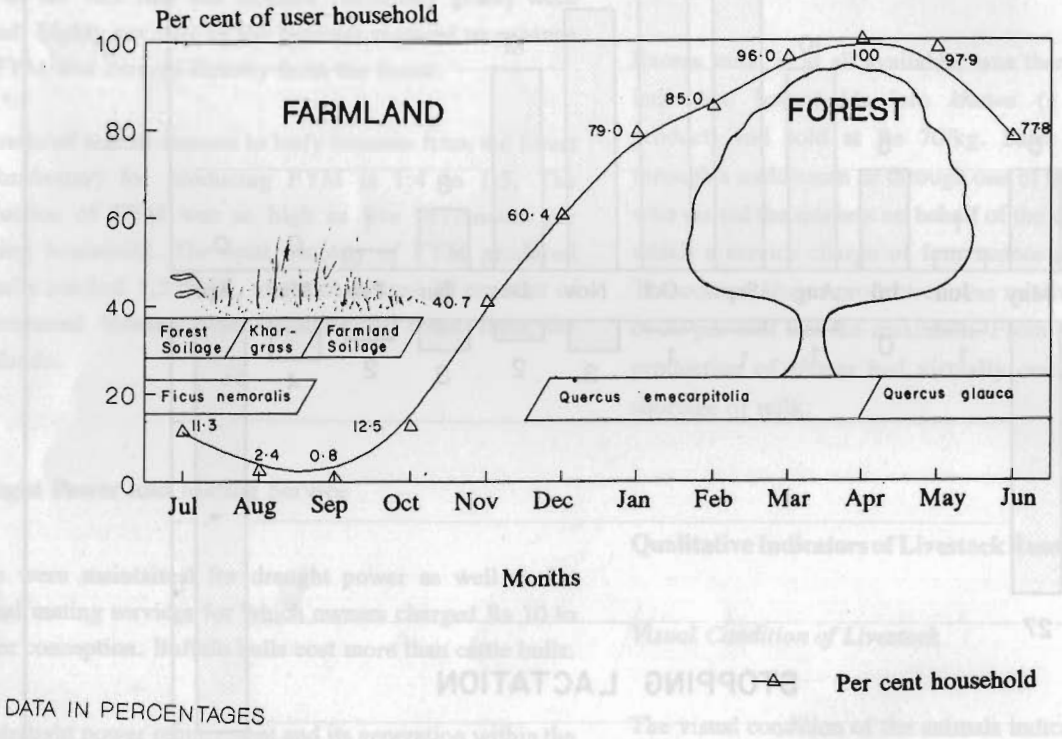

Figure 12: Dependance of Households on Forests for Fodder Materials during a Normal Year

There were two distinctive periods when more than 50 per cent of the farm households collected leaf fodder and dry leaves from the forest floors, mostly of the *Quercus* and *Rhododendron* species. During the peak season in the month

of March, 100 per cent of the user households in the area collected forestry resources from the Gairi, Gupteswor, and Phulchoki *Pakha* forests, all of which fall outside Bhardeo.

From June to September, more than 80 per cent of farm households drew livestock fodder requirements from the farmlands. This was estimated to be around 1,900MT of fresh fodder material or approximately 120 harvesting days for each household, amounting to 60kg of fresh fodder material per day. The feeding of fresh farmland soilage fodder was not without problems. The ratio of green fodder to carbon-rich roughage, such as straw, was higher in the monsoon feed. Most households had used up their carbon-rich roughage fodder, such as straw and maize stalks, during the dry period. This led to higher incidences of bloating during the rainy season, causing animal losses. The total biomass available in Bhardeo for livestock is given in Table 16.

Table 16: Total Biomass (Fodder, Feed, and Bedding Materials) Available in Bhardeo

Resources	Quantity (MT)	Estimated Fodder air-dried matter (MT)	%
Farmland Sources			72.5
Grains	13.4	13.4	
Maize (stalks/husks)	377.8	283.4	
Gatte (mustard straw)	3.2	2.4	
Chhwali/nal/paral (straw)	30.8	22.5	
Fresh soilage fodder	1900.0	475.0	
Leaves	120.0	30.0	
Kharbari	6.8	1.4	
Forest Source*			27.5
Leaves	648	194.4	
Sottar **	163.4	8.1	
Patkar ***	120.0	-	
Total	3383	1030.6	100

* The sources of forestry biomass were located on Phulchoki *Pakha*, Gairi, and Gupteswor*pakha*, all outside the Bhardeo district.

** Green soilage fodder cum materials for enhancing manure.

*** Dry leaves for winter bedding.

Crop Residues as Fodder

Crop residues, such as maize stalks and maize husks, as roughage fodder were produced on 118 ha of dryland slopes. Table 17 estimates the importance of maize crop residues as a source of roughage fodder for ruminant animals in the area.

Table 17: Major Roughage Fodder

Roughage		Quantity (MT)
Maize stalks stems/leaves	:	306.1
Maize husks	:	71.7
Mustard straw (*gatte*)	:	3.2
Wheat/millet straw *	:	30.8
Total	:	411.8

* *Chhwali/Nal*

The major component in maize crop residues was harvest waste, such as stems and leaves, which accounted for 91 per cent of the farmland roughage fodder. Dry maize leaves were fed only in the early post-harvest dry season at the rate of six kg/day/Livestock Unit (LSU) from November to January. In the late dry season from February until the middle of May, the remaining stems, stalks, and husks were fed at the rate of six kilogrammes per day per LSU.

Since the area under paddy cultivation was small, rice straw (*paral*) was a minor source of roughage fodder, while mustard straw (*gatte*), wheat straw (*chhwali*), and millet straw *(nal)* were fed to all types of ruminants. The feeding practice was as follows: eight kilogrammes of mustard straw (*gatte*) and 10kg of wheat straw (*chhwali*) respectively were fed to large ruminants and the smaller ruminants received a lesser share of roughage.

Farmland Soilage as Fodder

Farmers cut and collected diverse grasses and herbs (such as *charpate [Scutellaria scandens]* and *khursane [Pittosporum nepaulense]*) from the terrace borders, terrace walls, and from inside the cropped fields while weeding. Farmland soilage fodder accounted for a substantial proportion of monsoon green fodder, supplementing wet soilage fodder collected in the forests. Green soilage fodder collected on the farmlands exceeded 1,900MT annually. With 20 to 25 per cent of air-dried matter this would mean that 400 to 500MT of air-dried fodder was available for ruminants.

Fodder Trees

The principal fodder trees found in the area were noted and listed. *Saur (Betula alnoides), chuletro (Brassaiopsis hainla),* and *dudhilo (Ficus nemoralis),* the most ubiquitous, mature into fodder harvest in about 12 years. *Anjir (Ficus auriculata), nemaro (F. roxburghii), kafal (Myrica esculenta),* and *F. nemoralis,* induce increased milk yield. *Painyu (Prunus cerasoides)* was mainly fed to goats apart from during gestation periods. The local people had observed that there was a risk of abortion when this plant was fed to gestating animals. *Banjh (Quercus languinosa)* and *gogan (Sarauia nepalensis)* were some of the other fodder species.

Best in terms of productivity, growth condition, and as a major source of green leaves after the *Quercus glauca* period (about one month prior to the monsoon rains in May/June), was *dudhilo (Ficus nemoralis).* The species of grasses and herbs in the *kharbari* are given below.

Arthunge khar (Themeda sp.)	*Amriso (Thysanolaena maxima)*
Kansh (Saccharum sp.)	*Siru (Imperata cylindrica)*
Muse ghans (Capillipedium assimile)	*Babiyo (Pollinidium angustifolia)*
	Dubo (Cynodon dactylon)

Fodder trees on the farmland terrace benches and *kharbari* were used to produce green fodder in critical periods of the dry season. The estimated total of green leaves harvested was 120MT or 30MT of air-dried matter.

Kharbari (Grass and Shrubs)

Kharbari was the source of about seven metric tonnes of fresh fodder material or 1.4MT of air-dried matter. The first cutting of grass for fodder took place in July/August, although this was not a general practice. Only under conditions of acute fodder shortage do households undertake the first cut. This was one of the reasons why only about 30 per cent or six to seven metric tonnes of the potential fodder material were used for feeding animals in the Bhardeo area.

The experienced (quantitative) estimation in the area was that fully one-third to one-half of the December yield (i.e., 32MT) of thatch could be harvested in July as fresh fodder. This would have yielded 11MT compared to six to seven.

According to the local farmers, the total productivity was about one kilogramme of fresh matter per square metre of *kharbari,* which amounted to a yield of approximately 236MT annually. Not more than six to seven metric tonnes of *khar* grass were harvested as fodder by only 25 households. The fodder potential of the area was not fully utilised. This area could be a vital producer of diverse products such as tree leaf fodder, cut grasses, bedding materials, and also firewood, reducing the existing pressure on forests.

From June to October, the forests are used for wet soilage fodder-cum-bedding materials which are collected mainly for enhancement of FYM. So, even if the quality of the *khar* fodder is not good, it would still be better than the various materials collected from the forest floors as soilage fodder-cum-bedding materials for the same purpose.

People were using *khar* less for fodder production than for thatching material, which was reasonable in the absence of other roofing materials. As more and more people begin to use industrial tiles as roofing materials, the *kharbari* could become much more useful as a source of green fodder. Unless economically viable alternative roofing materials can be found and the grass and tree cover increased, it will be difficult for the community to use more than 20 to 25MT of *khar* grass as fodder.

Access to Forest Fodder Resources

Forests were used by local farmers for a number of things, e.g., green leaves for fodder, twigs *(jhikra)* for firewood, dry leaves for bedding and FYM, and wet soilage grass for fodder and for augmenting FYM. Forest products were used throughout the year, e.g., dry leaves *(patkar),* tree fodder, and wet soilage (grasses and herbs).

Lopping of Tree Leaves as Fodder. *Dale ghans,* or mature leaves of *Quercus semecarpifolia,* were used extensively before May before the fruit appeared. The appearance of fruit in this species coincides with the shedding of leaves, beginning in mid-May. By the end of August, the leaves grow back and during this period the leaves are not used.

Fodder collection from *Quercus semecarpifolia* required six to seven hours, compared to the three to four hours needed 15 years previously. On an average, people required two hours more to fetch a load of tree leaf fodder than a decade previously.

The average collection per household amounted to about 25kg of *Quercus* leaves per day throughout the dry season by the user households. Some farmers, who could not afford to go to the forests due to time and labour constraints,

bartered each load of leaves for two kilogrammes of maize flour. Leaves were normally fed with roughage fodder at the ratio of 25kg of green leaves to about 10kg of roughage fodder (Table 17).

Collection of *Patkar* (dry leaves from forest floors used as bedding material). During most of the dry period (November to May), about 10 to 12kg of dry leaves were collected in bundles of about two kilogrammes from the upper *Rhododendron-Quercus* forests. This took place before the start of natural leaf-shedding to avoid the hard and thorny *Quercus* leaves.

Collection of *Sottar* (wet soilage fodder from forest floors). During the wet months from June to September, the forests were used for collecting wet soilage fodder-cum-bedding materials, mainly to enhance the FYM.

The species of plants found in the wet soilage collected from forest floors were mainly herbs and grasses, e.g., *khursane* (*Pittosporum nepaulense*), etc.

Livestock husbandry and farming relied totally on forests in the area. On an average, the people used forest products for 26 weeks per annum. Thirty-two per cent of the households located in Ward numbers one, four, and eight used forest products for 25 weeks, whereas 7.5 per cent of the households located in Ward number three used forest products for 32.5 weeks. The other Wards (Nos. 2, 5, 6, 7, and 9) used forest products for 27 to 29 weeks a year.

The total amount of forestry biomass used for livestock management in Bhardeo is given in Table 18.

Table 18: Collection of Forestry Biomass - 1987/88

	Amount (MT)	Household mean (MT)	# of Households involved
Quercus leaves	972	3.9	248 (93%)
Dry leaves	120	0.74	162 (61%)
Wet soilage	163	1.8	89 (33%)
Total	1255	6.44	

* 33.3 per cent of this was woody-twigs used as fuelwood

Pasture and Grazing Practices

The area under study lacked good pastureland, both in the context of size and in the context of the quality of vegetation.

Grazing was not a general or regular practice, given the difficult terrain conditions in Bhardeo. The cattle and goats were taken to open spaces in the valley. Animals were led to open spaces and watering spots to graze upon the thin vegetation cover near streams and farmland terraces, mostly within Bhardeo. The total value of this source is difficult to quantify. Bullocks were let into the forests during the monsoon for fattening and were brought home just before the ploughing season in November. The absence of sheep and pigs was a positive sign. But it was difficult to judge how far fodder sources had been helpful in alleviating the problems of livestock management in Bhardeo. Was the quantity of fodder and other biomass needed sufficient to maintain the livestock in Bhardeo ?

With the fodder/roughage composition used in Bhardeo, for about 700 LSU, roughly 1,400MT of air-dried matter were required each year for maintenance. (The availability of dry matter in the area is inadequate and the fodder deficit is actually higher than was observed.) The role of the farmland is predominant in producing fodder and bedding materials, but, with the decrease in farmland productivity, more pressure will be brought to bear on forest resources. At the time this study was conducted, 27 per cent of the biomass was required for livestock.

Use of Common Forests, Private "Woodlots", and Water Resources

The discussions below on the use of forestry products, such as firewood, fodder, and bedding materials, pertain to forests outside Bhardeo, or even outside Lalitpur district. But forest products such as fern (*niuro* -- *Dryopteris* sp.) and mushrooms were also collected from forest areas within Bhardeo. There were no organised forest slope management groups.

The people of Bhardeo shared the use of the forests located in neighbouring villages such as Gairi, Gupteswor, Phulchokipakha, Khirauli Bhanjyang, and Phulbari, together with farmers from Naldu, Lele, Manikhel, Gotikhel, Chalal, Kaleswor, Chaughare, Dhungkharka, Behbar, Roshi, and Khani villages outside Bhardeo. The percentage of Bhardeo households frequenting Gairi forest was 12.4, Gupteswor 20.6, and Phulchokipakha, 36.4.

Use of Private Woodlots "Kharbari"

The area under *khar* (thatching material) production was estimated to be 23.6ha (14% of the total land). Historically, these plots could have been part of the community forests in this area. In subsequent years, the slopes were claimed by individual households and also used for cultivation. This was a primary factor in the loss of forest lands. During the course of the study, observations were made of plant species which indicated the type of forest that could have been in existence before the land was converted into *kharbari: falant (Quercus glauca), banjh (Q. languinosa), khasru (Q. semecarpifolia), punwale (Ilex doniana), chilaune (Schima wallichii), musure katus (Castanopsis tribuloides)*, and *lankuri (Fraxinus floribunda)*.

Other species of trees and bushes normally found were *gurans* (*Rhododendron* sp.), *angeri* (*Lyonia* sp.), and *ghangaru (Pyracantha crenata)*. Only one-half of the 56.4 per cent of households that maintained shrublands as *kharbari* normally harvested thatch *khar* in December, producing 32MT of dry woody grasses of diverse species.

Harvesting *Khar* (thatching material). One *ropani* of *kharbari/kharpakha* (slopy shrubland), generally yielded about 500kg of *khar*, equivalent to 20 loads, each with 40 bundles (*mutha*) of air-dried *khar*. The second cutting of *salimo khar*, which took place in November/December, was considered good thatching material. *Khar* materials were sold at Rs 0.40 to 0.50 per bundle of about one kilogramme in weight. More and more people were using tiles. More than five per cent of the households had used other roofing materials such as terracotta tiles. At the time of the study, the prevailing price of *khar* was Rs 0.50 per kilogramme.

Use of Forest Resources

Local farmers used the forests for multiple products such as fodder, firewood, and charcoal all year round.

Access to Forests, Fodder, and Firewood Sources

The major use of forests was for collecting leaf fodder, followed by firewood collection. About 972MT of leaf fodder-cum-twigs were collected annually by 265 households[6] and 450MT of firewood were collected annually by all the households. Three species of *Quercus* were used for leaf fodder collection.

The *Quercus semecarpifolia* species of tree can be collected for six to seven months until the end of April and *Quercus glauca* and *Quercus lamellosa* can be collected during the month of May. The twigs and branches (*jhikra*) of the two species are different. *Q. semecarpifolia* is a heavier type of wood and the leaf fodder contains twigs and branches accounting for 35 per cent of the weight of a load as firewood *(jhikra)*, whereas *Q. glauca* and *Q. lamellosa* contain only about 25 per cent of twigs and branches.

It is to be noted that the twigs and branches *(jhikra)* that are collected with tree leaves provide the firewood supply for individual households. People normally need such twigs during the pre-monsoon months. The quantity of such material is over 300MT and it is kept outside the house to dry. Good timber wood would have accounted for a large part of the local firewood consumption had it not been for the use of such twigs (to the extent of about 1.69MT/ household, worth Rs 750 at the prevailing local price of firewood).

Firewood was normally collected during the months of March to May for the rainy season. Bhardeo households needed 1.69MT of firewood/household per year, almost 2.5 times more than the farmers in warmer areas, e.g., the lower parts of Dhading district. Some households hired labourers to collect firewood, and this normally cost about Rs 0.40 per kilogramme of firewood.

Charcoal-making. On average, 200 to 250kg of good quality timber wood were used for each load of 50kg of charcoal, preferably *Q. semecarpifolia*, and at times the *Rhododendron* sp. according to the market demands for charcoal. About 40 to 50 households in Bhardeo were involved in this "illicit" trade.

The major risk involved in transporting charcoal was that of being caught by forestry staff and the police. One very courageous labourer made up to three overnight trips per month carrying his charcoal to Patan market to avoid the police and heavy penalties. Their patience, perseverance, and drive in marketing the charcoal were remarkable.

6. Only one household does not keep a ruminant animal

Use of Minor Forest Produce

Mushroom and Edible Fern (*Niuro*) Collection. According to the people of Bhardeo, there were ten different forest locations surrounding Bhardeo where *Quercus* sp. dominated and were hosts to different mushroom species, particularly to *polypores*. *Quercus glauca* is host to the mushroom *Grifolia frondosa* and *Q. semecarpifolia* to *Laetiporus sulphureus Murr*. There were five to six different mushroom varieties available at different times during the summer season of 1987/88 (Table 19).

Table 19: Collection of Mushrooms

Available months	Mushroom Variety (*Chyau*)
May/June	*Mirge* (*Lentinus edodes*)
June/July	*Kamde* (*Pleurotus ostreatus*)
August/September	*Falant* (*Grifola frondosa*)
	Kanne (*Auriculeria auricula*)
August/October	*Rato* (*Laetiporus sulphureus*)

One labourer generally collected enough to fill between ten to fifteen locally-made, special baskets (*perungo*) of 100 to 200 grammes per day. The number of households engaged in this activity was between 150 to 180 in Bhardeo during the mushroom season. The activity included the collection and packing of roughly six metric tonnes of fresh mushrooms and bringing them to ten different collection points within Bhardeo. There were middlemen who paid some money in advance to the collectors before the onset of the mushroom season.

Fern (*Niuro*). Edible fern was collected by individual families from April/May to June/July from the forests and packed into 30 to 40 shoots per bundle. The local price of *niuro* was Rs 1 to 1.50 per bundle. No packing was done. The processes of collection from the forests and marketing were similar to those used for the mushrooms.

Medicinal Plants (*sano+thulo okhati* and *bhyagute*). Quite a few households made side incomes by collecting and drying medicinal herbs and selling them to markets in Patan (at Rs 2-3 per kg). The price offered by the markets for the *thulo okhati (Astilbe rivularis Buch.Ham.)* was very low, even an easily available cucumber would cost more.

Nigalo (*Arundinaria* sp.) The local species preferred was the *dhuti-nigalo*, a thin bamboo variety, used for manufacturing ropes and a variety of baskets used locally. About 60 to 100 culms harvested in a single day were sufficient to produce four large, local all-purpose baskets. The price of the basket (*doko*) locally was Rs 15 to 25. Very few households produced *nigalo* on their farmlands. Forests were the major sources of thin bamboo.

The Forest Resource Management System

The people started stall feeding ruminants a long time ago in order to avoid grazing in the forests. Afforestation took place, mainly with pine trees, some 16 years ago in limited areas of Ward Nos. one, two, and six on the south slopes of Naldu Ridge. The other areas had been under afforestation programmes for about four or five years, with a slight emphasis on *Quercus lanuginosa*. There was a tree nursery to cater for the needs of the afforestation programmes of the watershed project. Priority was given to the greening of slopes. About 3,000 saplings were produced annually. The collection of species in the nursery did not reflect the needs of the local community. As the newly afforested areas of Bhardeo will not be productive for another 10 to 20 years and the species planted hardly fulfil the biomass requirements of the community (fodder, timber, etc), these measures can hardly be seen as an investment for the community.

After the 1981 floods, the community became motivated towards finding new methods of protecting the forests. Not that forests were unprotected previously during the Rana Regime. Even prior to 1951, the forests in the area were protected for cattle. When the nationalisation of forests took place in 1956/57, the community began to feel alienated from the forests.

The community wanted to manage plots of forest lands, firstly for the protection of their own lands located below the forests and for the harvest, primarily of fodder grasses, and secondly of dry twigs and branches as firewood. Individual households, at least, had come out openly on the side of private management of forest areas. The water resources were, too, in a very poor condition and this was directly or indirectly linked with the depleted nature of Bhardeo's forested slopes.

Use of Water Resources

Operating Water Mills

Although Bhardeo has large mountain slopes, there are very few natural perennial water sources. The most important water spring is located in Ward No. seven. The stream water in Ward Nos. four and five was inadequate for grinding mills, yet these waters were used as such. The grinding mill was for the Bhardeo people. Maize was milled throughout the year.

The maximum milling capacity of the simple grinding mill in Bhardeo was around 120kg of maize within a 24 hour period. During the rainy season the water available was adequate. Roughly 100MT of maize, 9 to 10MT of wheat, 0.4MT of barley, and 0.32MT of millet needed to be milled throughout the year. The total amount used was allotted among 15 mills, and each mill had to mill more than seven metric tonnes of cereals per annum. This left the mills operating at one-sixth of their capacities. The milling charges were uniform for maize, wheat, millet, and barley. The charges were four per cent of the milled commodity payable either in kind or in cash.

All mills in the area were not operative. Some stopped milling during the high monsoon period from June to September and others operated only in daylight hours. One reason given for this situation was the lack of sufficient milling materials. At the same time, operating mills ran for 24 hours. The operation of mills at night was profitable because, according to mill operators, mills operate up to 60 per cent more efficiently during the night because of the favourable water conditions.

Irrigation

Paddy cultivation in the area was not significant enough for a large quantity of water for irrigation to be required. People used one or two places from the nearby stream to irrigate fields located on the valley floor.

Drinking Water

Bhardeo is one area where people have used all sorts of methods to tap the natural springs for drinking water purposes. Most households had piped water, albeit too poorly laid to be hygienic. There were hardly any springs left to be tapped. The only promising source of water that was adequate in quantity was located in Ward No. seven at an altitude of 1,900m, limiting its access to households higher up.

Water Management

Given the conditions of water sources and streams, water management in Bhardeo was an example of how the local people had tried to make the most of what was available without doing much to protect the stream sources.