4. Changes in the Resource Base

All the local resources, such as human, farmlands, livestock, and fodder, as well as forest resources, were equally exploited. The resources had not been used in a sustainable manner. The Bhardeo community experienced serious shortages that had worsened over the years, particularly in the recent past. The poverty found in Bhardeo was due to a combination of serious economic problems and the depleted natural resource base, it was not the outcome of a single event like the floods of September 30, 1981, neither was it an outcome of happenings over a short span of time. The changes that the area had undergone might not have been noticed by outsiders.

The general changes that ultimately affected the local resource base and weakened the capacity of the resource "managers" started, apparently, with increasing urbanisation and population growth in the Kathmandu Valley to which the area was "exposed but not integrated" (Banskota 1989). Bhardeo was exploited for its firewood and timber (*Quercus* sp. and *Pinus* sp.) as well as charcoal, mushrooms, fern vegetable (minor forest products), animals, and animal products.

The lifestyle in Bhardeo might be no different from any other rural village in the Nepalese Himalayas in terms of environmental changes affecting natural resources. So what really changed in Bhardeo? Physical degradation of cultivated and common lands, loss of productivity, and an increase in the number of households, compared to the situation 10 to 15 years previously, had been the distinct changes noted by the community. The indicators of change seemed to be multiple, but the most visible were recorded.

Loss of Vegetation

Depletion of Minor Forest Products

As far as the other "minor" forest products are concerned, such as *niuro* (a fern species), mushrooms, and medicinal plants, e.g., *thulo okhati* (*Astilbe rivularis*), the productivity tended to have remained more or less constant. Outsiders were not as skilled as the locals in collecting these products. However, the lack of marketing skills led to exploitation of the villagers by traders and moneylenders. Because of poverty, a large quantity of the finest products had to be collected for a small income. Collecting mushrooms, etc was a self-defeating activity. In addition, the forest cover essential for the growth of mushrooms and other forest products, especially *Quercus* sp., decreased. Therefore, the sustainability of these products could not be maintained.

Depletion of Forest Resources

Historically, the forests of the area were used both extensively and intensively for animals belonging to the ruling families. According to the people of Bhardeo, the cattle farms of the ruling families existed until the early 1950s.

The people recalled that, two decades previously the slopes of Bhardeo had an adequate stock of trees (also of *Quercus semecarpifolia*) supplying sufficient biomass in the forms of fodder and bedding materials, including firewood for marketing. Each household, on the average, used to harvest three to four loads of leaves or about 70 to 100kg of fodder daily.

The use of Bhardeo forests had almost become a part of local history. The same areas, at the time of the study, were covered with very few trees and the *Quercus lanuginosa* species had degenerated into dwarf bushes. This species is hardy and well coppiced. It has withstood heavy lopping, browsing and, at times, forest fires.

Forest resources were under severe pressure because of decades of unregulated exploitation of this resource, e.g., for firewood, charcoal, tree fodder, and timber. Forest resources (for collection of biomass), in the nearby bordering forest areas within Bardeo, were scarce. The marketing of firewood and timber had to be halted as the scarcity had become critical. Wide variations were observed in the use of neighbouring forests by the Bhardeo households, for which accessibility was a major factor.

People had been compelled to go outside their community area boundaries to Gairi, Gupteswor, or Phulchokipakha, to collect forest products. Ninety-three per cent of Bhardeo households were dependent upon these and other outside forests for their daily needs. Table 20 shows the extent to which these forests were being used.

Table 20: Exploitation of Trees (MT) by the Bhardeo Community in Forest Locations of Gairi, Gupteswor, and Phulchokipakha during 1987/88

Forests	Firewood	Leaf fodder	Dry twigs	User hh (%)
Gairi	86.9	119.3	59.6	12.4
Gupteswor	132.7	186.5	93.2	20.6
Phulchokipakha	202.3	309.6	154.7	36.4
Other areas*	28.0	32.7	16.3	23.6
Total	449.9	648.1	323.8	93.0

* Other forest areas also lie beyond Bhardeo's boundaries

Grazing of animals in the forests, especially goats, was rare. Forest resources were selectively collected. For example, leaf fodder was hand lopped and carried home. Despite precautions, there were certain symptoms which the farmers had observed as signs of degradation of forest resources. How long these resources can be sustained at the current rate of exploitation in high pressure areas, such as those mentioned above, is anyone's guess.

Reduced Capacity of Individual Trees

The condition of forests in these areas, in general, had undergone many changes within the previous decade in terms of the differences in the time taken to collect fodder or firewood. Farmers either moved to different forest plots for collection or selected a large number of trees for a single load of leaves or firewood. Forest plots visited for the collection of biomass had also changed within a single forest area, and this was true for almost all the forests in the area. The average time needed by the households to collect *Quercus* leaves was six to seven hours as against three to four hours 10 to 15 years previously. Generally, an increase of about two to five hours in the time taken for harvesting was observed. The ability of a farm labourer to traverse a certain distance to fetch biomass was determined mainly by the daylight hours of the season and by the gender of the collector. Collection of biomass was carried out mostly by the womenfolk.

The maximum pressure was on the slow growing *Quercus* species of the cool temperate areas above 1,900m. Pressure decreased slightly only during four to five months of the monsoon. Three species of *Quercus* sp. trees, in particular, were affected by over-exploitation. *Quercus semecarpifolia*, occurring at cool temperate altitudes, was affected the most, followed by *Quercus glauca* and *Q. lamellosa* which blossomed in the months of April/May. Exploitation of these two species for leaf fodder was carried out in spring, during the blossoming season, which deprived the species of the crucial leaf area needed in spring, thereby weakening the trees physiologically. Given that deforestation of this nature will continue, farmers will need to respond differently and develop other strategies to solve their fodder and firewood problems.

Loss of Farmlands

According to the local estimate, a total loss of seeding area of 22ha of prime farmland (mostly located on the valley floor) was recorded after the floods of 1981. This was a great loss when we consider the food and fodder values of the yields from 22ha. In a community where 54 per cent of the households owned, on an average, farmland property below 0.5ha, the loss had a profound effect on the economy.

The rains of 1981 also destroyed many terraces. (A precipitation of 86mm of rainfall was recorded at Khumaltar [1,350m] on the 29th of September and 169mm of rainfall at Godavari [1,529m] on the 30th of September 1981 [HMG 1984], both these locations lie slightly outside the north-eastern area of Bhardeo.) The community had still to give final shape to the terraces which they had started to reconstruct immediately after the floods in 1981. In addition, farmland soils were lost from most of the maize terraces.

The loss was twofold: the real loss of farmland property; as such, a physical loss, unless the debris covering the farmlands could be cleared; and the loss of topsoil. There was no external support to help farmers reclaim the farmlands. Reconstruction of terraces remained incomplete while the relatively flat valley bottom was still under debris cover.

Loss of Soil Fertility and Productivity

One of the most plausible indicators of the general degradation of the local environment was soil fertility. Soil productivity had been decreased. The low productivity was indicated by low plant density (germination problem), spotty concentration of plants (on low gradients in relatively fertile parts of the field), and the retarded growth of vegetation in general (agronomically very poor). The productivity of the maize terraces, reclaimed after the 1981 disaster, had been low.

The loss of productivity must have been gradual but the process could have been aggravated by the 1981 floods which damaged terraces and caused widespread soil erosion. This point was supported by the farmers' observations of noticeable fluctuation in production and even decline in productivity within the previous 12 years. Production declined by about 11 per cent between 1971 and 1975 in the district of Lalitpur. In the case of Bhardeo, productivity had been fluctuating at the lowest point reached in 1975. Three major factors accounted for this decline, and they are given below.

1. Labour shortage: decrease in the number of family members tilling the land or hauling fodder and other organic materials to augment FYM.
2. Decrease in the supply of forestry biomass used for fodder and FYM production leading to a noticeable reduction of available FYM than previously.
3. Damage of farmland terraces by the floods in September 1981, destabilising the precarious soil fertility balance maintained by hard labour.

In the meantime, the cost of production had also effectively increased. It cost farmers an additional capital of five per cent of their cash incomes to purchase chemical fertilisers which contributed greatly to the higher cost-benefit ratio of farmland incomes. Though this might have helped augment nitrogen inputs, it was not known whether the soil in the Bhardeo area was deficient in nitrogen or not. In the absence of any marketable surplus from farmland products, it virtually meant that the meagre income from the rare off-farm sources had to be used to subsidise cultivation and farming.

Although the total macro-nutrients available for the Bhardeo soil was adequate by agronomic standards, at least for maize cultivation, other factors, such as soil erosion and loss of land, played a crucial role in declining productivity. Most of the land used for cultivation was located on steep slopes (reclaimed after the 1981 landslides) where surface erosion was highly visible. This had affected the local economy and slowed down the development process. The farmers were unable to rehabilitate their lands speedily, primarily because of the lack of labour and time. The little time available had to be invested to earn cash income. During the dry period, they migrated in search of off-farm opportunities. During the monsoon, when they faced critical food shortages, they collected minor forest products to sell for cash to buy food.

The practice of using chemical fertilisers in the area was less than a decade old. In fact, the combined use of urea and the usual doses of FYM by 34 per cent of Bhardeo households failed to produce comparatively higher amounts of food grains, as expected in 1987/88, in terms of seed and chemical fertiliser inputs. This explained, to some extent, the soil fertility conditions. This comparison was made with farmers who were unable to afford chemical fertilisers and used only the FYM which was available. There were also other factors such as over-use of chemical fertilisers as against under-use of other fertilisers, agronomically a self-defeating effort.

The loss in productivity was directly related by the villagers to reduced availability of FYM, as a result of deforestation. Productivity loss and its direct bearing on soil fertility was noted by the farmers in the study area. Table 21 schematically shows how the people perceived the loss of soil fertility.

Table 21: Soil Fertility and Farmland Productivity

Geographical Dimension	Soil **Fertility**	Farmland **Productivity**
Upper slopes > 1900m	**high**	**increased** through chem. fertiliser
Middle slopes > 1800m	**medium**	**sustained** with chem. fertiliser
Valley bottom > 1700m	**reduced**	**decreased** despite the use of chem. fertiliser

Source : Personal Communication (1988)

Access to forestry biomass was still relatively easy due to proximity to the forest at higher altitudes. Increased production was observed only on the upper slopes, as a result of the heavy input of forestry biomass combined with chemical fertilisers. Despite the amount of biomass available, and the use of chemical fertilisers in the lower areas, production could not be sustained. Farmers had been convinced that only higher doses of FYM, together with slope corrections, would cause a noticeable increase in productivity and reduce topsoil loss.

The loss of topsoil was most visible on new sloping terraces, built after the 1981 floods. The growth of plants on these terraces indicated that there was a need for better farmland management, taking into consideration the degree of soil loss and productivity.

Reduction in Livestock Productivity

Livestock productivity had decreased within a short period because of the scarcity of fodder materials in the forests, whereas, in the past, good quality fodder from *Quercus semecarpifolia* was abundantly available. The reasons for this decline were deforestation, the difficulty in reaching distant areas with better forest cover, and the difficulty of collecting a load of leaves from a larger number of trees. The quantity of leaves brought from distant places was only one third of the amount that used be collected in previous years in Bhardeo itself.

The level of FYM production was approximately one third of the level 15 years previously; thus affecting both food grain and fodder production. If this situation were to continue the livestock sector in Bhardeo would experience even harsher fodder shortages in future. Environmental degradation had become a serious problem. Harnessing adequate fodder resources to meet livestock requirements was becoming increasingly difficult; thus affecting land and livestock resources' productivity. During the previous decade, the farmers had observed a gradual decline in fodder resources from different types of fodder sources ranging from farmlands to forests. More than 20 per cent of the households experienced a fodder deficit during eight months of the year.

Decreasing Water Resources in Bhardeo

In the past, the flow of monsoon streams was less damaging to the fields lying in their course flow than at the time of the study. According to the farmers, the quantity of water available in the stream beds and springs during the dry period was less than before and was not sufficient to meet the requirements of the fifteen grinding mills in the area. The milling efficiency of individual mills had decreased by 50 to 70 per cent after the water channels were damaged by the late monsoon rains on September 29 and 30, 1981.

The water and debris flows caused by the floods had destroyed the natural water courses and also the traditional system of using short, narrow irrigation channels diverted into the fields. Most farmlands on the valley floor, especially the paddy fields, were damaged and covered with debris during the initial hours of the floods because of the drainage channels which diverted the floodwaters into the fields; hence causing significant damage. The people attributed these problems to the loss of forest cover on the slopes.

The few examples cited could well indicate that the sustainability of the system was gradually declining. Although unsustainability itself may trigger off rapid degradation, it could well be a problem that has a solution. The situation requires adjustment efforts, yet adjustment also becomes difficult to sustain because of its negative effects on different resources.

The condition of unsustainability could have been the result of the land use practices which remained unaltered and unadjusted over a long period of time. The people's awareness of unsustainability has an important bearing on the future use of local resources. Their means of solving this problem were positive but inadequate, e.g., by reducing their dependence on local resources. These responses could lead to a more prudent resource use system, e.g., minimum use for maximum benefit, ultimately creating a kind of sustainability.