Chapter 9

The Dichotomy of Crop Diversity Management Issues in Subsistence and Commercial Hill Farming Systems in Nepal

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Introduction

In the last few years, commercialisation of agriculture has taken place in a few areas of the Nepalese hills. There is serious concern that commercialisation of agriculture has endangered crop biodiversity. We were interested in assessing the status of diversity in both species and varieties and in looking at the perspective of farmers by examining the real situation in villages where intervention had taken place and in those in which there had been no intervention.

Genetic diversity in crops is important for many reasons. First, the issue of present and future food security and sustainable development are based primarily on the ability of breeders to use the genetic diversity in crops to breed new, superior varieties. Second, the genetic diversity in crop species and varieties buffers the outbreak of diseases and insect pests, thus stabilising production over time and location. Third, genetic diversity helps to meet the different needs, tastes, and preferences of people from different parts of the world with different ethnic, social, and cultural backgrounds. Finally, the genetic diversity of crops forms a part of the chain of a larger ecosystem, the erosion of which, it is feared, will have detrimental consequences.

It has been widely documented that biological diversity (including plant genetic resources) is being lost at an alarming rate (Cunningham 1991; Haverkort and Millar 1994). The main reasons for this rapid loss are considered to be the degradation of natural habitats, the displacement/elimination of land races by modern crop cultivars, and the change in land-use systems (monocropping). The displacement/elimination of land races results from the need to increase the yield and quality (in some cases) of crops to sustain better livelihoods.

The mountains of Nepal are rich in crop genetic resources, the result of both ecological and sociocultural diversity. In the past, Nepalese hill agriculture was mainly subsistence farming. However, in recent years, increased urbanisation and transportation facilities, together with external technological inputs, have resulted in the rapid transformation of some areas in the hills into commercial centres of production of food and vegetable crops. This transformation has raised serious concerns about the potential depletion of plant and animal genetic resources. Nevertheless, the claims made so far have not been supported by quantitative information from the field. In this paper we describe the results of observations of crop genetic diversity made in commercial areas where there has been a lot of intervention and in areas with moderate to low intervention and commercialisation. This paper discusses the preliminary findings of the observations and experiences, together with some issues related to crop genetic diversity in the mountains of Nepal.

Methodology

The genetic diversity of field and vegetable crop species and varieties was compared in 'intervened' and 'non-intervened' areas in Tanahun and Syangja districts. The 'intervened' areas included Yampaphant (V_1) (475 masl) and Rishing Patan (V_2) (350 masl) where development and research activities have been going on for the last ten and five years respectively. The 'non-intervened' areas included Baradi (V_3) (410 masl) of Tanahu district and Bagtar (V_4) (370 masl) of Syangja district where direct intervention by development agencies is minimal. Yampaphant (V_1) and Baradi (V_3) are located along a major highway, they have good access to markets, and the majority of land is under irrigation; Rishing Patan (V_2) and Bagtar (V_4) are away from the main road, they have some access to markets, and there are equal amounts of *khet* (paddy field) and *bari* (rainfed upland) in the village. The findings presented are based on information collected at community level and describe the number of species and varieties of crops and vegetables.

Findings and Discussion

Diversity at Species' Level

Figure 9.1 shows the number of crop species grown at present, lost and added for staple crops and vegetables. Field crops show a higher crop diversity in the 'intervened' area than in the 'non-intervened' area, an average of 26 species per village compared with 16 species per village. Crop diversity in vegetables is

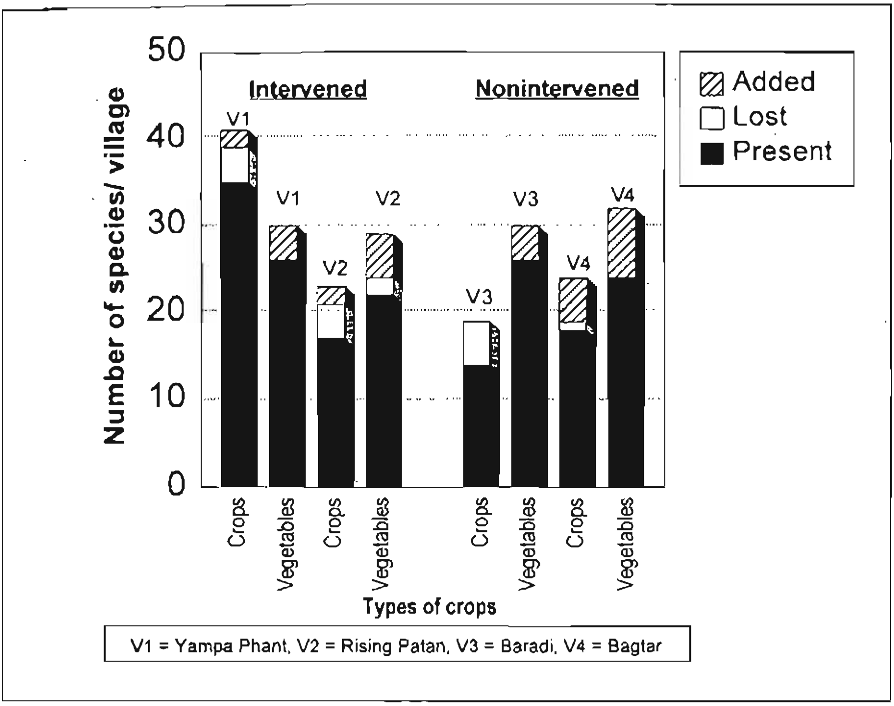

Figure 9.1: Diversity at Species' Level in Two Villages of 'Intervened' (V1 and V2) and 'Non-intervened' (V3 and V4) Areas, Nepal

comparable in both 'intervened' and 'non-intervened' areas, with 24 and 25 species per site respectively. Though there are a few commercial farmers in this area at present, they and others still maintain the old crops. Thus the species' diversity is higher on average in the areas with commercial agriculture than in those with non-commercial agriculture. The reason for the low diversity in field crops in the 'non-intervened' area is not known.

Four and three species of field crops had been lost from 'intervened' and 'non-intervened' areas respectively. Farmers did not report any loss of species in vegetables in the 'non-intervened' area, two species were reported as lost from one village, Yampaphant, in the 'intervened' area (Chinese cabbage and turnip). Thus, there was more species loss in field crops than in vegetables, irrespective of commercialisation. This could be mainly because of the higher original level of diversity in field crops. Second, more rationalisation of field crops has taken place with farmers concentrating only on a limited number of high potential crops and dropping others. The need and the market demand for a variety of vegetables require farmers to maintain different species. In addition, new vegetable species have been introduced, such as carrots, cabbages, and cauliflower, which were traditionally not grown by the farmers, whereas this is not the case for field crops. Both commercial and subsistence growers co-exist in the same area, thus complementing each other in terms of crop diversity at village level. Traditional crops are maintained in a small area. Therefore, evidence from this limited area suggests that agricultural development is not necessarily associated with genetic erosion.

Crops lost in both 'intervened' and 'non-intervened' areas include *kauno* (*Setaria italica*), *junelo* (*Sorghum* spp), *gahat* (*Dolichos biflorus*), *filongo* (*Guizotia abbysinica*), *siltung* (*Vigna umbilata*), cotton and tobacco. The first two crops are of minor importance and were only cultivated under the slash and burn (*Khoria*) system. Since *Khoria* cultivation has been abandoned, these crops have also been lost. This is the main reason reported by farmers. The loss of *gahat* and niger is the result of the change in the land-use system from *bari* to irrigated *khet*. Similarly, the loss of cotton and tobacco has resulted from their now limited utility in the villages since supplies of commercial products became easily available in the local market. This suggests that subsistence farming probably needs more species' diversity than commercial farming.

Diversity in Varieties

The number of varieties of field crops and vegetables grown at present, lost, and added is shown in Table 9.1. The general trend for six different field crops is that the number of varieties grown at present in the 'intervened' area is higher (41 varieties/site) than in the 'non-intervened' area (27varieties/site). The number of crop species lost in 'intervened' areas ranged from 9-16 species compared to 3-16 species in 'non-intervened' areas. The trend of vegetable species' loss ranged from 2-10 in 'intervened areas' compared to 1-3 in 'non-intervened' areas. The additional species' diversity in the 'intervened' system is comparatively higher (22-23) compared to 'non-intervened' areas (5-14). The situation is different for different types of crops, as shown for example by early rice and finger millet. The number of varieties of maize and finger millet grown in the 'intervened' area is less than in the 'non-intervened' area. This is because the 'intervened' area is highly commercialised and farmers are not interested in growing maize and finger millet. Instead, farmers usually grow cash generating vegetable crops. Early rice is an introduced crop whereas finger millet is an indigenous crop. There is a clear indication that displacement and replacement of varieties is a continuous process and is higher in 'intervened' areas than in 'non-intervened' areas. Intervention has resulted in an increased choice for farmers rather than depleting the genetic base of the area. However, the fate of indigenous land races as a result of the introduction of new varieties is not yet known.

There are 30 and 28 varieties per site of the nine types of vegetable grown at present in 'intervened' and 'non-intervened' areas, respectively. This indicates

Table 9.1: **Diversity in Field Crops and Vegetables at Study Sites**				
Particulars	Type of crops	Number of crops		
		Present	Lost	Added
Intervention (Yampa)	Field crops	46	16	22
	Vegetable	35	2	18
Intervention (Rishing Patan)	Field crops	36	9	23
	Vegetable	25	10	17
Non-intervention (Baradi)	Field crops	22	6	5
	Vegetable	19	3	11
Non-intervention (Bagtar)	Field crops	32	3	14
	Vegetable	36	1	14

that there has been little loss in the total number of varieties of the vegetable crops included in the study. This may be because there is less diversity anyway at the level of varieties, a point which needs further study. Biodiversity is difficult to define as it varies with time and space (Witcombe *et al.* 1996). Intervention has actually added to the total diversity in varieties, but more species have been lost as well as more added. This clearly indicates a case of variety displacement, wherein local land races have been displaced. It also indicates that farmers have a greater choice of varieties in the 'intervened' area than in the 'non-intervened' area. Farmers are still trying to assess different crop varieties for the diverse situations, and this seems to be the main reason why the loss of variety is low and diversity still high in the 'intervened' area. The process of erosion in the number of varieties is still going on and superior varieties are displacing older varieties. There may be a need for *ex situ* conservation of rejected land races which could contain unknown traits that might become valuable in the future.

The varieties of different vegetable crops grown in three different areas are shown in Table 9.2. The three areas include 'intervened' and 'non-intervened' areas of site set 1 (Tanahun) and a 'non-intervened' area in Syangja. The diversity in varieties in the 'non-intervened' area of Syangja is higher than in either of the areas in Tanahun. The 'non-intervened' area of Syangja is highly subsistence in

Table 9.2: **Diversity in Varieties of Selected Vegetable Crops at Five Different Sites**					
Crop	Number of crop varieties				
	Tanahun site, set 1		Tanahun site, set 2		Syangja
	Intervened (V_1)	Non-intervened (V_3)	Intervened (V_2)	Non-intervened	Non-intervened (V_4)
Cowpeas	7	2	4	5	6
Rayo	2	2	2	3	8
Radishes	4	3	2	4	5
Cucumbers	5	2	1	2	5
Taro	4	4	2	6	8
Chillis	4	2	3	6	7
Total	26	15	14	26	39

nature and is remote from the road head, so the level of intervention is very low. It was also found that the varieties grown in 'intervened' areas were usually introduced and the varieties grown in 'non-intervened' areas were usually local land races.

Some Issues

Crop genetic diversity is important at both species' and variety level. The case studies described here show that the loss of crop species' from an area can be low and rather slow. However, the loss of genetic resources at the level of varieties seems higher for field crops, whereas introduction has increased overall genetic diversity for vegetable crops. Technological intervention and commercialisation in an area can add to the genetic diversity since farmers do not abandon their old land races until the performance of new ones is known to be reliable. However, the process of displacement may well start later with local land races being displaced followed by older varieties, and the process will continue.

The issue that emerges is that genetic diversity in commercialised areas depends on outside sources. This is because commercial farmers always seek for more productive and profitable crops and varieties. Such varieties are bred at plant breeding stations. Private companies also breed and market seeds. This phenomenon is particularly applicable to vegetable crops. Farmers cannot produce seed locally (in the case of hybrids). There is no chance of local selection, segregation, and adaptation. The genetic diversity on commercial farms is controlled externally. This genetic diversity is not sustainable and does not belong to local farmers. Such uniformity has no meaning in non-mechanised farming systems. In contrast, in subsistence areas, the genetic diversity is locally produced, maintained, and used by the farmers. However, the situation is rather paradoxical; on the one hand commercialisation or intervention is required to improve the economic condition of the farming community and on the other hand genetic resources need to be conserved for sustainable development. Therefore, there is an urgent need to devise approaches to balance economic gains with long-term conservation goals. The diversity of species and varieties at household levels in different production systems needs to be studied, because maintenance of diversity actually occurs at the household level. The food security situation must also be taken into account when discussing large biodiversity conservation initiatives.

There are many approaches to genetic diversity conservation (Cooper *et al.* 1992). One of the most common methods is to collect local land races and conserve them in gene banks *ex situ*. In Nepal, this method has been used for some important crops such as rice, maize, and finger millet. However, it is hardly used for vegetable crops at present. Since there is wide genetic diversity in some local vegetable crops in Nepal, steps towards collection and conservation need to be strengthened. Nevertheless, this approach does not provide direct benefit to the community or to the individuals who contribute to the conservation process. Thus the need arises to complement *ex situ* with *in situ* conservation.

In situ conservation of crop land races is relatively difficult to implement because it involves farmers as well as their crops. Unless and until farmers are made aware of the potential benefits they can obtain by conserving genetic resources, it will not be easy to get their participation. Developing approaches that combine conservation with development of farming systems, and motivating the farmers, are the keys to the success of any *in situ* conservation strategy.

Commercialisation of crops in suitable areas could be initiated in order to help maintain the diversity in indigenous crop species such as traditional vegetables (taro, yam, chayote, *cyclanthera*, *Dolcichos* bean), upland rice, high quality rice, and different fruit crops. A similar kind of effort has been initiated in Kenya by the Indigenous Fruit and Vegetable Development Project (Kiambi and Opole 1992). This project aims to encourage the conservation of indigenous fruits and vegetables through increased use of local germplasms at the community level. The nutritional and other qualities of crop species/varieties traditional to Nepal could also be analysed in such projects. Participation of farmers in selecting the varieties of these indigenous crops/land races could also increase the diversification. Furthermore, organically grown land races could be promoted in the market and thus fetch premium prices.

Another approach to *in situ* conservation of indigenous land races is through farmers' groups. Farmers of a village or community can be organized into groups and made aware of their genetic resources, networking can be facilitated between these groups to enable them to share information and materials. Along with the introduction of high-yielding crop varieties, farmers would be asked to plant small areas with their local crops/land races. In this way, both commercialisation and *in situ* conservation of genetic resources can be achieved.

It has been observed that two kinds of farmer reside in the same village, one with a commercial scale of production and the other with a subsistence-scale of production. In such cases, subsistence farmers could grow the local land races found in the village to serve their own needs. This is advantageous to such subsistence farmers since they can enjoy the local taste and avoid the costs of extra inputs. However, creation of awareness of genetic resources is necessary even among such villagers.

Still another approach would be to encourage national programmes to recycle the useful genes available in land races in breeding programmes. Some successful approaches have already been demonstrated by Sthapit *et al.* (1996) for rice in

Nepal. This approach will combine the best of land races with the desirable traits in the exotic parent to give an output suited to the local environment.

Conclusion

Genetic erosion is taking place in both commercialised and traditional farming and in both cereal and vegetable crops. It is difficult to make the generalisation that commercialisation leads to genetic erosion. There are cases in which intervention increases agrobiodiversity, but it can also reduce agrobiodiversity. The detailed socioeconomic and anthropological situation should be taken into account. It was apparent from this study that farmers constantly update their genetic resources by dropping unwanted crops and varieties and adding useful ones. Further studies are required to understand the fate of land races, the area under different production systems, and the contribution of major varieties to the food security situation of the region. What is clear, however, is that when the increase in the number of varieties is based on seed produced externally, this is not genetic diversity for the area in the true sense because it cannot be sustained by the system.

Since commercialisation in agriculture is essential for raising the economic status of farmers, approaches should be devised to balance economic development with conservation of genetic resources. Approaches such as *ex situ* conservation of indigenous crops and land races, *in situ* conservation through the commercialisation of traditional crops, market promotion through breeding, farmer participation in variety selection, networking through farmers' organizations, cultivation of land races together with commercial crop varieties, and involvement of subsistence farmers can be useful to rescue endangered genetic resources. It is important to note that a high level of farmer awareness and motivation will be required to realise *in situ* conservation goals.

However, the preliminary findings from the current study do not support the contention that commercialisation of agriculture has endangered crop biodiversity, at least not in the villages studied. One aspect is clear though, the crop biodiversity in commercialised areas is mainly dependent on external sources and does not have a local base or long-lasting nature. It is mainly a replacement process, in which less beneficial types are dropped. Since some improved varieties have high yield and quality under ideal conditions, it is natural that farmers are attracted towards such varieties. Thus, the conservation of land races in a dynamic state is a real challenge.

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