Chapter 32

Organizing Mountain Farmers to Carry Out *In Situ* Conservation of Their Agricultural Resources' Diversity

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Farmers have managed genetic resources ever since they began cultivating crops and domesticating animals. Farmers' selection, breeding, and continued maintenance of crop variety and livestock breeds have been used to meet environmental conditions and develop diverse farming systems in mountain areas. Systems such as those that exist in the area called Garhwal in Uttar Pradesh, India, are the product of farmers' innovations and informal experimentation. Biodiversity-based mountain farming systems and the central role of farmers in their management must be appreciated and not dismissed as 'traditional'. The 'traditional' can be an important tool for evolving 'modern' approaches to sustainable development.

The main issues facing agrobiodiversity stem from the current mountain transformation process, which is directed by the Green Revolution. In this process the overwhelming emphasis is placed on a small number of cultivars with high commercial value and the heavy use of external inputs. The role of farmers in conserving and using agrobiodiversity has often been undermined. Institutional mechanisms are biased and lack a pragmatic vision. There is such ignorance about the consequences of the loss of agrobiodiversity that many people think that it is simply an extinction of species. Currently the politics related to control of the world's gene pool poses a further potential danger for the regions, nations, and areas rich in agrobiodiversity.

This paper attempts to identify and analyse the diversity in mountain agriculture, the relationships between farmers and agrobiodiversity, and the traditional strategies used by farmers for biodiversity management using the area of Gharwal as an example. These strategies have been, and continue to be, pivotal in developing farming systems, many of which have been sustained for centuries. When the agriculture in Garhwal shows general symptoms of unsustainability, generally as a result of erroneous external development intervention, farmers try to reverse the negative trend. The paper also assesses how the farmers' approach to conserving local biodiversity can help show a path towards sustainable agriculture in the region. The paper describes a situation in one area where a near disaster resulting from the introduction of monocropping was turned into a success story of farmer-led reintroduction of indigenous land races and agricultural practices.

The Area

The northern part of the state of Uttar Pradesh in India, popularly called *Uttarakhand*, lies in the Himalayan mountains. This area has two parts, Garhwal and KumaOn. Garhwal has five districts - Uttarkshi, Chamoli, Auri, Tehri, and Dehradun – covering an area of 29,968 sq. km. The total area of Garhwal and KumaOn is 50,952 sq. km. The present study concerns the Garhwal Himalayas, which account for nearly 59 per cent of the total area of the Central Indian Himalayas. The altitude ranges from 300 to 8,000 masl. The terrain is comprised of steep terraced hillsides traversed by many streams and rivers. The area encompasses four climatic zones: sub-tropical (250-1200m), sub-temperate (1200-1700m), temperate (1700-3500m), and alpine (3500m and above). The average population density is 98/km^2. There are some 8,000 villages, and more than 80 per cent of the population live in rural areas.

Farmers in the Gharwal valleys have developed active networks aimed at improving the ecological, economic, social, and cultural situation. These networks have emerged to confront the negative effects of mainstream development interventions that people have experienced during the last few decades. One farmer is conducting systematic experiments on and demonstrations of traditional cultivars.

After a preliminary reconnaissance, four villages in the Gharwal area were selected for study: Paturi, Palas, Jardhargaon, and Swali. The villages cover a very wide range of agricultural situations.

The evidence presented in the paper is based mainly on the information gained and observations made during intensive field visits to the selected villages. Efforts were made to obtain all the information of interest from men and women farmers of all age groups. The views of resource persons, NGOs, social workers, public departments, and agricultural scientists have also been incorporated. Personal links with the farmers' organizations, and working closely with the Save the Seed Movement and other ecological movements, were of immense help in the collection of information.

Species and Genetic Diversity

One of the most outstanding features of mountain flora is the enormous diversity of both cultivated and wild plants that offer edible products. In the past, people in the Himalayan mountains have enjoyed a very large number of food items, some of forest origin and others cultivated. For example, people in the Henwal Valley of the Garhwal Himalayas have access to at least 127 different food-providing plants and 15 different species of fodder plant (Table 32.1). The food-providing plants include 23 different wild fruits, buds, flowers, and seeds obtainable from the forest ecosystem. Villagers collect 14 different types of wild vegetables and grow 33 different kinds of cultivated vegetables (mostly grown around homesteads); 18 fruit species are cultivated on private land; and nine types of spices and condiments are collected from the wild or cultivated. Other crops include 12 different cereals, millets, and pseudocereals; 10 types of pulses; and eight types of oil seed. The 15 species of fodder (mostly trees and bushes) are fed to domestic animals and, after being converted into milk and milk products, also contribute indirectly to the human diet.

Table 32.1 : **Plant Species Used for Food in the Henwal Valley of the Garhwal Himalayas**

Type of food	No of species
Wild fruits	5
Flowers and buds	18
Cultivated fruits	18
Wild vegetables	14
Cultivated vegetables	33
Cereals and millets	12
Pulses	10
Oilseeds	8
Spices	9
Tree fodder	15

The actual use of the available food resources varied in the valleys. People in Jardhargon, for example, were fond of uncommon food resources, whereas those from Palas and Sawali did not like wild food. The residents of Jardhargon said that the older generation realised the importance of wild food, but these nutritious food products did not attract the attention of the younger generation. The younger people had no time and patience to collect them.

Farmers' Diverse Strategies for Managing Agricultural Diversity

Agro-ecosystems with many different niches occupied by many different species are likely to be more stable than those with only one species (monocropping) and thus give the farmer more security (Reijntjes et al. 1992). Functional diversity, achieved by combining complementary plant and animal species in a synergistic system, provides sustainability in such agro-ecosystems.

Using the central concepts of complementarity and synergy, farmers in the central Indian Himalayas increase the functional diversity through practices such as specific crop rotation or sequences and cropping patterns and associations.

Increasing functional diversity leads to unique crop rotations and fallow practices. The rotations may vary according to altitude, irrigation conditions, moisture regime, soil type, degree and direction of slope, and sometimes farmers' personal choice. More than 90 per cent of the cultivated land in irrigated valleys in Garhwal is managed under rice-wheat rotation. The rice-proso millet-wheat sequence is adopted in only a few villages. In contrast to the uniformity maintained in the major crop rotations on irrigated land, the crop rotations on upland (rainfed) are amazingly diversified. The cropping systems are characterised by a large number of crop species - cereals, pulses, millets, oil seeds, pseudocereals, beans, vegetables, fruits - with a broad genetic base. The crop rotations fulfill diverse local needs and ensure that the health of the agro-ecosystems is maintained. Shallow and deep-rooted plants are sown together so that crops use different soil depths. Land of different quality is used for different crops, for example, irrigated land is generally used for growing wheat and rice, which need more moisture, and more degraded and gravelly land is used for pulses, oil seeds, and pseudocereals. Agro-forestry is common in rainfed areas.

Mixed and intercropping methods are common practices in Garhwal. Finger millet is usually mix cropped with twelve different crops: buckwheat, amaranth, French beans, black gram, rice beans, green gram, horsegram, soybeans, sorghum, foxtail millet, kidney bean, and *jakhia* (*Cleome* spp). This cropping pattern is known as *bharanaja*[1]. Sometimes finger millet is intercropped with three or more crops, a unique example of relay cropping. Amaranth is generally grown together with finger millet. However, at higher altitudes it is also cultivated as a dominant component, usually mixed with beans, most commonly the kidney bean. In upland areas, wheat is generally mix cropped with lentils. Barnyard millet is sown around the rice on many terraces in upland areas. *Jakia* grows naturally but is also raised with finger millet.

Farming is linked to culture and history. The rich experience of farmers, gained from continuous interaction with nature and its rich resources, has from time to time been pivotal in reshaping the agricultural system towards higher biodiversity and sustainability. Farmers have developed a great variety of farming systems, and these have never been static. Farmers have created innovations by consciously

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[1] *Literally means twelve food grains*

and skillfully manipulating the biophysical and socioeconomic resource base and have always kept the system in a dynamic state, setting a positive trend.

In mountain areas every farm tries to use the entire range of diversity available in that area and to cultivate all the native genetic resources of all crops that thrive on a site. Each farm, however small and scattered, is a unique system in itself. The common history, culture, wisdom, experience, and common control over Common Property Resources (CPR) are the integrating factors among farms. Social cohesion is often reflected in sharing or exchanging germplasm, labour, farm agricultural operations, and irrigation.

Most of the agricultural technologies in the Garhwal Himalayas were developed by the farmers, who are the natural specialists, not by formally educated scientists. Research institution, universities, and government departments claim to be a central source of innovation; but in fact they are not and neither are their extension systems. Most innovations have been invented by the farmers themselves. The innovations have been spread throughout the community through the farmers' own informal extension system.

The indigenous knowledge of a farming community, generated from past experience and enriched by new experience, has been, and continues to be, a driving force in farmers' innovations. Indigenous knowledge is not static, it is dynamic like the farming system itself. An understanding of indigenous knowledge is of vital importance for developing and introducing technological changes aimed at biodiversity conservation and management for sustainability in mountain agriculture. Farmers apply the principles of agro-ecology in a holistic fashion in the process of managing the biological-physical resource base and deriving full advantage from the resource characteristics. The strategies evolved by farmers over a long period of trial and error are reflected in the diverse methods used to exploit the resource base for soil fertility management, pest management, weed management, and genetic resource management, and in the diverse economies that have been created.

Conserving the Genetic Wealth: Farmers' Experimentation

Unlike in the Green Revolution areas in the plains, the pace of genetic erosion in the mountains has been relatively slow. However, those irrigated valleys accessible to development agencies display considerable genetic uniformity. Even in the upland rainfed areas, some crop species and varieties have been squeezed out of local agricultural practices. Nevertheless, as a result of the very high degree of inaccessibility, genetic uniformity has not taken over in the mountains. Almost all the local crop cultivars exist in remote and highly inaccessible pockets.

The problems experienced in the Henwal Valley (in which the village of Jardhargaon is situated) and the approach used to solve them, provide a useful lesson in the potential problems associated with external intervention and the importance of indigenous knowledge for the success of agriculture in difficult areas. The Henwal Valley in the Garhwal Himalayas is an area that once witnessed a situation of near genetic wipe-out. Until recently (1988) large areas of irrigated flatland were occupied by only two crops - wheat and rice - and only two varieties of each crop. A considerable proportion of the arable land in the upper rainfed area had come under white-seeded soybean cultivation (an introduced crop). The majority of the farmers had switched over to 'improved' cultivation practices using recommended chemical fertilizers and synthesised pesticides, and heavily reliant on external 'expertise'. The almost completely transformed valley was virtually converted into an experimental ground for an agricultural university and a Watershed Management Project. These agencies conducted their experiments and demonstrations and distributed 'tested' seeds of modern varieties (MVs), chemical inputs, and 'improved' tools and implements to the farmers.

It was only a matter of time until this genetic uniformity displayed its weaknesses. The area was struck by an unprecedented drought in 1986-88 and by pest epidemics in the following two years. The MVs, which had an extremely narrow genetic base, were badly damaged and the farmers saw the worst days in their lives.

To confront the emerging crisis of genetic vulnerability of the narrow genetic base of the MVs, the farmers collected the indigenous seeds that had almost disappeared from the valley. They collected seeds of 10 local rice varieties from remote village areas not affected by transformation technology and re-introduced them into the fields. These varieties showed a remarkable performance, but further pest epidemics still occurred during this crop season.

The next year more farmers in the valley opted for indigenous varieties. The seed produced during the first year was distributed to other farmers in the valley. After strenuous efforts, 35 indigenous varieties or land races were collected during the second year and were all raised on farms. That year nearly 60 per cent of the valley area around Jardhargaon village was covered by indigenous rice land races.

During the third year, a total of 110 local rice varieties were re-introduced, and the Genetic Diversity in rice increased dramatically. Nearly 90 per cent of the area under crops was covered with indigenous varieties. In the fourth year, the total number of rice varieties went up to 126 and the year after to 130.

The yields of different varieties were recorded in the summer season of 1994, at the farm of the farmer who was the leader of the Save the Seed Movement.

Thapachini, a widely cultivated indigenous rice, gave the highest yield (5 t/ha)) of grains. The other indigenous varieties *Jhumkya, Khushboo, Agriya, Lathmar, Kali Makhri, Basmati Nagni, Lalmati, Congressi, Nailchamya, Rekhalaya*, and *Rhikwa*, also gave impressive yields (4.3 to 5.0 t/ha). When the average yields of local rice cultivars were compared with those of MVs cultivated at the nearby demonstration site of the Pantnagar Agricultural University, it was found that the average yield of the land races (4.0 t/ha) was significantly higher than of five MVs (2.8 t/ha), even when the latter were provided with the recommended doses of fertilizers and pesticides. The land races were not provided with any chemical input, but only with organic manure at the rate of about 2.5 t/ha. The manure application rates for seasonal crops do not vary much from farm to farm in the mountains, thus this amount of manure was probably applied on most farms when growing MVs.

The average percentage recovery was also much higher in indigenous rice varieties (72%, ranging from 69% in *Hansnaj* to 75% in *Thapachini*) than in the MVs (60%). In other words MVs had a greater amount of husk, a useless by-product for mountain farmers. The grain husk ratio of the indigenous land races (2.6:1) was higher than that of the MVs (1.5:1), indicating that the land races were superior to the introduced MVs in producing useful biomass (edible rice grains).

Farmers in the mountains do not grow crops for grain only. The straw by-product for livestock feeding is of equal value. The straw-grain ratio of local rice varieties (ranging from 1.4:1 in *Lathmaer* to 2.3:1 in *Congressi* and *Hansraj*) was also higher than that of the MVs (ranging from 1.1:1 in Govind to 1.6:1 in Saket).

The MVs were also said to grow quickly, but the experiment showed that most of the local varieties were ready for harvest earlier than the MVs. Varieties such as *Knaheri, Nyuri*, and *Gorkhpuri* take close to 120 days to mature, whereas MVs sown in the area take at least 150 days.

Under the Save the Seed Movement programme, farmers are also searching for indigenous varieties of all other hill crops. So far, they have successfully collected and re-introduced 50 genetically distinct varieties of kidney beans, nine varieties of rice bean, and about a dozen of amaranth. These varieties, now restored, had earlier disappeared from the cropping systems.

Under the influence of modern agro-techniques, farmers in the valley had given up growing three crops: proso millet, pearl millet, and sorghum. These crops have now been re-introduced into the farming system. Thus, the farmers in this valley in Garhwal are enriching Genetic Diversity at the species' level as an expression of their consciousness of the importance of agrobiodiversity.

The Save the Seed Movement is not just limited to saving traditional seeds and developing diversity. In the words of Vijay Jardhari, the main inspiration behind the movement: *"We have to save and revive the very principles, concepts, and approaches that, working in close cooperation with nature, made traditional agricultural practices sustainable"*. Traditional seeds produced in the village are distributed to the areas from where they have vanished. The community seed exchange system, which was a life-line for mountain agriculture, has been automatically revived. Now farmers do not have to look to development agencies for improved seeds.

Conclusions

For generations, agrobiodiversity in mountain regions has been in the hands of traditional farmers. Traditional systems of management and traditional ecological knowledge have been the vital means by which farming communities have evolved diversity-rich food production and diverse livelihood systems. Traditional knowledge develops from the natural process of adaptation and differs from conventional scientific knowledge in being intuitive, moral, ethical, spiritual, theosophical, and holistic.

One thing that seems to be certain is that, in the historical process of agricultural development, farmers have always sought to enhance the level of biodiversity. The characteristic elements of farmers' strategies for enhancing diversity include managing the different genotypes of all the available species of economic importance, creating ecosystem heterogeneity and complexity, and maintaining intensity of ecosystem use.

Farmers' strategies, driven by indigenous knowledge and enriched by newer experiences based on trial-and-error, are dynamic rather than static. They are not symptomatic of backwardness, but are always innovative and futuristic. If one looks at the vision farmers have developed to manage agrobiodiversity in the mountains, and analyse's their strategies, one cannot help appreciating the efforts they have made and the innovations they have created.

Since agrobiodiversity is the most potential resource for the sustainability of agriculture, and traditional farmers are the best managers of this diversity, any meaningful development exercise in the Himalayan region should incorporate these two as its main ingredients. Agrobiodiversity cannot be isolated from overall biodiversity. The one has a bearing on the other. Therefore, agrobiodiversity conservation should take into consideration the conservation of the whole ecosystem to deliver support and other valuable ecological services.

It is very necessary to identify the main factors and processes responsible for the loss of functional diversity. These include both internal and external factors.

An understanding of these factors would help to address the situation resulting from the loss of agrobiodiversity effectively.

There is an immense need to develop effective institutions for biodiversity conservation in order to provide a more suitable framework for human action, to respond to environmental feedback, to enhance resilience, to identify traditional strategies, and to develop meaningful socioeconomic interrelationships. The thrust of policy should include protection of local rights and elimination of open access in marginal areas. Recognition of the unique role of farmers would help stimulate farmers' own interest in conservation activities. Our projects on sustainability-oriented agrobiodiversity management should encourage farmers to set up their own conservation movements, experiments, demonstrations, and extension services, and should also help them strengthen their creative networks.

References

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