In situ conservation and farmers' access to and control over germplasm go hand-in-hand. If biodiversity were the potential source of sustainability, on-farm conservation of crop species and genetic resources must be the inevitable process to realize sustainability in marginal areas like mountains. Farmers are at the center stage of agrobiodiversity management. If farmers' rights are to be safeguarded and their independence is to be ensured, on-farm conservation of germplasm must remain in the hands of farmers. In situ conservation is also a way to keep the negative effects of Green-Revolution-type agriculture at bay, including the possible extinction of valuable landraces.

Keeping in mind these deeper issues and concerns, farmers in the Henwal Valley of Garhwal Himalayas started a *Beej Bachao Andolan* (Save Seed Movement). By saving the traditional seeds and landraces, along with in situ conservation of biodiversity, this kind of initiative brings positive changes to local agricultural systems, leading to ecologically sound, self-reliant, and sustainable agriculture. It also empowers farmers with seeds, which are the most potent symbols of their power and independence. Conserving landraces and biodiversity, along with empowering farmers, are the main targets of the *Beej Bachao Andolan* (BBA). Those active in the movement are trying their best to reintroduce seeds that were lost when the so-called high-yielding varieties (HYVs) produced by institution-led research were introduced. Farmers are reviving ecologically regenerative farming practices by improving the common property resource base, mainly the forest ecosystems.

This paper attempts to present the experiences of the *Beej Bachao Andolan,* which is, in fact, a landrace renaissance in which mountain farmers are the sole motive power. This story might help to stimulate farmers and pro-farmer organizations in other areas of the world to establish this sort of conservation and development effort, with farmers at the heart of it.

A historical perspective

Garhwal is a part of the Uttarakhand Himalayan area in India, which was once a unique repository of biodiversity in its forests, grasslands, and farmlands, including a variety of unique landraces. This has been reflected in the foods and folk culture of the area. Mountain people have been relatively prosperous; unique landraces have contributed to their prosperity in a big way. Quoting Walton's findings of the 19th Century, Bahuguna (1989) writes, "The Hill man [is] indeed specially blessed by the presence in almost every jungle of fruits, vegetables, and roots to help him over a period of moderate scarcity."

The prosperity of the region in the past is also evident from oral history and written documents: "The people were well off and they used to export wheat, rice, coarse grains, oil seeds, ginger, saffron, herbs, walnut, handmade paper, copper rods, musk, honey, ghee, woolen clothes, cows, bulls, ponies, etc., in the markets of foothills and imported only *gur* (molasses) and cotton cloth" (Bahuguna 1989). Lt. Col. Pitcher, who was appointed to inquire into the conditions of the lower classes, reported in 1838, " The peasants of Garhwal and Kumaon are better off than the peasants in any parts of the world, who neither live in such well-built houses, nor are so well-dressed as the peasants of Kumaon (Bahuguna 1989).

This richness of Garhwal's agriculture was clearly evident right up to the end of the first half of the twentieth century. The picture has now reversed entirely, largely due to external development and complete neglect of local perspectives. The type of agricultural development associated with the Green Revolution began in relatively fertile irrigated valleys, leading to the management of monocultures of a few HYVs of just two cereal crops. These required liberal use of chemical inputs

(fertilizers and pesticides), for which lot of incentives and subsidies were provided to the farmers of the area. The HYVs of many crops also spread to rain-fed upland areas, which led to the reduction of the large number of landraces the region was famous for.

Beej Bachao Andolan: The genesis

The fertile valleys in Garhwal Himalayas witnessed a near genetic wipeout in agriculture. By the mid-1980s, large areas of irrigated flatlands were occupied by only two crops—wheat and rice—and only a few varieties of these crops. A considerable proportion of arable land in the upper rain-fed areas had come under cultivation of introduced white-seeded soybeans. A majority of farmers had switched over to "improved" cultivation practices using recommended chemical fertilizers and synthetic pesticides, and were heavily reliant on external "expertise." This almost completely transformed the mountain valleys, which were virtually converted into an experimental ground for government-sponsored agencies. These agencies conducted their experiments and demonstrations and distributed chemical inputs, "tested" seeds of modern varieties, and "improved" tools and implements to the farmers.

It was only a matter of time until this genetic uniformity was struck by disaster in the form of an unprecedented drought during 1987–88 and by pest epidemics in the two following years. The modern crops had a very narrow genetic base and were badly damaged; the farmers experienced the worst days in their lives.

To confront the crisis of genetic vulnerability, the farmers in the Henwal Valley of Garhwal began collecting indigenous seeds, which had almost disappeared from the accessible fertile valleys. Initially, they collected seeds of 10 local rice varieties from remote rural areas not affected by changes in technology and reintroduced them in their fields. These local varieties exhibited remarkable performances. The pest epidemic recurred during this crop season, but it hit only the modern crop cultivars. The reintroduced landraces remained undamaged.

The next year, more farmers in the Henwal Valley opted for indigenous varieties. Seeds of the landraces produced during the first year were distributed to other farmers in the valley. After strenuous efforts, 35 indigenous varieties of rice were collected during the second year and were all raised on farms. Nearly 60 percent of the total area of the valley was covered by the reintroduced landraces that year.

During the third year, a total of 110 landraces of rice were reintroduced, and the genetic diversity in rice increased dramatically. Nearly 90 percent of the cultivated area in the valley came under landraces. In the fourth year, the total number of local varieties went up to 126 and the year after, 130. Experiencing the wonderful performance of the landraces, the farmers of the valley launched the *Beej Bachao Andolan*, (BBA) which has now spread its roots throughout the whole of Garhwal.

The BBA searches, collects, reintroduces, tests, distributes, and popularizes all available local varieties of mountain crops. So far, it has reintroduced 300 genetically distinct varieties of rice, about 200 varieties of kidney beans, 12 of amaranth, and so on, in the Henwal Valley alone. The number of landraces reappearing in the once genetically transformed valleys is increasing year by year. Free exchange of seed within the community—the life-line of traditional mountain agriculture—has also been revived. BBA is witnessing a landrace renaissance in the mountains. Superb landraces, once lost to the so-called HYVs, are becoming an increasingly potent symbol of farmers' self-respect, self-reliance, and independence.

Impact of modern varieties—farmers' perspective

In transforming agriculture, seed has been the most potent weapon in the hands of the external development agencies, including multinational corporations. Along with a variety of chemicals, alien cultivation practices also came with the new "miracle" seeds. This gradually undermined farmers' traditional wisdom and innovativeness. A vicious cycle of dependence on market and development agencies for new seed varieties, chemical inputs, and technological know-how started in the region.

Because of the inevitable dwarf characteristic and narrow straw-grain ratio of the HYVs, they provide considerably less fodder compared to their long-stalked traditional counterparts. The quality of fodder provided is also inferior. The dwarf varieties have thus led to a severe shortage of the fodder and manure that are always badly needed by the livestock-dependent communities of the mountains. In addition, when there is a fodder shortage, the workload of women farmers increases (Singh 1992).

Monocultures with a narrow genetic base are extremely vulnerable to epidemics and unfavorable weather conditions. The seeds of HYVs cannot even be stored in houses without chemical treatment. They are thus a potential source of environmental pollution and health hazards. Indiscriminate use of chemical fertilizers and pesticides also reduce soil fauna and flora and severely affect the health of soil ecosystems.

Seeds have always been regarded as a common property resource by farming communities in the mountains. Free exchange of seeds within mountain communities has been one of the most outstanding features of agriculture. Under transformed agriculture involving new seeds and external inputs, seeds cease to be a common property resource, as does their free flow among farmers. Seeds are now a private resource of big corporations or public organizations. Patents and intellectual property rights, etc., are the means to treat vital seeds as weapons of a newly emerging biological imperialism.

Superb landraces

Rice in the Himalayan mountains was once a natural treasure of genetic diversity. In this region rice can be grown successfully up to an altitude of 2000 meters. Himalayan valleys are especially well known for the special varieties of rice that grow there. Traditional rice varieties, like *hansraj, ramjawan, kanguri, bagwai, gorakhpuri, basmati, thapachini, jhumkya*, etc., thrive in lowland areas, while *chawaria, mujil, jhailda, lekmal, kallao, almunji, chwatu*, etc., grow well in upland rain-fed areas and at high altitudes. Some of varieties can even be grown close to glaciers. Some varieties demand more water, some less, and some need no irrigation at all. The productivity of rain-fed rice varieties is comparable with that of irrigated ones. Such rare, hardy, and sturdy varieties would hardly be found in the plain areas anywhere in the world.

HYVs cannot match traditional varieties in their palatability, or, perhaps, nutritive value. Due to chemical applications, HYVs can pose a potential risk to human health and disturb the natural food chain. The taste and distinctive aroma of some traditional rice varieties, e.g., Indian *basmati*, are known throughout the world. Many rice varieties in the mountains, e.g., *kafalya, kallao, ghyasu*, and *ramjawan* are comparable to *basmati*.

All landraces are known for their characteristic size; the shape and size of ears; color, shape and size of seeds; palatability; aroma; cooking quality, etc. In addition, *lathmar* and *jhailda* are free from

splitting problems. They are generally planted in areas prone to hailstorms. Even wild animals cannot harm them because the ears of the plants bear awns. Some landraces are also of high medicinal value; for example, *kafalya* is used to cure leukorrhea and many other gynecological problems.

The *baranaaja* culture: Diversity is prosperity

A cropping pattern based on intermixing finger millet, locally known as *baranaaja*, is a symbol of prosperity in the region. *Baranaaja* literally means "12 food grains." The adage "diversity is prosperity" holds well from the perspective of mountain agriculture. Finger millet is intercropped with as many as 12, and sometimes even more, other food grains. Amaranth, buckwheat, kidney beans, horse gram, black soybean, black gram, green gram, cowpea, adjuki bean, sorghum, and *cleome* are the main crops intermixed with the base crop of finger millet. *Baranaaja* provides a unique example of how a mountain farmer cultivates diversity. Marginal and small farmers inhabiting the mountains manage agrobiodiversity in such a way that they can harvest the maximum number of food items from the minimum amount of land. The degree of agrobiodiversity is directly proportional to the level of their (food) security, and *baranaaja* is the core of their (agri)culture.

The main result of conventional interventions in agriculture is to replace the unique *baranaaja* culture with monocultures of white-seeded soybeans. Soybeans as a cash crop is projected as a panacea for the land-based economy of the mountains. This crop was introduced recently as one of the packages of the Green Revolution and is said to be a source of protein, milk, and oil. Soybean, in fact, has never been an ingredient of local diets, nor has it fetched more money for the farmers. Farmers who switched to soybean cultivation from *baranaaja* generally barter their produce for salt or rice. Unlike all major mountain crops, soybeans do not provide fodder for livestock, which has contributed to fodder problems in the area.

Realizing the potential dangers to local agrobiodiversity, the majority of local farmers have given up raising soybeans at the expense of the unique *baranaaja*. BBA, with the help of farmers has been successful in reviving the *baranaaja* culture, to the joy of mountain communities.

Ecological regeneration of common property resources

The mountain farming systems typical of Garhwal comprise forests, cropland, livestock, and households as four organically linked components (or subsystems). No input from outside the system is required. This traditional system is "closed," and self-containment is one of its most essential features. Forest biomass flows into cropland (cultivated land) in the form of organic manure via the agency of livestock. Crop biomass is recycled into cropland through livestock and human beings.

This farming system is altogether different from the one operating in the plains under Green-Revolution agricultural practices. In the latter, organic linkages among components are virtually missing. Forests are almost absent. Almost all the necessary inputs are supplied from outside. The forests and grasslands in the mountains, on the other hand, are managed as common property resources, with cropland continuously receiving a subsidy from them. Such a unique farming system could be termed a "nature-subsidized, solar-powered agroecosystem." Green-Revolution agriculture, on the other hand, is a "fossil-fuel–subsidized, solar-powered agroecosystem" in which petroleum-based inputs (chemical fertilizers, pesticides, and machines powered by fossil fuels) are inevitably used.

Common property resources play the most vital role in providing ecological integrity to mountain agriculture. Biodiversity in these areas has enormous bearing on agrobiodiversity. Ecological regeneration and enrichment of diversity in these areas is also a focal point of BBA. Plentiful biomass harvests, especially of fodder and fuel wood, from common property resources have strengthened organic linkages among the components of farming system, infusing health into the whole farming system. Cropping systems are more fragile than forest ecosystems. If there is crop failure due to an erratic weather cycle, for example, common property resources can fill much of the requirement for food. They also ease pressure on croplands. In their absence, more and more areas would have to be cultivated, which would exact a heavy cost from the ecological balance in the region.

Common property resources also play a significant role in enhancing food security. Villagers in Garhwal have access to at least 127 different food-providing plants. Many of these food plants occur in areas that are common property resources. People incorporate 23 wild fruits, flowers, and buds and 14 wild vegetables in their diets. These uncultivated foods complement the cultivated ones. Foods obtainable from uncultivated common property resource areas often have very high nutritive value. Many of these have medicinal value as well. At least 100 more plant varieties that occur naturally in uncultivated areas are exploited as fodder for livestock and thus become part of human nutrition through milk and milk products.

When looking at the food spectrum of prehistoric humans, we come to know that they embraced at least 1500 species of plants, while over 500 vegetables were utilized by ancient civilizations. However, in contemporary times, human nutrition is based on no more than 30 plants, with three crops—wheat, rice, and maize—accounting for 75 percent of our cereal consumption (SAM 1984).

It can clearly be inferred from this that human societies have been moving steadily towards a state of food poverty based on the decline of food diversity. The state of food diversity is grimmer in agriculturally transformed areas deluged by high-yielding, fertilizer-dependent varieties of food grains. In these Green-Revolution areas only a few species of plants with a limited number of varieties remain the sole source of human nutrition. There is no mention of and no debate about uncultivated foods. In urban mountain areas, where the public distribution system is the only way to feed people, most of nutritional requirements are met by *dal-bhat* (pulses and rice). But the plates of rural mountain people are piled with delicious and diverse foods thanks to the enormous biodiversity flourishing in their forests and agroecosystems.

Because of the continued neglect of common property resources in policies and planning, however, considerable ecological damage has been witnessed in these areas over the last few decades. BBA took stock of this situation and designed concrete strategies for ecological regeneration. *Van suraksha samiti* (forest protection committees) have been formed. Inspired by the Chipko Movement, the village youths involved in these committees have taken on the task of regenerating the rapidly depleted forests. Overgrazing of the common property resources by cattle and ovine species is not allowed. Only hand-lopping (no cutting with sickles) of oak leaves is permitted. Oak forests represent the natural climax vegetation of the Middle Himalayas, playing a very specific role in soil and water conservation and microclimate maintenance. These forests are especially protected from overexploitation. Only dry branches and twigs can be removed for firewood. The committee's sanctions are to be followed by all. BBA has enhanced the biodiversity of the common property resources through massive plantings of food-yielding trees. These trees have begun bearing fruit and contributing to food security.

As a result of this community management, village residents in the Henwal Valley of Garhwal are now obtaining fuel, fodder, and several kinds of wild foods (fruits, flowers, buds, vegetables, seeds, honey, etc.), along with cultivated fruits, from the common property resource areas—free of cost on sustained basis. Water springs have been rescued and these supply clean drinking water to villagers. The reappearance of several wild animals—boars, bears, leopards, etc.—indicates that the ecological balance is being restored. Farmers are getting plentiful natural subsidies in the form of forest biomass, water for irrigation, etc., for agriculture, and the impact on agronomic yields in cropland is visible.

Farmers' Experimentation

BBA keeps records of the performance of all the landraces. BBA farmers also do their own informal experimentation on the landraces. The performance of all the landraces is compared with the so-called HYVs demonstrated by external development agencies. All the traits of vital socioeconomic importance, rather than just grain yields, are taken into consideration. The results of one such experiment conducted in Jardhargaon of the Henwal Valley are presented in table 1. In their experimentation, farmers do not apply any statistical design, but they do take into consideration more traits and factors than an agricultural scientist would conventionally do. Some of the interesting observations are listed below.

- The average yield of 27 landraces (40.00 q per ha) was significantly higher than the yields of five HYVs (28.00 q per ha).
- *Thapachini*, a widely adopted landrace, gave the highest grain yield (54.00 q per ha).
- *Jhumkya, khushboo, agariya, lathmar, kali mukhri, basmati nagni, lalmati, congressi, nailchamya, rekhalya,* and *rikhwa* also gave impressive yields.
- Most of the landraces attain maturity earlier than HYVs.
- The average recovery percentage of landraces (72 percent) was significantly higher than that of HYVs (60 percent).
- The average grain-husk ratio of landraces (2.6:1.0) was wider than that of HYVs (1.5:1.0).
- Straw-grain ratios of most of the landraces (1.4:1.0 to 2.3:1.0) are higher than those of HYVs (1.1: to 1.6:1.0), thus supplying more fodder, a critical produce, no less important for livestock production in the region.
- Yields of the landraces are fairly sustainable. This has been observed for more than a decade in the Henwal Valley of Garhwal.
- More yields with low inputs (zero external input) indicate the high-energy efficiency in landraces.
- Landraces show considerable tolerance to diseases and pest infestation, and some of them can thrive well under rain-fed conditions, thus exhibiting the unique trait of drought tolerance. HYVs, on the other hand, are vulnerable to several sorts of pests and cannot grow under rain-fed conditions.
- In addition to organic manure, HYVs usually require external inputs (chemical fertilizers and dreaded pesticides); hence, their cultivation contributes to environmental pollution and

Table 1. Performance of Some Landraces and High-Yielding Varieties of Rice in a Village of the Garhwal Himalayas, India

Name of Landrace/ HYV	*Production (q per ha)*		Straw-Grain Ratio	*Plant Height, (cm)*	Days of Maturity
	Grain	*Straw*			
Landraces					
Thapachini	54.00	96.00	1.8	140	140
Khushboo	49.00	80.00	1.6	125	145
Kali Mukhri	46.00	80.00	1.7	122	145
Agaria	49.00	78.00	1.6	125	145
Kanguri	38.00	54.00	1.4	115	120
Lalmati	45.00	64.00	1.4	120	140
Rikhwa	43.00	64.00	1.5	125	130
Jhumkya	50.00	80.00	1.6	130	140
palphaBasmati Nagni	45.00	88.00	2.0	135	150
Utauli	36.00	64.00	1.8	118	145
Bangoi	40.00	65.00	1.6	125	140
Congressi	45.00	104.00	2.3	126	145
Anjana	29.00	48.00	1.7	125	145
Gajraj	33.00	48.00	1.5	126	150
Ghyasu	37.00	72.00	1.9	135	150
Lathmar	47.00	65.00	1.4	115	150
Rekhlya	43.00	70.00	1.6	120	140
Gorakhpuri	36.00	65.00	1.8	135	120
Hansraj	33.00	75.00	2.3	130	160
Bhagwandas	33.00	58.00	1.8	125	135
Nyuri	35.00	60.00	1.7	110	120
Palyopar	36.00	66.00	1.8	120	140
Basmati Doon	32.00	55.00	1.7	125	150
Nailchamya	43.00	72.00	1.7	120	145
Chawarya	32.00	60.00	1.9	122	135
Luakat	37.00	60.00	1.6	130	145
Ramjawan	33.00	57.00	1.7	125	130
High-Yielding Varieties					
Kasturi	24.00	34.00	1.4	85	150
Pant Dhan – 6	30.00	40.00	1.3	72	155
Saket – 4	41.00	64.00	1.6	72	165
Pant Dhan –11	30.00	40.00	1.3	80	160
Govind	17.00	18.00	1.1	85	155

Note: Landraces were grown at the farm of a BBA farmer, while HYVs were the demonstrations of an agricultural university near the same farm. Organic manure was applied to all the plots at the rate of 250 q per ha. HYVs, in addition, were also provided with recommended doses of chemical fertilizers and pesticides.

health hazards, whereas the landraces thrive under organic culture, ensuring environmental quality.

- Landraces not only satisfy people's hunger and contribute to food security, but they are also used in many rituals. All through the history of Indian civilization, these landraces have been used as symbols of religion and culture.
- The social acceptability of landraces is very high.

Regular features of the movement include organizing meetings to review the progress of the BBA and occasional walking trips, along with seed fairs and participation in museums, fairs, etc., in urban areas. These have been considered necessary for creating awareness in the community. The relentless search in remote and poorly accessible areas for the collection of more and more seeds of landrace varieties exhibiting unique characteristics goes along with the awareness-raising activities. An inventory of the unique traits of landraces is made with the help of farmers in remote areas, and oral histories relating to their cultivation are recorded. BBA has also prepared a biodiversity register for elaborating the characteristics of individual landraces.

Seeds of the local varieties of crops, such as rice, kidney beans, black soybeans, several local pulses, amaranth, etc., can now be found for sale in urban markets, indicating their increasing economic value in the market. Landraces, in fact, are fetching handsome returns for some of the families in the area. Many varieties of the crops grown only in the mountain areas are known for their special food and medicinal values and have great export potential.

Future Implications

Traditional systems of management and ecological knowledge have been the vital means by which mountain communities have evolved richly diverse food-production and livelihood systems. Traditional knowledge develops from the natural process of adaptation and, unlike conventional scientific knowledge, it is moral, ethical, aesthetic, intuitive, theosophical, compassionate, and holistic, resulting in a diverse local and bioregional economy.

One thing that seems certain is that in the historical process of agricultural development, farmers have always sought to enhance the level of biodiversity. When they opt out of following the biodiversity-destructive ways of the Green Revolution, they return to the biodiversity-based agriculture they have tested over millennia. Farmers in the Garhwal Himalayas, through BBA, are doing this.

Diversity in agricultural crops, landraces, and their wild relatives in the Indian Himalayas have been maintained by farmers for centuries. In India, the endemic species inhabit two areas for the most part: approximately 4,200 species are found in the Himalayas and 2,600 in the peninsular region. In the Indian Himalayas, crop diversity is related to eight groups of crops and 71 species. As a result of the selection pressure exercised within the species by locals over the millennia, enormous diversity has evolved in the form of local landraces (Pant 1998). Too much emphasis on HYVs has led to the extinction of several landraces during recent decades. People's movements, like the BBA, would help remove such extinction scenarios from the mountains.

The efforts of BBA are noteworthy in that they have revived the cultivation of unique landraces and cropping systems, promoted on-farm conservation of genetic resources, enhanced biodiversity in forests and agroecosystems, and encouraged the growth of organic farming based on the principles

of a living soil, biodiversity-complexity, and cyclic flow patterns. The success of BBA suggests that it is possible to combine diversity, productivity, and livelihood security in future agricultural policy.

Since many of the local landraces exhibit unique properties—like taste, aroma, essential amino acids, high calcium content, medicinal (Ayurvedic) value, and the like—they can have very high market value in the plains and can bring in handsome returns to local farmers. A mountain-friendly agricultural policy can play a pivotal role in this regard. Prices should be decided on the basis of the characteristic properties the produce possesses. Mountain agriculture, in fact, should be dictated by the principle of value, rather than volume. Value rather than volume should also be the main concern of the agrarian economy of the mountains and other marginal areas harboring unique biodiversity in their ecological niches.

When agrobiodiversity is managed and controlled by farming communities, it is virtually regarded as a common property resource. Conservation of plant and animal genes should be seen as an aspect of management of the common property resource. It should, therefore, be seen as a fundamental duty of both institutions and farmers to conserve biological and genetic resources. BBA reminds us this moral obligation.

A farmers' movement, rather than just farmers' participation or farmers' involvement, is the most radical approach towards realizing the most desirable change in a system. This approach itself takes care of any bias and lack of institutional mechanisms for change. It also reverses negative change into positive. By creating local gene pools through large-scale farmers' movements, on-farm management (conservation and sustainable use) of genetic resources will also help marginal farming communities, like those of the mountains, to remain impervious to the global politics surrounding control of the world's gene pools.

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Empowering Farmers through Participatory Plant Breeding: An Initiative of the Green Foundation

Vanaja Ramprasad and Shibu M P

Abstract

In the so-called *difficult environments*, institutional plant breeding appears to be a failure, mainly because breeding is directed at increasing yields in more favorable environments. Although the improved varieties have broad adaptability, under varied marginal environments, they do not express their yield potential or they do not satisfy other user requirements. In any environment, the potential of a plant is controlled by the interaction of its genetic composition with the environment. This involves adaptation of the plant to both physical environments (climate, soil, abiotic and biotic stress) and the socioeconomic environment (user concerns, consumers' preferences, economic status, markets, etc.). After the introduction of high-yielding varieties and hybrids during the Green Revolution in India, hundreds of landraces and indigenous varieties have become extinct or on the verge of extinction, largely because they have not been considered economical to grow under the present market economy.

Despite this, small-scale farmers in marginal environments continue to grow a mixture of crops and varieties as a buffer against temporal and spatial variation to cope with stress factors. It has been a time-tested practice by farmers to continue to select their next generation of seeds, thereby modifying the genetic characteristics of the crops. Tapping into this practice and empowering farmers to improve their crops has now come to be referred to as "participatory plant breeding."

Conservation of plant genetic resources has been initiated by the Green Foundation, working in the dryland regions of South India. As a means of empowering farmers, the Green Foundation has conserved several varieties of staple food crops, like finger millet and rice, on-farm. Using the genepool available to them, farmers have selected varieties, based on a set of criteria, for varietal purification, as a first step towards participatory plant breeding. This paper describes the process of varietal selection for improvement of local cultivars and the upgrading of farmers' skills as independent seed producers.

Introduction

Indigenous seed practices encompass practically all aspects of crop production, since seed saving is an integral part of cropping activities in indigenous systems. Farmers engaged in the production and multiplication of quality seeds deal with asexual propagation, land preparation and soil management, seed and seedling preparation and care, crop and pest management, flowering induction, the enhancement of seed quantity and quality, crop improvement, harvesting or collection, seed processing, storage, and genetic conservation (Fernandez 1994).

The holistic understanding of cropping in semi-arid areas has lent support to the conservation of diversity in various parts of the country. In the last few decades, there have been dramatic changes in Indian agriculture. The advent of the Green Revolution in the mid-1960s has been a major threat to India's vast genetic diversity. Intercropping has been replaced by monocropping, and as a result, food production is perched on narrow genetic diversity. The erosion of agricultural biodiversity threatens the long-term stability and sustainability of Indian agriculture in the following ways:

- It erodes the genetic base on which scientists are dependant for crop breeding.
- A monocrop of high-yielding varieties (HYVs) does not provide adequate insurance against failures caused by natural calamities.

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Need to revive biodiversity

A considerable amount of the genetic material that has been maintained by farmers over several years is now no longer available to the farmers. The ex situ collections play an important role in preserving germplasm under freezing conditions but they have their own limitations, like cost and loss of viability during storage. This limits the natural course of evolution, since the environmental conditions to which crops are constantly adapting cannot be recreated in a refrigerated gene bank.

It is in this context that a plant-genetic-resources conservation program was introduced in 1992, to ultimately create a village-based community seed bank. Since then, the program has gone through the stages of collection, multiplication, monitoring, evaluation, and farmers' participation in selection, rating, and distribution of varieties.

The profile of the area

Thally block, in the State of Tamil Nadu, and Kanakapura, in the state of Karnataka, are semiarid, with an annual rainfall of 700–900 mm. The Green Foundation works in the dry-land regions lying between these two administrative regions—Tamil Nadu and Karnataka. Seed conservation work extends across 85 villages, involving more than 500 farmers. The agricultural scene paints a bleak picture. The combination of illiteracy, poor infrastructure, poverty, and small land holdings on the one hand and changing agricultural practices and market pressures on the other have rendered agriculture very vulnerable for the farmers of the area. More than 85 percent of the cultivated area comes under rain-fed dry-land. Changing rainfall patterns have affected the improved varieties introduced in the area. Yet the area also represents a rich source of biodiversity, which is on the verge of extinction. It is against this backdrop that the Green Foundation has initiated a genetic resource conservation program.

The major food crops of this region are finger millet and dryland paddy, followed by wetland paddy, pulses, sorghum, maize, oilseeds, vegetables, and other minor millets. Many of the indigenous varieties have been reintroduced with low-input agriculture since 1993, when the foundation started its work in the area. Table1 gives the details of the collections between 1995 and 1999. In 1998 an attempt was made to upgrade local varieties through a process of participatory varietal selection, and as an initial step, *ragi* (finger millet) and rice crops were selected.

Earlier practices recall cultivation of four seasonal crops such as *gingelly* in the pre-monsoon season; groundnuts, paddy during early monsoon; *ragi*, pulses in the monsoon season; and horse gram in the post-monsoon period.

Changes in climatic variations have had an impact on the rainfall pattern and, as a consequence, have affected different crops in different ways. Intercropping has been popular as a traditional practice, although many farmers have shifted to the improved varieties of finger millet, leading to erosion of traditional ones. The program of seed conservation has widened the choice of finger millet varieties for farmers (figure 1).

The focus of the program was not only to widen the choice of varieties but also to increase yields by improving the quality of seeds. The on-farm conservation program, with nearly 34 indigenous varieties of finger millet and 38 varieties of wetland and dry-land paddies provides the basic materials for the participatory plant breeding (PPB) process.