present context. The conducive policy context and supportive institutional and regulatory frameworks are essential to materializing, promoting, and scaling up PPB to increase people's livelihoods and have a broader impact on resource-poor farmers. The regulatory measures have great bearing on PPB—how supportive they are to promoting PPB and how strong they are to protect farmers' rights and to prevent bio-piracy, genetic erosion, monopoly of transnational seed companies, etc. It is essential to develop the institutional capacity, relationship with farmers, and research-institutions to create an environment favorable to promoting PPB. Decentralized management structures and effective mechanisms for sharing and disseminating information, as well as systems for regular monitoring, evaluation, feedback, and feed-forward are important characteristics of institutions that can and will support and promote PPB. However, policymakers, planners, and senior managers of agricultural research have yet to realize the importance of PPB, at least in Nepal. For example, in Nepal there is neither clear policy on PPB nor any interest or concern from policymakers and politicians. Similarly, neither there is regulation on the import or informal entry into the country of genetically modified or terminator seeds that can have a negative impact on the local seed-management system and which can contribute to genetic erosion. Nepalese laws and regulations are either silent or unclear about genetically modified crops, patenting, bio-piracy, CBD, or farmers' rights (Timsina 2000).

New professionalism to improve PPB performance. Since PPB itself is an integration of social and technical sciences, it is essential to develop a new professionalism with an adequate understanding of the importance of both sciences. Shared cognition and intention, along with appropriate institutions are essential ingredients to an interactive design that views people as participants, not as object that can be instrumentally and strategically manipulated (Roling 2000). So far, the egocentric attitudes of natural and social scientists, and their lack of knowledge and skills in participatory processes, have restricted collaboration not only in participatory R&D activities but also in developing this new, integrated professionalism. PPB not only deals with technical issues of genetics, plant breeding, entomology, and plant pathology but it also combines the perspective of economics, sociology, anthropology, farm management, etc., to social issues like the attitude and behavior of farmers; their economic, social, and cultural conditions for adaptation of PPB outcomes; local knowledge and information about the characteristics of particular plants and varieties, etc. One can not assume that the goals of PPB are the goals of farmers. At this juncture, there is a gap between social and natural scientists that could be bridged by developing a new, integrated professionalism through appropriate training, sharing, and experimentation.

It is increasingly realized that the "delivery" of science-based innovations like plant varieties to farmers does not work (Roling 2000). This approach was attempted by the Green-Revolution model but failed to reduce the gap between rich and poor, which increased instead. Therefore, a new approach is essential in order to develop effective action according to the objectives, expectations, priorities, and knowledge of farmers. It is time to integrate hard, positivist-objectivist, biophysical science with soft, participatory, constructivist social science to deal with PPB, which imparts knowledge, skills, and a change in the attitude of scientists (both social and biophysical), and to work in a collaborative and complementary way to improve the performance of PPB. One important characteristic of a successful professional, whether breeder or social scientist who works with communities, is the learning attitude and communication skills. One of the major constraints observed in PPB is the lack of internalizing the role and importance of integrated professionalism. Changing from an ethnocentric, own-discipline bias to accommodation of multidisciplinarity—shifting perspectives and feeling from "we are the master and, therefore, part of the solution and they are the lay person and therefore part of the problem" to "we both are learners and collaborators"—is another challenge to be internalized by PPB professionals. Attitudinal differences between two groups of scientists are due to different kinds and levels of knowledge, orientation, background, professional bias, and experience. Therefore, balancing recognition and exploring latent conflict is essential to increasing commitment, collaboration, and interdisciplinarity.

Potential threats to PPB

In this section, the effect of globalization, intellectual property rights, UPOV, genetic engineering and biotechnology, and bio-piracy is presented from the PPB perspective. The dominant reductionist scientific world view of the West and its inventions like genetic engineering and biotechnology is causing suffering, widening poverty, and destroying earth (Ho 1998). International agricultural trade does not benefit the poor because it is based on the monitory interests of transnational and multinational companies. Rather, it is severely threatening farmers' rights to seed and plant genetic resources (Action Aid 1999). It is increasingly accepted that genetic engineering, in general, and patenting of genetic resources, in particular, have a potentially negative impact on resource-poor farmers. Studies have shown that the liberalization of global trade is not only exerting enormous pressure on resource-poor agriculture and marginalizing poor and small farmers, but it is also promoting starvation and the erosion of agricultural biodiversity and indigenous knowledge (Action Aid 1999). Transnational and multinational agribusiness corporations are benefitting from globalization and the liberalization of trade at the cost of inequality, hunger, and the threatened survival of resource-poor farmers of developing countries like Nepal.

Threats to PPB by genetic engineering and biotechnology. In the field of breeding, genetic engineering and biotechnology is a departure from the conventional breeding induced by industrialized countries. The sole motive of these innovations is to monopolize global agriculture and maximize profit (Ghale and Upreti 2000). Genetic engineering is widely touted by the giant biotech industries of the developed countries as the cure for world hunger. Their argument is that genetic engineering and biotechnology will help to restore a healthy environment, prevent further degradation of plant genetic resources, and globally provide more choices and opportunities. It is assumed that hunger is due to lack of food. But that is a simple and incorrect analysis of world hunger. The fundamental cause of hunger is not lack of food but a whole range of things from unjust and inequitable political and economic structures to ecological degradation for maximization profit to the marginalization of poor people (Ghale and Upreti 2000). Even some ecological economists argue that hunger is the inevitable result of globalization and the free-market economy.

Genetic engineering and biotechnology have been directed solely at meeting the commercial interests of a few giant food producers and processors in industrialized countries. Genetic engineering and biotechnology bypass the natural reproduction process because they horizontally transfer genes from one individual to another, as compared to vertical transfer from parents to offspring. These horizontal gene transfers not only spoil genetic diversity but also raise ethical questions (for example, human gene transfer to pigs, sheep, or bacteria). Transgenic plants are generally resistant to broad-spectrum herbicides, which cause acute and chromic toxicity and have a negative impact on biodiversity (ESRE 1999). Similarly, intervention in agriculture through genetic engineering and biotechnology reinforce existing social structures, maximize monopolistic profits, and intensify agricultural practices, which will lead to widespread environmental destruction and ecological imbalance.

Intellectual property rights, the Union for the Protection of Plant Varieties, and PPB. Intellectual property rights (IPR), plant breeders' right, and patents[2] as a regulatory arrangement introduced in the field of breeding to universalize the command and control of most developed countries has not provided protection to public interests in developing countries (Ghale 1999). How do breeders and other professionals working in the field of PPB perceive plant breeders' rights as embodied in the UPOV convention, which strongly centralizes the plant breeding (TWN 1996)? Which options do breeders involved in PPB prefer in IPR protection—protection through patents of protection *sui generis*[3] or open?

Due to the UPOV convention, the trade-related intellectual property rights (TRIPs), and genetic engineering and biotechnology, the control over plant breeding and seed is shifting from farmers to giant multinational seed companies. In this context, do participatory plant breeders advocate farmers' rights to use, produce, multiply, share, exchange, sell, modify seed, and plant genetic materials freely? The restrictions imposed by IPR infringe on farmers' rights. UPOV claims that the implementation of the new plant variety protection (PVP) arrangement stimulates protection of the environment and conservation of biodiversity and stability of food availability. That is only a nightmare and misleading (GRAIN 1999) because the uniformity criterion specified for PVP by UPOV tends to destroy diversity and enhance genetic erosion. If PPB practitioners realize this, then the fundamental shift from conventional PPB to PPB led by advocacy and lobbying is essential. This is probably too hard for the breeders. Another ethical question related to PPB is the IPR issue. PPB builds directly on farmers' knowledge and germplasm to select and develop crop varieties. Therefore, the ownership rights, access, benefits, and control of such varieties needs to be held by farmers instead of breeders. But does this happen in reality?

Threats to PPB from globalization. Technological advancement and the international expansion of trade and commerce have fundamentally shifted the focus on plant breeding. Global competitiveness is emerging as a determinant of plant breeding. The World Trade Organization (WTO), through its TRIPs arrangement and patenting of life forms, is posing new challenges and eroding the scope of self-supporting PPB. In the developed world, local seed saving is increasingly considered as a barrier to trade and commerce, and provisions are being imposed on farmers to pay royalties to plant breeders and companies. Globalization, through WTO and other similar arrangements, is forcing a radical change, not only on the setting of agricultural research but also by pressurizing member countries to change their legal, regulatory, and fiscal policies. In the case of plant breeding, the development of genetically modified foods and terminator technology by giant multinational agro-biotech companies like Monsanto, Novartis, and DuPont are examples of threats to PPB.

As the global market becomes more liberal, there is a countervailing trend to privatize knowledge and agricultural innovations for commercial profit (Action Aid 1999). Under TRIPs, if farmers use patented seed, they will be forced to pay royalties to the patentee if they keep seed to re-sow in the following years. Giant bio-tech companies are using local knowledge on the properties of plants to identify "useful" genes. They then patent the gene and its use. As a consequence, farmers in the country of origin have to buy it back and pay royalties. For example, neem trees from India and Nepal, basmati rice from India, and jasmine rice from Thailand are patented by Monsanto-like

2. A patent is a form of intellectual property protection that gives a monopoly right to exploit an invention for a period of 17 to 20 years. Article 27.3b of TRIPS requires developing countries to allow companies to take out patents on the products and processes of biotechnology. This article also demands that countries supply either patent protection or an effective sui generis (a unique intellectual property system for a specific good or process).
3. *Sui generis* is a Latin phrase commonly used in the IPR debate, which means "of its own kind."

companies. By placing the control of germplasm in the hands of the most powerful corporate bodies in global agriculture, the social, political, and economic structures that underpin poverty and hunger will continue to flourish (Action Aid 1999).

The open-market economy, free trade, and economic liberalization are the basic premises of WTO, in which patenting and IPR are the most controversial issues related to agriculture. Article 27.3 (b) of the TRIPs agreement does not recognize the right of local communities to their indigenous knowledge and agricultural practices. This article forces members to protect their rights to genetic resources for food and agriculture (GRAIN 1999). The commercialization of terminator technology, a genetically engineered trait that causes crop seeds to become sterile at harvest time, is posing another threat around the world (GRAIN 1999). The majority of the international and transnational life science companies are not only ignoring basic ethics and values but are also destroying indigenous knowledge, technologies, and practices for the sole aim of profit (UvA 1999). Therefore, excluding agricultural biodiversity and plant genetic resources from the patent protection within TRIPs 27.3 (b) and the protection of farmers' rights is essential to minimizing the negative effect of the TRIPs agreement on the livelihood of resource-poor farmers. In reality, the relationship between intellectual rights on life forms and the conservation and sustainable use of biodiversity is highly contentious (GRAIN 1999).

Bio-piracy as an emerging threat. Bio-piracy is another threat emerging from patent arrangements and TRIP. Bio-piracy from developing countries to patent innovation and earn money is on the increase. Recent seed-related research in Nepal has shown that bio-piracy is rapidly increasing in that country (Timsina 2000). The research report states that the germplasm of buck-wheat (*Fagopyrum spp.)*, barley (*Hordeum spp.*), chuche karela (*Momordica spp.*), wild rice varieties containing nitrogen-fixing bacteria (*Oryza spp.*), several herbal medicinal plants, and colocacia were taken from Nepal without permission by Japanese, German, and American researchers working in and or visiting the country. Nepalese breeders and NGO workers supported them in this bio-piracy.

Conclusion

It is time to rethink the approaches, methodologies, and focus of PPB to address changing global challenges and to raise the livelihood of resource-poor farmers. As a people-centered approach, PPB has to work in the spirit of conventional plant breeding, which seeks to promote the establishment of a sovereign community and indigenous rights to plant genetic resources. TRIPs/WTO, UPOV/ plant-variety protection, genetic engineering and biotechnology, and bio-piracy are becoming increasingly serious threats to PPB, food security, indigenous knowledge, and conservation of biodiversity. Corporate control of seed and plant genetic resources is creating inequalities. To minimize these adverse effects, it is essential for PPB to take the initiative in developing a germplasm-sharing network among farmers, PPB practitioners, and civil society, by establishing in situ seed banks as a common property resource, promoting the exchange of indigenous knowledge, registering seed and plant genetic resources at the community level, strengthening the management capacity of farmers for plant genetic resources, recognizing farmers' innovations, etc.

Since the last decade, PPB has been widely advocated by donor-supported research centers rather than poor farmers. Much of the discussion on PPB has been rhetoric, venturing into professional debate among the believers of PPB. Some practical efforts have been made to promote PPB, but they have been limited to a small-scale, disorganized, and mechanistic use of a few participatory tools such as PRA, on-farm trials, and farmer groups in a superficial level. Not much attention has been given to empowering farmers and increasing their livelihood. Therefore, a substantial reform in existing PPB—through the development of new professionalism and ideas, frameworks, and methodologies, particularly by engaging in collaborative action—is essential if PPB is to address the globally emerging challenges in plant breeding. Experiences over the last decade suggest that plant breeding approaches are donor driven, operating under the broad conceptual framework and financial conditions imposed by donors, which are, therefore, more rhetoric than "real participation" to empower a weaker section of society. The lack of communication and facilitation skills, conducive policy measures, and supportive institutional and regulatory frameworks in national agricultural research systems, combined with the egocentricity of breeders and social scientists and a sectoral approach, are some of the major bottlenecks to promoting a PPB that aims to use participation both as an end and a means. The scaling-up, institutionalizing, simplifying (demystification of prevailing jargon and rhetoric), empowering of farmers, managing change, reorienting training, coping with globalization and TRIPs/patenting, and developing a new professionalism are some of the major areas to be improved in order to reform the existing PPB.

The only way to cope with the threat of genetic engineering and biotechnology at the global level is to work in line with the Convention on Bio-Diversity, an international treaty that has been signed by more than 160 member states of the United Nations. This convention provides an international legal framework for the conservation of biological diversity, including access to and exchange of genetic materials and biodiversity prospecting.

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Adding Benefits to Local Crop Diversity as a Sustainable Means of On-Farm Conservation: A Case Study of an in Situ Project from Nepal

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Abstract

Effective management and conservation of genetic resources on-farm takes place where the genetic resources are valued and used to meet the needs of local communities. The in situ conservation project supported by the International Plant Genetic Resources Institute (IPGRI) in Nepal recognizes that farmers maintain local crop genetic resources if they remain competitive with other options or have value for special use. It has been demonstrated that community participation can be strengthened by sensitizing the farming community and consumers through public awareness, by developing markets for local products or providing market incentives, by improving the farmer's varieties and adding benefits through policy incentives. A variety of innovative and participatory initiatives to increase the value and benefits of landraces for farmers has been identified, and three strategic options in adding benefits were used in this study. Option 1—participatory plant breeding, seed networks, and grassroots strengthening—seeks to improve quality, disease resistance, high yield, better taste, and other preferred traits through technical means, including seed networks and participatory plant breeding. Option 2—non-market and non-breeding—includes creating awareness and sensitizing communities through educational means. Option 3—market methods—works through improved markets and information. Tools like diversity fairs, diversity blocks, and community biodiversity registers (CBRs) have been found effective in consolidating the roles of the farming community in the conservation process. This paper documents some processes using diversity fairs and CBRs that demonstrated how various options for adding benefits could be developed, tested, and linked with market networks.

Introduction

The goal of in situ conservation is to encourage farmers to continue to select and manage local crop populations (Brush 1999). In situ conservation aims to conserve not only genes themselves but also the farming systems and agroecosystems that produce and maintain genetic diversity (Eyzaguirre and Iwanaga 1996). Effective management and conservation of genetic resources on-farm takes place where the genetic resources are valued and used to meet the needs of local communities. The in situ conservation project supported by the International Plant Genetic Resources Institute (IPGRI) in Nepal recognizes that farmers maintain local crop genetic resources if they remain competitive with other options or if they have value for special uses. Jarvis and Hodgkin (1997, 1999), Sthapit and Jarvis (1999), and Brush (1999) suggest that one method to encourage farmers to continue to select and manage local crop populations is to increase the value of local and diverse crop populations to farmers who might otherwise stop growing them. In this paper, we concentrate on

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The in situ conservation project is implemented in partnership in Nepal between the Nepal Agriculture Research Council (NARC), Local Initiatives for Biodiversity, Research and Development (LI-BIRD), and the International Plant Genetic Resources Institute (IPGRI). The authors wish to extend their gratitude to IPGRI and the PPB symposium organizers for giving us this opportunity to share our experiences globally.

the contribution of various options to add benefits that help maintain and maximize the genetic diversity within the total crop gene pool.

The Nepal project has developed a variety of innovative and participatory methods to increase the value and benefits of landraces for farmers and society. Benefits may be sociocultural, economic, ecological, or genetic and may apply to farmers, communities, or society as a whole. This requires an in-depth understanding of the value of local crop diversity and potential ways of adding value and market networks. Brush (1999) identified three types of value in local crop diversity: direct, indirect, and optional.

This paper documents some case studies on options for adding benefit, carried out in three study sites: Jumla (2200m), Kaski (1200m), and Bara (85m) in Nepal.

Understanding the direct value of local cultivars and information sharing

Direct values refer to the harvest and uses of crop varieties as a part of a subsistence, commercial, and/or industrial process. Direct values have been considered as the basis of in situ conservation. Farmers value local crop diversity in terms of local adaptation to ecological diversity , pests, and pathogens; risk management (socioeconomic); and culture, rituals and food culture. A baseline survey, diversity fair, and focus-group discussion across three eco-sites in Nepal have documented typical examples of the direct value of local crop diversity (appendix 1).

These values may vary among farmers and are influenced by such factors as wealth, land, and labor resources; proximity to market and technological information, and government policies. No single variety can satisfy the concerns of all the farmers in a village, resulting in a complex range of crop diversity being maintained.

Evidence clearly shows a varying degree of local crop diversity in Nepal. These resources have been used and categorized broadly into ecological, socioeconomic, and cultural or religious, linked with traditional food recipes. The in situ project has the challenge of developing appropriate methods that enhance their conservation on-farm.

Strategy for adding benefits

Jarvis and Hodgkin (1999) suggested that value may be added to crop genetic resources in two main ways: (1) the materials themselves may be improved or (2) the demand for the material or some product may be created or increased. In addition, nonbreeding and non-market methods are equally important as they are linked with access to information and genetic resources and creating awareness at different levels.

How can local crop diversity be improved? It is important to understand why and where local crop populations are maintained, as well as understanding what the value of particular landraces is and what the limiting factors are and what traits are not preferred. We can appreciate the farmers, contribution to biodiversity conservation, but we need to understand why some crops and varieties are grown on a larger scale by many farmers, while at the same time, a few farmers grow a few selected varieties by themselves—often in niches. Understanding the rationale behind this will assist plant breeders in seeking technical opportunities to improve the materials. In Kaski, Nepal, *Bayerni* and

Biramphul rice is grown by a few, richer, households for its high quality. In terms of yield, these varieties are not competitive with other landraces, such as *Jetho budho* and *Pahele*. It is assumed that many households may start planting *Bayerni* and *Biramphul* if these varieties are improved in terms of yield without losing their quality traits. Table 1 shows the number of landraces selected in the study sites for adding benefits to see whether landraces, per se, can be conserved by adding value.

Table 1. Setting Breeding Goals for Adding Benefits in Selected Rice Cultivars

Site	Landrace selected	Constraint	Adding benefits—PPB
Jumla	*Jumle marshi*	Low yield, chilling injury	Increase yield by select blast- and cold-tolerant cultivars
Kaski	*Anaga*	Low yield, poor grain/panicle	increased yield
	Mansara	Low yield, less response	non-lodging
	Thulo/sano gurdi	Low yield	early maturity
	Ekle	Low yield, late	improved eating quality
	Biramphul	Lodging, low yield, late	
	Pahenle	Long straw, low yield	
	Madishe	Eating quality, low yield	
Bara	*Dudhisaro*	Low yield, lodging,	grain quality
	Nakhisaro	Lodging, low yield	non-lodging
	Rato basmati	Pest BHP, low yield, blast	pest tolerance
	Lajhi	Lodging, low yield	increased yield
	Mansara	Lodging	blast tolerance

Source: Adopted from Joshi et al. (1999) and Rijal (1999).

Adding benefits through participatory plant breeding

Participatory plant breeding (PPB) can improve the materials, but the materials can also be improved by eliminating diseases and pathogens from planting materials or clones, e.g., taro, diseases in potato and citrus. Sthapit et al. (1996) have demonstrated that *Chhomrog* rice has been enhanced because its red rice grain was replaced by a white color, while cold tolerance was improved. The project is also assessing the value of landrace enhancement for those landraces that are widely grown and preferred by farming communities. Strengthening the skill of selection and exchange of enhanced materials will also assist in the process of on-farm conservation. *Jetho budho* in Kaski, *Basmati* in Bara, and Jjumli marshi in Jumla have already been identified and preliminary work has been initiated.

The most important strategy for increasing the value of local crops is to use them for a crop-improvement program. PPB covers the full range of crop improvement activities: assessing local diversity and uses, setting breeding goals, creating variability, selecting varieties from variable populations, evaluating varieties, and scaling up through farmer-to-farmer seed networks. Joshi et al. (1999) documented the detailed process of PPB to study whether PPB can be considered a strategy to enhance on-farm conservation as well as to meet the productive needs of farmers. The roles of formal plant-breeding institutions (e.g., NARC) and NGOs (e.g., LI-BIRD) have been mutually agreed upon for each key step of the PPB process. The multidisciplinary team categorized rice landraces by their distribution and frequency, as described by Joshi et al. (1999). Breeding goals for the Bara and Kaski eco-sites were developed in a participatory manner, involving breeders, socioeconomists, and farmers, to analyze the strengths and weaknesses of the landraces. In the process of selecting parents, farmers strongly felt that the preferred traits should be maintained even if inferior traits were the targets for improvement through PPB. Thus, the breeding strategy has a role to play in improving and conserving traits and characteristics that are *not* linked specifically with social, religious, or medicinal norms and beliefs or used in local recipes.

Adding benefits through nonbreeding and non-market methods

A number of participatory approaches have been used to date to increase local awareness about the importance of agro-biodiversity and to improve the flow of seed within and between communities (Rijal et al. 1999). Diversity fairs, diversity theaters, diversity songs, poetry journeys, community biodiversity registers (CBRs), and diversity blocks are some of the popular activities carried out to increase awareness and sensitize the community.

In the context of strengthening access to germplasm and information in the farming community, diversity fairs, diversity blocks, and community biodiversity registers have been identified as powerful options, which also enhance the farmers' capacity in managing their own crop genetic resources.

The diversity fair. Here, the term *diversity fair* refers to a tool used to demonstrate or display local crops along with the associated knowledge resources of an ecology, as defined by community-based organizations (CBOs). Traditionally, local seed markets and fairs constitute an important part of the informal seed exchange system in the villages. Local markets, *haat bazaar,* and "agricultural fairs" provide a good opportunity for the exchange of seeds and knowledge. In recent years, these informal systems have been threatened by outside intervention, particularly in the seed sector. As a result, indigenous knowledge associated with local genetic resources has begun to erode.

The community-organized diversity fair focuses on indigenous landraces. In Nepal, diversity fairs have been used as an entry point to raise the level of awareness about in situ crop conservation programs before more technical aspects of the project are implemented. By organizing competitions between groups of farmers, the project promote access to farmers and encourages farmers to maintain the maximum genetic diversity. The in situ project uses diversity fairs as a participatory research and development tool in Nepal. It aims at creating competitions between farmer groups on a regular basis in order to accomplish the following:

- to recognize farmers who maintain large amounts of genetic diversity and who possess a good deal of associated knowledge, to act as a source of information for others
- to locate areas of high diversity
- to identify and locate endangered landraces
- to prepare an inventory of crop genetics, along with a knowledge resource base
- to identify the main sources of the informal seed supply within the community
- to understand the value of diverse genetic resources in terms of use, economics, culture, religion, ecology, etc.
- to empower local communities to have control over their genetic resources
- to help develop a sense of ownership in the community