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Recognising and enhancing local innovation in managing agricultural biodiversity

by Fetien Abay, Edson Gandarillas, Pratap Shrestha, Ann Waters-Bayer & Mariana Wongtschowski

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An increasing number of projects promote the role of farmers – smallholders, herders, forest people, fisherfolk and other local resource users – in conserving natural resources and agricultural biodiversity. However, these projects often do not recognise the efforts made by local people themselves to make new uses of and enrich genetic resources. The long history of indigenous domestication, selection and breeding of plants and animals is acknowledged. Much less attention is paid to farmers' current activities in domesticating wild species and in selecting and breeding plants and animals in view of changing conditions and new opportunities. Farmers are exploring new ways of using biodiversity in a sustainable way with a view to spreading risks, enhancing food security and improving their livelihoods. Especially poorer farmers are innovating in biodiversity management in order to increase their options to cope with variable environmental conditions and to exploit micro-environments ("niches") in their agro-ecosystems. Since decades, anthropologists have described local people's innovativeness, e.g. Richards (1985) referring to the "indigenous agricultural revolution" in rice varietal management in Sierra Leone. But rarely has this information been fed into the design of projects focused on agricultural biodiversity.

Here, the focus is on the current innovativeness of local people: not how their ancestors developed local varieties and breeds, but rather the current *dynamics* of indigenous knowledge (IK): how farmers, on their own initiative, develop new ways of using and managing genetic resources. Such endogenous (from within) processes are often overlooked when outsiders intervene in efforts to conserve biodiversity. Indeed, some interventions may unknowingly undermine local creativity and energies. But there are encouraging examples of projects that support local initiatives in managing agricultural diversity.

What is local innovation and why look for it?

Local innovation is the *process* by which local people develop new and better ways of doing things, using their own resources and on their own initiative. They may be exploring new possibilities simply out of curiosity, or may be responding and adapting to changes in the condition of natural resources, availability of assets, markets and other socio-economic and institutional contexts brought about by higher-level policies, disasters, climate change and other external influences.

The *outcomes* of these innovation processes are local innovations developed by local people. These innovations may be technical and socio-institutional**,** including policy change at local level, e.g. bylaws for using natural resources. A successful process of local innovation leads to local innovations that improve the lives of many people in the area (Wettasinha *et al* 2008).

Local innovation *= process of developing new and better ways of doing things*

Local innovations *= the new ways of doing things, in terms of technology or socio-economic organisation or institutional configuration, that result from the local innovation process*

Recognising – i.e. identifying and appreciating – local innovation processes and the innovations resulting from them makes scientists and development agents more aware of the relevance of local innovativeness for meeting the needs of farm families and communities. It brings to light site-appropriate ideas that deserve support and encourages both farmers and "outsiders" to interact in joint research and development (R&D) to improve agriculture and natural resource management (NRM). Local innovations offer entry points for identifying questions of mutual interest which farmers, development agents and scientists can explore together. Recognising local innovation reinforces the dignity of local people and their self-confidence to manage and improve the resources on which their lives depend.

This approach to R&D reflects the very principles of good biodiversity management: appreciating local specificity, valuing and ensuring the continued existence of multiple types of assets (be these genes or creative ideas), keeping possibilities open for adaptation and, thus, assuring resilience and sustainability.

Local innovation in domesticating wild species

In several countries, observant scientists and development agents have come across individuals who keep their own "botanical gardens". These individuals are often local healers, who either want to have easier access to the plant ingredients needed for their work or have recognised that useful plant species are disappearing in the wild. Indeed, it is often a combination of the two. As certain wild species required for treatments or other purposes become rarer, healers have to travel further to obtain them, and then decide to transplant or grow by seed and multiply the plants near their homes. For similar reasons, farmers innovate in domesticating wild animals, including wild bee species also used for medicinal purposes (e.g. Hailu & Yohannes 2006).

Anthropologists such as Posey (1985) and scientists in the PLEC (People, Land Management and Environmental Change) network documented fascinating cases of how "forest farmers" in Latin America continuously manipulate vegetation. Pinedo-Vasquez *et al* (2000) report on how Amerindians in Amazonia produce, manage and conserve agricultural and natural biodiversity by systematically sowing or transplanting crop species in forest openings, selective cutting and enriching the forest areas with desired species of timber, medicinal plants and fruits. This is not purely "traditional" but rather an ongoing process of innovation and transformation that responds to changes in relative value of different plant species and in environmental and social conditions. Thus, the farmers continuously enrich biodiversity to suit their changing opportunities and needs.

PLEC was one of the few projects giving attention to farmer adaptation to environmental change through innovating with species diversity. PLEC worked with the concept of "agrodiversity": "the many ways in which farmers use the natural diversity in their environment for their livelihoods, including their choice of crops and animals but also their management of land, water and biota as a whole" (www.unu.edu/env/plec). Agrodiversity encompasses local knowledge, innovativeness and adaptation of ideas from whatever source, including introduced knowledge, as well as the diversity in local social organisation that supports biodiversity management.

An R&D support organisation that encourages such agrodiversity is LI-BIRD (Local Initiatives for Biodiversity, Research and Development), the non-governmental organisation (NGO) coordinating the PROLINNOVA (**PRO**moting **L**ocal **INNOVA**tion in ecologically oriented agriculture and natural resource management) network in Nepal. Among other things, it recognises and supports farmers' initiatives in domesticating medicinal plants (see Box 1).

Box 1: Domestication of wild plants in homegardens in Nepal

by Pratap Shreshta, LI-BIRD, Nepal

The mountainous areas of Nepal are rich in medicinal and aromatic plant species with huge economic potential for pharmaceutical and cosmetic use. These plants are most commonly found in forests and on other public land. In recent years, their sustainable use and conservation have become threatened by gradual destruction of the natural habitat and increased commercialisation. The few local people who have rich traditional knowledge about the habitats and uses of the

medicinal plants are the *vaidyas* (healers), who are professionally engaged in preparing local a*yurvedic* medicines to cure a wide range of illnesses. However, the traditional knowledge and practices for conserving medicinal plants are gradually being lost. Most *vaidyas* keep their knowledge and practices secret in order to protect their profession. In many cases, such knowledge dies with the person.

Jaya Bahadur Thapa and his wife Lal Kumari Thapa of Chaur village of Kaski District in western Nepal are *vaidyas* who continue the ancestral tradition of their families. Before marrying, Lal Kumari learned about medicinal plants while helping her father collect them from the forest. Now she works together with her husband, also a *vaidya*. Jaya Bahadur used to collect medicinal plants from the village forest to prepare medicines. Later, the couple started growing many of these plants in their homegarden to save time and secure supply. Initially, they were not sure if the medicinal plants found in the wild could be grown in their homegarden and still be used for making medicines. They closely observed the growth habits of the plants in the forest – their natural habitat – and started collecting seed and saplings. The couple planted them in different ways, applied different management practices and monitored their growth performance. The Thapas have now domesticated about 145 medicinal plants species in and around their homegarden.

They are members of the *Pratigya* Cooperative in Chaur. In 1997, the Cooperative started working with LI-BIRD, NARC (Nepal Agricultural Research Council) and Bioversity International on *in-situ* conservation of agricultural biodiversity. It invited the couple to help identify medicinal plants and record associated knowledge found in the village for the Community Biodiversity Registration Programme started by the biodiversity project. The Thapas helped identify and record 165 medicinal plant species found in homegardens, farmland and the village forest (Sthapit *et al* 2008).

With support from UNDP-GEF and the Norwegian Development Fund, the Cooperative also used the services of the Thapa couple as resource persons to disseminate information about medicinal plants to other local farmers and to visitors from other parts of the country. The couple takes part in the local Biodiversity and Agriculture Fairs organised annually and on special social occasions by community-based organisations and the local Chamber of Commerce to raise wider awareness about the value of indigenous medicinal plants and possibilities of domesticating them. The Thapa home has become a Knowledge Resource Centre for people, including schoolchildren, to learn about domestication and use of these plants.

Local farmers who now grow medicinal plants in their gardens have started earning money by selling the produce to the Thapa family. More people from outside the village know of the couple and come to them for *ayurvedic* medicines and treatment. Through the Cooperative, the project also helped the couple improve links with traders in medicinal plants. The demand for these plants has increased, as have sales and the couple's earnings.

The innovative work of Jaya Bahadur and Lal Kumari has contributed greatly to raising awareness and helping local people identify and use medicinal plants, and to promoting domestication and *in-situ* conservation of these plants in and outside their village. The couple freely shares its medicinal knowledge so as to keep such knowledge alive and in use for the benefit of more communities. The couple is passing the detailed knowledge about collection, cultivation, processing and use of medicinal plants to their son and daughter-in-law and is also willing to pass on such knowledge to other interested people (Sthapit *et al* 2008).

Despite heavy household chores, Lal Kumari takes special care in drying, storing and processing medicinal plants, and entertains visitors while sharing knowledge and information. Recognising her contribution in domesticating and popularising threatened plant species, LI-BIRD awarded her the "Innovative Women Farmers' Award for Conservation of Biodiversity" in 2007.

Recognising and building on women and men farmers' knowledge and innovation are effective for *in-situ* conservation of genetic resources. Social and economic incentives encourage the farmers to share their knowledge for wider community benefit. These holders of knowledge about genetic resources are prepared to forego their intellectual property rights, provided their contributions are adequately recognised, e.g. through awards and public recognition as resource persons. Development projects should use persons like Jaya Bahadur and Lal Kumari as change agents to promote local innovation in agricultural biodiversity management. This should be further supported by policies that recognise and reward local women and men innovators, and invest in them in research and development activities for sustainable management of genetic resources.

Visitors observing the Thapa couple's garden of domesticated medicinal plants in Nepal (Photo: LI-BIRD)

Mrs Lal Kumari Thapa with award received from LI-BIRD for her innovativeness in domesticating medicinal plants (Photo: Shashish Maharjan)

Local innovation in plant and animal breeding

Over the centuries, farmers have developed countless crop varieties and animal breeds to suit specific agroclimatic conditions and culinary purposes. But the point here is that farmers – especially those in more marginal areas – *continue* to develop new varieties and breeds, often without any direct support from R&D services or projects. Under pressure of population growth and/or changes in population structure (e.g. because of rural emigration), changes in environment and in access to natural resources, and sometimes massive interventions to promote "modern" diversity-poor agriculture, smallholders have shown amazing resilience in maintaining or even increasing their biodiversity innovation activities (see Box 2).

Box 2: Farmer innovation in developing site-appropriate barley varieties in Ethiopia

by Fetien Abay, Mekelle University, Ethiopia

In Tigray Region, a detailed scientific study (Fetien 2007) revealed how smallholders have, within recent years, deliberately developed locally adapted varieties of barley to suit changing conditions and local needs. Using single-plant and mass selection, sometimes in plots set aside for this purpose, farmers have developed new naked and hulled varieties of barley that local people and now also scientists recognise as being superior to cultivars recommended by formal plant breeders. Conventional breeding seeks a small number of "best" varieties for a region. It does not produce varieties acceptable to a wide range of farmers operating under very diverse, marginal and high-risk conditions. The farmer-developed varieties were found to be better able to tolerate stresses such as disease pressure, waterlogging and drought in the low-input farming systems in semiarid areas of Tigray. These varieties are in high demand for local food products, such as snacks made from roasted barley (*kollo*), that Tigray women have started to commercialise on their own initiative.

The local innovation process involves both men and women, as couples decide jointly on the number of varieties to grow, seed selection and plot allocation. Seed storage is the women's domain. Local sayings such as "no wife, no seed, no life" mirror the role of women in managing seed. In one case, the wife of a farmer breeder experimented with different barley varieties to find the best one for making good *injera* (Ethiopian pancake). She is also heavily involved in seed exchange with other villagers, who regard her household as a local seed bank.

Researchers from Mekelle University have been able to strengthen the existing IK and local innovation in plant breeding by engaging in participatory research with farmers and development agents. In seven districts of Tigray, village trials that include the farmer-developed barley varieties are being carried out under farmer management. This form of *in situ* conservation and innovation

to enhance local biodiversity was scaled up through a village-level workshop involving farmer breeders, development agents, scientists and local policymakers, who discussed experiences and challenges related to seed production and variety release.

The joint research led to scientists' appreciation of the valuable transformations that farmers continue to make in domesticated plants, building on generations of IK and innovation, and to wider acceptance of farmer-led R&D in agricultural biodiversity. Farmers' knowledge of genetic resources and their ongoing plant selection and breeding efforts have created a good germplasm base that, combined with scientists' knowledge and special breeding techniques, could lead to identification and co-development of valuable cultivars with wide potential for use in semiarid areas, also beyond Tigray.

Farmers visiting experiment by farmer-breeder Kahsay in Tigray, Ethiopia (Photo: Fetien Abay)

Tigray farmers characterising barley varieties (Photo: Fetien Abay)

Local innovation in socio-economic organisation for sustainable use of biodiversity

Although individual farmers exhibit outstanding innovativeness in managing and enhancing biodiversity, even these individuals generally acknowledge that their accomplishments grow out of past and present knowledge in the community. GAIA (2002) points out that most innovation at local level results from "a collective process over many generations which cannot be cut into separate pieces, and is generally not considered to be owned by any individual or even any community". The social and organisational context shapes the way that natural and agricultural species are valued and used. Many indigenous communities have developed and continue to adjust local institutions for protecting species useful for community survival. Without external support, they have created new institutions to be able to balance the development and biodiversity-conservation needs that they themselves have recognised. As examples, in northern Ethiopia within the lifetime of local informants, Saho-speaking communities on the Tigray escarpment changed "traditional" rules for the use of woody species (Yohannes & Waters-Bayer 2007) and Irob farmers developed new local regulations for managing cattle and bee fodder in the highly valued but threatened Sengade pasture (Mengistu 2003). This has occurred without "awareness-raising" or other forms of project-related intervention by outsiders, and still goes largely unseen by the mainstream development establishment – both state and bilateral development projects – in the area.

In some cases, however, state actors have indeed recognised local institutional innovation and/or community groups have lobbied state actors to provide protection and support so that the local initiatives can continue and prosper (see Box 3).

Box 3: Endogenous development of alternative uses and markets for Andean roots

by *Edson Gandarillas, Victor Iriarte and Franz Terrazas, PROINPA, Bolivia*

Two women's associations in San Juan de la Miel (Coroico Municipality, Department of La Paz) developed alternative uses and markets for Andean root crops. They re-assessed the traditional uses of the roots, added value to them to suit the current market, linked with the municipal government and researchers, and developed association rules for marketing the new products.

San Juan de la Miel is characterised by a rich diversity of Andean roots and tubers, e.g. *racacha* (*Arracacia xanthorriza*), *yacon* (*Smallanthus sonchifolia*), *achira* (*Canna edulis*), *walusa* (*Xanthonoma* sp), *ajipa* (*Pachirrisus ahipa*) and *jamachepeque* (*Maranta arundifolia*). Some of these are cultivated for food, e.g. soups, *phuti* made from *walusa* cooked in water with salt, "spicy" from *racacha* with hot sauce, and sponge cakes (sweet bread) made with *jamachepeque* starch. Others grow wild, and some had not been used as food. An "alternative development" project had promoted cultivation of bananas, coffee, pineapple, pepper and citrus to replace production of coca for drug trafficking. Cropping areas expanded and farmers had new sources of income. After the project ended, the new crops disappeared, but the genetic diversity of native root crops had been eroded and the local diets changed.

Realising this, the women of San Juan de la Miel organised themselves to promote the use of traditional roots, especially as food. They asked Coroico Municipality for funding support to enhance local biodiversity and tourism. They documented their botanical knowledge of roots, set up varietal gardens on municipal land, organised biodiversity fairs and assessed their work yearly. Until then, the women had sold the roots raw and cooked them only for home use but, at the fairs in Coroico, they saw that tourists appreciated the culinary qualities of the traditional foods prepared from the roots. Recognising the commercial potential, the women – together with the Coroico Municipality – sought people involved in food research and processing to collaborate in adding value to the Andean roots.

The women's associations contacted PROINPA (Promotion and Research of Andean Products), a foundation working on sustainable use of genetic resources, food sovereignty and linking agriculture to market. Working with PROINPA, the women deepened their knowledge about the roots, particularly about their nutritional value and potential uses for processing. They took advantage of the high starch digestibility (suitable for infants, elderly and the sick) and the elasticity and agglutinative properties of the roots to develop new products such as precooked flakes, flours, purées and starches.

These new products offered opportunities but also created new challenges in marketing. The women's associations had procedures for selling raw roots, but now they had to a) produce with high quality, b) keep to industrial standards, c) agree on profit distribution, and d) establish business relations for selling in Coroico Municipality and La Paz city. The women drew up new regulations to deal with these challenges. This required organisational change and developing new knowledge, attitudes and skills. To ensure that rural families could access the new markets, changes were also needed in policies and regulations of the municipal government and the entities responsible for the farmer markets in La Paz.

PROINPA accompanied the associations through these changes, using a knowledge-management approach based on what the women knew and "learned by doing" while selling their products in Coroico and La Paz. The women gained more income from selling a greater variety and better quality of fresh roots, as well as processed products. The Coroico Municipality played an important role in supporting the women's initiative by providing funds, allocating sites for varietal gardens and marketing, and institutionalising the diversity fairs.

Women were empowered in their municipality, associations and families. In the words of Ms Alejandra Ramos from Incapampa Community: "*The money earned has been used for women to be considered by the husbands as an important pillar of the family. Before, we were subjugated to the husband's decisions. Now women are recognised in decision-making. This achievement suggests we must conserve the roots, gain more knowledge about them and find new partners to enhance our alimentation, families and association.*"

Sra Josefa Ramos marketing Andean roots (Photo: PROINPA)

Biodiversity market in La Paz, Bolivia (Photo: PROINPA)

Policy implications

Local women and men are innovating in biodiversity management and enrichment on their own initiative, according to their own needs and priorities. R&D to conserve and further develop agricultural biodiversity in a sustainable way will be more effective if it recognises this innovativeness and seeks ways to build upon it, deliberately seeking to integrate with these local initiatives. This will also strengthen local capacities to adapt more quickly to changing conditions. Specific lessons for policy that can be drawn from analysing the above cases are:

- Scientists and development practitioners need to be more aware of local people's creativity and innovation in managing genetic resources and in developing local institutions to govern their management. They need to look beyond traditional knowledge about genetic resources and recognise the *dynamics* of local experimentation and innovation in managing biodiversity.
- Not only men but also women farmers are engaged in innovation for conservation and sustainable use of agricultural biodiversity. It is therefore important to ensure that genetic resource policies are gender sensitive and recognise and support women's role in biodiversity management.
- Recognition of the importance of local innovation in managing and making sustainable use of biodiversity is needed especially among local governments, which are well placed to promote these initiatives and fit them into local development strategies.
- Decentralised research set-ups are needed to allow attention to be given to crop and livestock species and varieties/breeds that are locally important to meet cultural needs and to suit site-specific agro-ecological conditions.
- Capacity building is needed to prepare numerous researchers, development agents and local administrators to recognise local innovation and to facilitate farmer-led processes of joint experimentation and learning. Only in widespread *decentralised* R&D can adequate attention be given to crop and animal species and varieties/breeds that are locally important to meet cultural needs and to suit site-specific agro-ecological conditions.
- Imposing ownership (intellectual property rights) on innovation processes related to biodiversity could undermine these processes.

- An enabling policy environment is crucial to strengthen endogenous innovation and to stimulate participatory research involving local biodiversity innovators. This is in line with the Convention on Biological Diversity (CBD), which provides for protection of indigenous peoples' knowledge, innovations and practices; and ensuring equitable sharing of benefits arising from their use. The CBD states that protecting ecosystems and natural habitats is important to support local innovation in domesticating biological resources for livelihoods. Likewise, the International Treaty on Plant Genetic Resources for Food and Agriculture ("IT") supports Farmers' Rights to continue to maintain and develop crop genetic diversity and to be rewarded for this contribution to the global genetic pool. Farmers' Rights comprise, among other things, participation in relevant decision-making and rights to save, use, exchange and sell farm-saved seed.
    - This paper argues that Farmers' Rights to decision-making should include their rights to decide about the research agenda related to agriculture and NRM. Realisation of this right would help institutionalise a participatory local-innovation approach to developing genetic diversity in crops and livestock.
    - This paper shows that farmers not only conserve seed but also *develop* improved seed for local conditions – something that is often overlooked.
    - The IT calls for the promotion of farmer participatory plant breeding activities, which requires review and adjustment of breeding strategies and regulations concerning variety release. Still, however, farmer-relevant traits and highly preferred varieties may not be certified because farmer-developed varieties are not recognised in national seed legislation systems. This adjustment would increase the efficiency of plant breeding for the benefit of resource-poor and marginalised farmers.
- The IT and CBD require member countries to formulate national policies that support and provide incentives to local innovation in conservation and sustainable utilisation of biodiversity. This paper provides examples of how such policies can be implemented.

Practical implications for development cooperation

Few of the local innovators in biodiversity management are recognised by outsiders, although they are usually known locally by other farmers. Development projects for conserving and managing agricultural biodiversity should deliberately seek such persons or groups, who can be driving forces behind cooperation with local people. Based on experience of PROLINNOVA and similar initiatives, here are some tips for development facilitators concerned with conservation and management of agricultural biodiversity:

- At the outset of cooperation, systematically identify innovations and initiatives of local men and women in the realm of agricultural biodiversity and seek to understand how they are deliberately managing genetic resources in the face of change. Together with these and other local stakeholders, assess the merits and demerits of these innovations, and agree on activities needed to support the ones regarded as successful in improving local livelihoods.
- As a first step in planning local-level farmer-led research and development activities, find out from local men and women farmers what questions they are interested in exploring, who in the locality has already tried to explore these questions and what others in the locality think of the results, including what deeper-going questions the farmers have about these innovations. Then plan a joint experimentation process to work on these specific issues.
- Create opportunities to include local biodiversity innovators – both women and men, or couples who work together – as resource persons in project activities, e.g. inviting them to workshops, organising visits of other farmers and encouraging the formation of small common-interest groups around the local innovators to jointly plan and implement R&D activities. These should not be limited to plant- or animal-based activities but should include also capacity strengthening to influence policy in favour of genetic enrichment by local individuals and groups.
- Offer locally appropriate forms of rewards and encouragement – in terms of both recognition and socio-economic benefits – to encourage farmers to innovate for sustainable management

of biodiversity. Such incentives could include: public awards, recognising and using local innovators as resource persons, protecting farmers' rights to their (dynamic!) knowledge and genetic resources, ensuring mechanisms for access to and sharing benefits from their genetic resources, and recognising the plant varieties and animal breeds that have been and are being developed by farmers.

- Monitor not only the changes in management practices or uses of biodiversity foreseen in the project document but also other practices and uses developed by exceptional ("deviant") local individuals and groups in the area.
- Help local people document their innovations in biodiversity management and make them more widely known beyond the locality.
- Support farmer groups in organising biodiversity innovation fairs as a way to share their knowledge and achievements. Such fairs offer good occasions for awarding local innovators. They make the general public more aware of and interested in the wealth of biodiversity in rural communities and can generate public support for biodiversity-related initiatives. The fairs can also attract tourists and thus contribute to local income and development.
- It is especially important that younger people and extensionists learn to value local biodiversity knowledge and initiatives. Some plants that are becoming extinct in the wild can only be found in the backyards of outstanding local botanists. Schoolchildren and young farmers and extension agents should "go to school" in these backyards, so that the local botanists' knowledge about and enthusiasm for biodiversity can become infectious. Such activities can be linked to school science programmes and environment clubs.

Partnerships of different stakeholders – such as, in the Bolivian case, women's associations, local administrators, researchers and food processors – can enhance local innovation processes to generate sustainable uses of biodiversity. Multistakeholder partnerships to deepen knowledge about the local genetic resources are essential to make full use of their properties and reveal opportunities to add value to the local biodiversity.

Farmers involved in such partnerships can incorporate scientific knowledge and new genetic material into their local resource-use systems. The farmers develop self-esteem and skills in public communication and can then play a stronger role in community learning and development activities. This is especially so when women innovators are given public recognition. The interaction of support organisations with local biodiversity experts builds their capacities to engage in dialogue also with other stakeholders in R&D. The farmers thus become better able to play decisive roles in influencing the R&D agenda at higher levels in their country and globally.

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Case studies from Africa, Asia and Latin America, examining significance of local knowledge and role of farmers and local communities in managing crop genetic diversity.

Brookfield H. 2001. *Exploring agrodiversity*. New York: Columbia University Press. 348pp.
Analyses the world's agricultural diversity, using case studies of small-scale farming in Africa, Asia, Latin America and the Pacific. Subjects include: crop biodiversity, classification and history of agrodiversity, diversity within rotational land-use systems, agricultural change and the causes of transformation, and the future of agrodiversity. Stresses that the adaptive dynamism of agrodiversity is its most essential property for survival, but it would survive more securely with stronger public backing.

Brookfield H, Padoch C, Parsons H & Stocking M (eds). 2002. *Cultivating biodiversity: understanding, analysing and using agrodiversity.* London: Intermediate Technology Publications / United Nations University. 224pp.
From United Nations University project on People, Land Management and Environmental Change

(PLEC); focuses on skills of smallholders in cultivation, NRM and maintaining their livelihoods in difficult circumstances, drawing on experience of farmers working with scientists in 12 countries. Claims that smallholder farmers have conserved and created more biological diversity and more economically important species than all protected areas combined.

Brookfield H, Parsons H & Brookfield M (eds). 2003. *Agrodiversity: learning from farmers across the world.* Tokyo: United Nations University Press / UNEP / GEF. 343pp.
Summarises PLEC's work in identifying, evaluating and promoting smallholders' resource-management systems and practices in conserving biodiversity to generate income and cope with changes in social and natural conditions. Shows how farmers use their knowledge and expertise to manage biodiversity and other environmental resources efficiently. Gives evidence of how the project succeeded in changing scientists' perceptions of farmers' knowledge, experimentation and innovation and in raising farmers' self-esteem and pride in resource conservation.

Fetien Abay. 2007. *Diversity, adaptation and GxE interaction of barley (Hordeum vulgare L) genotypes in northern Ethiopia.* PhD thesis, Norwegian University of Life Sciences, Ås. 260pp.
Doctoral thesis on identifying and developing barley varieties suitable for semiarid conditions in Tigray Region, working with innovative and experimenting farmers who breed and select varieties for stable yields and to suit local tastes. In farmer-managed trials, the performance of four "modern" varieties, two farmer-developed varieties (FDVs) and three rare landraces were compared. FDVs proved to be superior and preferred by other farmers under the harsh conditions of erratic rainfall with alternating drought and waterlogging. Shows importance of involving farmers and their innovations in trials that can lead to a client-oriented breeding programme in barley.

Fetien Abay & Bjørnstad, Å. 2008. Participatory varietal selection of barley in the highlands of Tigray in northern Ethiopia. In: Thijssen MH, Bishaw Z, Beshir A & de Boef WS (eds), *Farmers, seeds and varieties: supporting informal seed supply in Ethiopia* (Wageningen: Wageningen International), pp56–85.
Shorter version of the above.

Fetien Abay, Waters-Bayer A & Bjørnstad Å. 2008. Farmers' seed management and innovation in varietal selection: implications for barley breeding in Tigray, northern Ethiopia. *Ambio* 37 (4): 312–320.
Describes how small-scale farmers in northern Ethiopia select and develop locally adapted varieties of barley, including how women are involved in managing crop diversity, above all, in seed management. Local farmers have developed varieties for variable environments in terms of rainfall and soil conditions. Diversity in the local barley varieties was found to be significantly related to a number of selection criteria expressed by both men and women in the farming communities.

GAIA. 2002. Biodiversity for sale: dismantling the hype about benefit sharing. *Global Trade and Biodiversity in Conflict* 4: 1–20.
Briefing note that questions whether local communities are deriving their equitable share of benefits from the use of genetic resources, because a commercial approach has taken precedence over benefit sharing in a broad and integrated sense. Argues for taking into account the intrinsic value of biodiversity for local livelihoods and the multiple benefits derived from its use at local level, rather than turning biodiversity and associated local knowledge into commodities. Calls for strong community rights that recognise the collective nature of local innovation and that promote its development and application.

Gyasi EA, Kranjac-Berisavljevic G, Blay ET & Oduro W (eds). 2004. *Managing agrodiversity the traditional way: lessons from West Africa in sustainable use of biodiversity and related natural resources.* Tokyo: United Nations University Press. 320pp.
Collection of case studies based on multidisciplinary PLEC work in Ghana and, to a lesser extent, Guinea, looking into how farmers conserve and cultivate biodiversity while using the land to produce food. Shows how participatory research and development can contribute to sustaining agrodiversity for rural livelihoods in risky, unstable and diverse environments.

Gupta A. 2003. Farmers as plant breeders: three cases from India. In: CIP-UPWARD (ed), *Conservation and sustainable use of agricultural biodiversity: a sourcebook.* Los Banos: International Potato Center – Users' Perspectives with Agricultural Research and Development, pp 332–336.
Presents examples of how farmers develop new crop varieties through their own selection and crossing procedures. Innovative farmer-breeders have a unique ability to observe distinctions between plants, i.e.

they have “an eye for detail, diversity and deviance”. However, they are usually not the main focus of researchers engaged in “participatory” plant breeding.

Hailu Araya & Yohannes GebreMichael. 2006. Local and "modern" innovations: what interests whom? *LEISA Magazine* 22 (3): pp 28–29.
Describes how farmers and other actors in agricultural research and development perceive locally developed and introduced technologies differently. Brings, among others, case of farmer innovativeness in domesticating wild bee species to produce honey used in human medicine.

Jarvis DI, Padoch C & Cooper HD (eds). 2007. *Managing biodiversity in agricultural ecosystems.* New York: Columbia University Press. 492pp.
Looks at how farmers manage, maintain and benefit from biodiversity in agricultural systems. Includes papers on maintaining local diversity at genetic, species and ecosystem level; farmers’ practices of managing crop, animal, aquatic and associated diversity (e.g. soil micro-organisms) in agricultural ecosystems; and innovation by smallholders in response to environmental and economic change. Numerous case studies show how farmers have managed biodiversity to enhance the stability, resilience and productivity of their farms.

Kaihura FBS & Stocking MA (eds). 2003. *Agricultural biodiversity in smallholder farms in East Africa.* Tokyo: United Nations University Press / UNEP / GEF. 245pp.
Collection of papers from a PLEC conference. Shows how farmers’ management of agricultural biodiversity is integrated with local ecosystems and livelihoods, and is site- and household-specific, so cannot simply be copied elsewhere using the conventional “transfer of technology” approach. Gives examples of how PLEC promoted successful local “agrodiverse” practices through a ‘farmers-learning-from-farmers approach. Also scientists learned from farmers and found entry points for improvements on existing resource management systems. Includes chapters either inspired by or actually written by farmers. Closes with policy recommendations so that the work on agrodiversity can benefit more farmers.

Kaihura FBS. 2003. Participatory technology development and dissemination: a methodology to capture the farmers’ perspectives. In: Kaihura FBS & Stocking MA (eds). *Agricultural biodiversity in smallholder farms in East Africa.* (Tokyo: United Nations University Press / UNEP / GEF), pp159–170.
About development of a methodology of working with farmers and building on local practices in managing agricultural biodiversity in order to improve them jointly.

Mengistu Hailu. 2003. *The soil makers: analysis of local socio-technical innovations and transformation of Irobland farmers, northeast Ethiopia.* MSc thesis, Wageningen University. 106pp.
Brings case of farmers of the Irob ethnic group in Tigray Region who have developed technical and institutional innovations to improve their livelihoods at the same time as conserving the natural resources on which their livelihoods depend.

Montecinos C & Altieri M. 1992. Grassroots conservation efforts in Latin America. In Cooper D, Vellvé R & Hobbelink H (eds), *Growing diversity: genetic resources and local food security* (London: Intermediate Technology Publications), pp 106–115.
Because the breeding and conservation efforts in the formal sector have done little to address small-scale farmers’ needs for sustainable production systems, various grassroots approaches to maintaining and using local genetic resources have arisen. The farmers’ own efforts aim at keeping open as many options as possible to meet different goals and needs in heterogeneous environments. Public recognition, diplomas and farm tools are given by supporting NGOs to encourage farmers to maintain biodiversity.

Pinedo-Vasquez M, Padoch C, McGrath D & Ximenes T. 2000. Biodiversity as a product of smallholders’ strategies for overcoming changes in their natural and social landscape. *PLEC News and Views* 15: 9–18.
Description of how forest farmers in Amazonia produce, manage and conserve biodiversity, by developing and adapting innovative management technologies to correspond to specific environmental conditions and in response to changes in the value of forest and fallow products.

Posey DA. 1985. Indigenous management of tropical forest ecosystems: the case of the Kayapó Indians of the Brazilian Amazon. *Agroforestry Systems* 3: 139–158.
Study of forest management in Brazil's Amazon Basin by Kayapó Indians, who semi-domesticated different species though long-term transplanting and selection. Indigenous knowledge of subtle

similarities between conceptually distinct ecological units allowed for interchange of botanical material between microclimates to increase biological diversity in areas managed by the Indians. Agues that this knowledge is extremely important in developing new strategies for forest and savanna conservation, while improving the productiveness of these ecological systems.

Posey DA (ed). 2000. *Cultural and spiritual values of biodiversity*. London: Intermediate Technology Publications / Nairobi: United Nations Environment Programme. 731pp.
Collection of papers on the link between culture and nature, highlighting indigenous peoples' science in health, agriculture and NRM, including conservation of genetic diversity through maintaining a mosaic of cultural, spiritual and social diversity. Brings examples of how local people have developed their own ways to conserve biodiversity in a wide range of environments and social conditions. Book arose out of Global Biodiversity Assessment (GBA), a review of current knowledge in biodiversity, commissioned by the United Nations Environmental Programme (UNEP).

Prain G, Fujisaka S & Warren MD (eds). 1999. *Biological and cultural diversity: the role of indigenous agricultural experimentation in development.* London: Intermediate Technology Publications. 218pp.
Examines the role of small-scale farmers' experimentation – both informal and on-farm participatory research – in fostering biodiversity and the cultural knowledge about it, combining the farmers' concerns for both production and conservation. The case studies from Africa, Asia-Pacific, Latin America, Europe and Australia illustrate the farmers' intimate local environmental knowledge, the site-specific nature of their experimentation, and the close links between biological and cultural diversity.

Rerkasem K. 2001. Farmers' management of fallow succession in Thailand. In: United Nations University, Secretariat of the Convention on Biological Diversity & International Plant Genetic Resources Institute (organisers). *Proceedings of International Symposium on Managing Biodiversity in Agricultural Ecosystems*, Montreal, 8–10 November 2001. 10pp.
Shows how upland farmers are finding ways to overcome problems of declining yields in subsistence crops and increasing demand to use land for other purposes; focuses on farmer innovation in managing biodiversity in plant succession on shorter fallows, deliberately using local pioneer tree species. Argues that understanding the scientific process behind farmers' management of local species is key to co-development of sustainable land management in shifting-cultivation systems in the region.

Rhoades RE & Nazarea VD. 1998. Local management of biodiversity in traditional agroecosystems: a neglected resource. In: Collins WW & Qualset CO (eds), *Biodiversity in Agroecosystems* (Boca Raton: Lewis / CRC Press), pp 215–236.
Deals with not only IK but also local experimentation and innovation in managing biodiversity. Stresses how farmers' strategies to preserve biodiversity are often embedded in community action. Points out that a key difference between formal and informal breeding is that scientists tend to narrow the genetic alternatives in search of yield and disease or climatic resistance, while marginal subsistence farmers tend to broaden their choices by seeking more diverse varieties to suit their overall needs.

Richards P. 1985. *Indigenous agricultural revolution: ecology and food crops in West Africa.* London: Hutchinson. 192pp.
Based on many years of ethnographic studies of small-scale rice farming in Sierra Leone. Claims that formal agricultural research failed to recognise the dynamism of farmers' practices: how the farmers innovate on the basis of their detailed agro-ecological knowledge. Advocates participatory approach in which research scientists support rather than supplant farmers' own initiatives in experimentation.

Sthapit B, Thapa A & Subedi A. 2008. One women's quest to raise the profile of wild medicinal plants. *Geneflow* (Rome: Bioversity International), p33.
An article in *Geneflow*'08 feature section on women and agricultural biodiversity that tells more of the story of the Nepalese *vaidya* Lal Kumari Thapa, who has domesticated a large number of medicinal plants (see Box 1).

Wettasinha C, Wongtschowski M & Waters-Bayer A (eds), *Recognising local innovation: experience of PROLINNOVA partners.* Silang, Cavite, the Philippines: International Institute of rural Reconstruction / Leusden: PROLINNOVA International Secretariat, ETC EcoCulture. 66pp.
Compilation of experiences in recognising and promoting farmer-led innovation processes in Africa and Asia, including cases on documenting local innovation and initial activities involving joint experimentation by farmers, extension agents and research scientists.

Yohannes GebreMichael & Waters-Bayer A. 2007. Trees are our backbone: integrating environmental and local development in Tigray Region of Ethiopia. Drylands Programme Issue Paper 145. London: International Institute for Environment and Development. 36pp
Compares government policies and practices to promote rural development and environmental protection with endogenous efforts to address the same issues. Brings cases of good local practices and adaptations in productive environmental management and extracts lessons to guide environmental policy.

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Institutional affiliation of the contributors:

Fetien Abay, Mekelle University, Mekelle, Tigray Region, Ethiopia (fetien.abay@yahoo.com)

Edson Gandarillas, Victor Iriarte and ***Franz Terrazas***, PROINPA (Promoción e Investigación de Productors Andinos / Promotion of and Research into Andean Products), Cochabamba, Bolivia (eg.gandarillas@proinpa.org)

Pratap Shrestha, LI-BIRD (Local Initiatives for Biodiversity, Research and Development), Pokhara, Nepal (pshrestha@libird.org)

Ann Waters-Bayer & ***Mariana Wongtschowski***, PROLINNOVA International Support Team, ETC EcoCulture, Leusden, Netherlands (ann.waters-bayer@etcnl.nl / m.wongts@etcnl.nl)

List of acronyms

CBD	Convention on Biological Diversity
FDV	farmer-developed variety
GEF	Global Environmental Facility
IK	indigenous knowledge
IT	International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGFA)
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
NGO	non-governmental organisation
NRM	natural resource management
PLEC	People, Land Management and Environmental Change
PROINPA	Promoción e Investigación de Productors Andinos / Promotion of and Research into Andean Products
PROLINNOVA	Promoting Local Innovation in ecologically oriented agriculture and NRM
R&D	research and development
UNDP	United Nations Development Programme