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# Sustaining Livelihoods through Animal Genetic Resources Conservation

Almost two billion people rely on livestock to supply part or all of their daily needs. Livestock forms a component of the livelihoods of at least 70% of the world's rural poor including millions of pastoralists and graziers, mixed farmers and landless livestock keepers. In Africa, Asia and Latin America, the poor and the landless derive a higher proportion of household income from livestock sources than do other households.

The complex, diverse, and risk-prone peasant livelihood systems of the poor living in marginal areas, and the marginalized living from scarce resources in higher potential areas, require animal genetic resources (AnGR) that are tolerant to harsh conditions, resistant to disease, productive and diverse.

Access by the poor to genetic resources is often limited by various social and cultural factors. Genetic erosion is also threatening the livelihoods of the poor by restricting their access to appropriate AnGR. By taking a sustainable livelihoods approach (SLA) to evaluate the importance of AnGR for the poor, it is possible to identify entry points and interventions to reducing poverty through AnGR management.

## Livestock Keeping as a Livelihood

Animals kept by people for agricultural purposes— livestock—are considered as livelihood assets, and the keeping of livestock is part of the livelihood activity of the household. There are four main livestock keeping systems:

- full-time livestock keepers who depend primarily on livestock for their livelihoods (they may be nomadic, sedentary or transhumant);
- livestock-keepers who do some cropping but livestock remain their main means of living (may be transhumant or settled);
- crop farmers who also keep animals and usually stay in one place all year round; and
- the landless who keep some livestock often as a subsidiary activity and live on the edge of villages, towns or cities.

Women livestock keepers often fall into the small stock keeper or the landless livestock keeper categories depending upon their land endowment and right of use within the household.

Livestock keeping:

- provides cash income from sales of animals, their products, and/or their services;
- provides buffer stocks when other activities do not provide the returns required;
- provides inputs and services for crop production;
- captures benefits from common property rights, e.g., nutrients transfer through foraging on common land and manure used on private crop land;
- is used to provide transport, fuel, food and fiber for the household; and
- fulfils social and cultural functions through livestock ownership.

For poor households, the non-income functions of livestock keeping are particularly important. These functions or benefits include savings, buffering, and insurance. For example in southeast Mexico, the main function of backyard pig keeping was found to be as a convertible asset available and easily traded to make payments for health care, schooling, food and other household requirements.

Productivity improvements may be important for some types of livestock keepers and a suitable objective in changing livelihood strategies of some rural people, but many situations will require a balance between productivity improvement and the need for secure savings and insurance, and other livelihood functions.

## Animal Genetic Resources and the Livelihoods of the Poor

The sustainable livelihoods approach can be used to analyze the well-being objectives that people aspire to, the resources or assets they have access to, and the way in which they use those assets to achieve their objectives. Key to the approach is an understanding of the way in which institutions, both formal (government, laws, markets) and informal (culture, kinship etc.), shape people's access to resources.

Factors that affect the ways these functions are fulfilled include:

- differences between species, breeds, and individual animals;
- narrowed genetic base due to genetic selection;
- change in environments, and livestock owners' purposes for livestock keeping; and
- new demands for AnGR suitable to agroecological and livelihood-oriented production systems.

**AnGR and contributions of livestock to the livelihoods of the poor**

| Contribution | Factors that differentiate between breeds |
|---|---|
| Regular cash income from animals or their products | Consumer preferences may favor or reject products from certain breeds. sales of Intermediaries will offer different prices for products and animals of different breeds. |
| Regular cash income from sales or use of animals | Certain uses met by breeds with desired characteristics (size, power, docility) and adaptation to environment (heat tolerance, walking ability, water requirements). |
| Buffer stocks | Survivability is important; also disease resistance and climatic tolerance; reproductive rate for accumulation of assets. |
| Inputs and services to crop production | Certain services best provided by breeds with required characteristics (size, power, docility), and adapted to environment (heat tolerance, walking ability, water requirements). |
| Capture of benefits from CPRs | Adapted to environment and behavioral characteristics (heat tolerance, walking ability, water requirements, foraging and scavenging ability). |
| Transport, fuel, food, fiber for keepers | Productivity capacity and reproductive rate. Social and cultural functions that provide status and identity. Appearance traits important (hide and skin color, horn size and shape, confirmation, etc.). |

Many of the animal genetic resources most important to the poor are not improved breeds, but local breeds that still have important adaptation traits to unfavorable environments and that are able to thrive on low external input-type management.

## Natural Capital Assets

Animal genetic resources are part of the natural capital assets of poor rural families. Access to these resources is crucial to many of their natural resource management activities, and hence their livelihood strategies. Access to appropriate AnGR resources in many cases had been negatively affected by the intense selection for desired traits, market demand and policies.

## Institutions and Social Relations

Formal and informal social institutions provide the socioeconomic context within which livelihood activities are carried out. The processes and structures of these institutions can largely influence access and use of animal genetic resources.

## Trends in External Factors

Trends in population demographics and location, e.g., urbanization, also technological changes in agroecosystems and marketing systems, can negatively affect AnGR. Commercial production systems tend towards uniformity of inputs, resources, and outputs, while livelihood-oriented systems thrive on diversity.

## Shocks

Sudden changes in climatic conditions (droughts, floods), the impact of wars and social unrest, and the advent of new or sporadic diseases and epidemics could mean the loss of AnGR that are low in number. Poor families are less able to respond to these types of shocks.

## AnGR Conservation for Sustainable Livelihoods

AnGR conservation aimed at sustaining livelihoods needs a holistic approach to breed attributes that recognize the array of contributions livestock make to livelihoods and the breed characteristics related to these.

'Local' breeds often have advantages in that they fulfill nonincome and socio-cultural needs as a result of selection for adaptive and appearance traits. Breeds that have been subjected to genetic selection for productivity traits— 'improved' breeds—generally improve their performance with increasing management levels. Crossbreds ('local' with 'improved') may express a combination of traits (adaptive and productive), and may or may not conform with local peoples' requirements for traits related to socio-cultural functions. Hence, the importance of local breeds as AnGR is not only their ability to fulfill livelihood functions, but also their genetic contribution to adaptive and other traits to crossbred animals.

From a livelihoods perspective, identifying and addressing the AnGR requirements of poor livestock keepers are important. This is best done through community-based AnGR management.

## Ranking Trait Expressions of Livestock Breeds

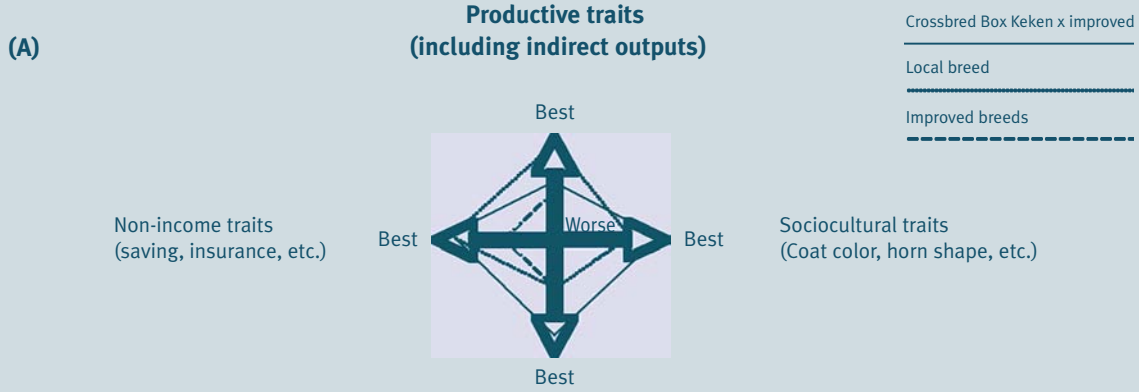
To make rational decisions that take a holistic account of livelihood functions, breeds could be compared using ranking (best to worst) of trait expression in common environments. Four general criteria can be identified—productive traits (PT), adaptive traits (AT), sociocultural traits (ST), and non-income traits (NT). As the sum of rankings for PT + AT traits increases, the importance of genetic conservation for future use in different livestock production systems also increases. As the sum of rankings for ST + NT traits increases the importance of genetic conservation for socio-economic and cultural reasons increases. By plotting the sum of rankings on a kite diagram with PT and AT on the vertical axis and ST and NT on the horizontal axis, the relative merits of breeds for conservation may be compared. Rankings can be elicited from different types of livestock keepers who may keep the breeds under different conditions. In this way, AnGR conservation needs can be differentiated for poor, not so poor, and better-off livestock keepers. As an example, the figures present a comparison of local, crossbred, and improved pig breeds from the perspectives of keepers who keep pigs for livelihood and semicommercial functions in southeast Mexico.

It is important to note that for the PT, AT, and NT traits the genetic basis of the same phenotypic traits ranked under different environments is not necessarily the same. For example, live weight gain in chickens, a PT trait, will be dependent upon different combinations of genes for its expression under a scavenging system where birds have to look for their own diets and under an intensive system where a balanced high protein diet is provided. Hence, comparisons are only possible under the same environmental conditions.

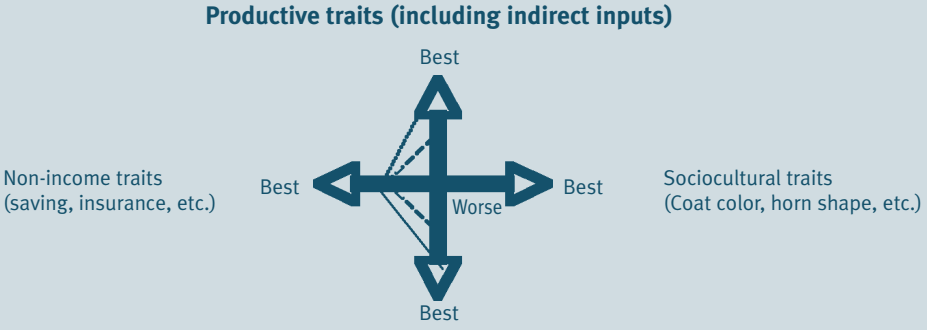
However, different livestock keepers apply different husbandry hence their requirements for AnGR are different.

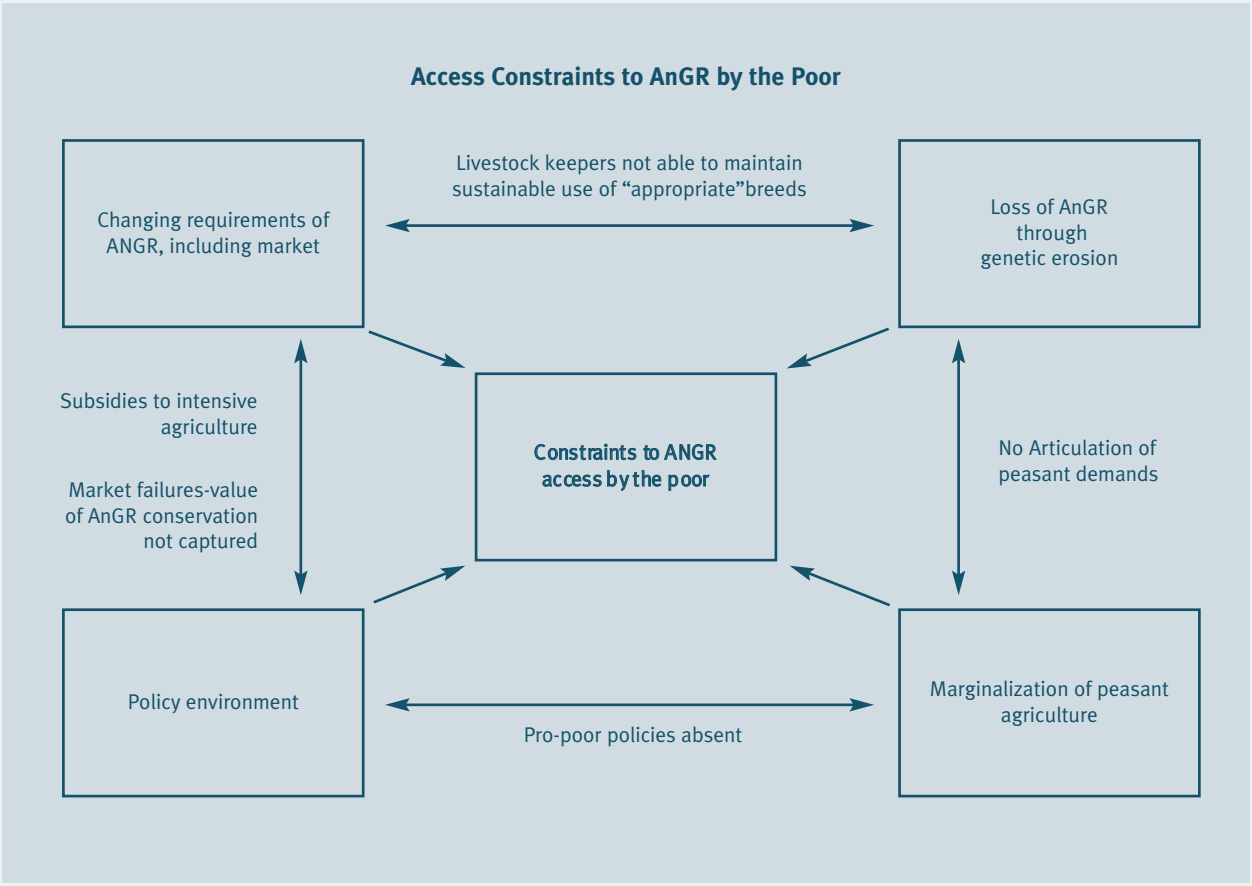
**A comparison of three pig types in southeast Mexico for (A) livelihood functions and (B) semi-commercial functions**

**(A)**




**(B)**






A livelihoods approach to AnGR management and conservation requires working directly with the poor to understand the complex interactions between AnGR and poverty, and to maintain or enhance the AnGR assets available to them. Central to this approach is the need to understand the functions of livestock as household assets, the purposes in investing resources in livestock keeping (income, non-income and sociocultural purposes), and the genetic traits that are important for meeting these purposes. AnGR conservation from a livelihoods perspective therefore should address the maintenance and enhancement of AnGR best suited to the livelihoods of the poor, and to ensuring equitable access to these resources.

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# Neglected species, livelihoods and biodiversity in difficult areas: how should the public sector respond?

**by Roger Blench**

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*Recent research on neglected crop and animal species suggests that there exists an important gap between the priorities of development and research agencies and the way small farmers, both in Africa and elsewhere in the world, treat such species. This paper argues that policies to promote neglected species will have positive effects on biodiversity and livelihoods, especially in more difficult areas where conjunctive management of common pool and private resources remains important.*

## Policy conclusions

- Neglected crops and livestock species are more important in their contribution to biodiversity and the livelihoods of the poor in difficult areas than widely believed hitherto. They merit more public sector attention than they have received.
- Such attention includes the comprehensive characterisation of varieties and species in these areas, such as the types of vegetation consumed by neglected livestock species, the agroecological niches occupied by plant types which are either little known or regarded elsewhere as weeds, and various economic characteristics of plants and livestock, including pest and disease resistance, their nutritional properties, labour requirements, complementarity with other varieties/species, and so on.
- The `niche' features of many such livestock species and plant varieties may mean that public resources cannot be allocated to in-depth research on them. However, it may be possible to promote farmer-to-farmer exchanges of materials and approaches, supporting these through the scientific information available.
- There is considerable potential for reshaping farming systems research towards more convincing descriptions of crop and livestock repertoires, thereby gaining a more accurate appreciation of the economic significance of minor species and their potential in niche markets.
- Characterising minor species with greater clarity also contributes to food security by making possible a more coherent understanding of diet in periods of nutritional stress and thereby informing the responses of agencies dealing with emergencies.

## Introduction

The study of `lost' or `minor' crops and livestock species is fraught with linguistic pitfalls; these species are no more `lost' or `minor' to the people who use them than Victoria Falls were `discovered' from the viewpoint of those who lived next to them. The usual meaning is that they have been neglected by Western-based research or that world production statistics are either not published or indicate low volumes compared to better-known crop or livestock species.

Two recent reviews (NAS [National Academy of Sciences], 1996 and Blench, in press) for crops and livestock respectively, suggest that at least in the case of Africa, there are wide disparities in the quantity and quality of research on many species. Moreover, neither their production economics nor their contribution to smallholder subsistence have usually been criteria for funding research, despite the supposed emphasis on food security or livelihoods. The International Livestock Centre for Africa (ILCA) famously discouraged research on camels, donkeys, pigs, rodents and indigenous avians in Africa, despite its apparent remit for the livestock of the continent. Other NAS publications on neglected Asian livestock and microlivestock suggest a similar pattern elsewhere in the world.

It is becoming increasingly clear that farmers make use of a much wider range of plants and animals than is

encompassed in standard lists of crops and livestock and that these may not be domesticated in textbook fashion. Recent research, especially in Australia and the African rainforest, has emphasised that it is not necessary to be a farmer to manage plants; in both regions yams are transplanted and pruned so as to improve both growth characteristics and accessibility. Similarly, pastoralists can manage non-domesticated animals, most notably the reindeer across the circumpolar regions of Eurasia. Adapting research and extension strategies to accommodate this expanded view of farming systems is a process that has hardly begun.

### The Pattern of Research

Despite the growth of participatory ideologies during the last decade, there has been very little increased emphasis on species of importance to smallholder farmers. It is ironic to note that much of the detailed descriptive work on such species dates from the colonial era. In the early period, descriptions grew out of Agricultural Officers' field experiences, but as professional agronomy took over, research agendas were increasingly set by the Western scientific system. The pattern of large-scale research tended to draw attention away from crops and animals of no perceived economic value outside their immediate area. The problem has been two-fold: a focus on fewer, better-known crops or species and an emphasis on higher-order issues whose relevance to the problems faced by farmers is not always clear.

Africa represents an elaborate mosaic of crop and livestock species and races produced using non-standard strategies. Weeds or weed hybrids symbiotic with cereals can be tolerated or even planted. Toxic yams can be cultivated to deter crop thieves. `Minor' livestock, such as the donkey, the land snail or the giant rat, can play a major role in the economic life of ordinary rural householders. They are, however, of no significant interest to major donor agencies and research is often confined to enthusiastic individuals. The first edition of *Useful Plants of West Tropical Africa* (1937) lists many species on the cultivation boundary; for the majority the bibliography has barely been extended. Early volumes of the journal Economic Botany are larded with `promising' tropical crops whose promise has never been realised. Despite encouraging texts on unconventional livestock (e.g. NAS, 1991), the volume of research remains small.

The sceptic's view of this might be that unconventional species are not further developed because they are in fact of limited value, i.e. they do not show the appropriate economic characteristics to expand onto the larger stage of international trade. However, this would be to ignore numerous other factors contributing to their neglect: the difficulties of maintaining research funding, the inaccessibility of the regions where these species are produced, culinary and nutritional conservatism and the powerful interests of large seed and veterinary companies who have actively discouraged biodiversity maintenance because of the higher costs of servicing a more diffuse market.

## Domestication, cultivation and taming

The process of domestication can be characterised as adapting the genetic makeup of a species to the needs of human society, a process often deleterious to the survival aptitudes of that species in the wild. Apart from the pig, the major species of domestic animal no longer have wild relatives in Europe and America and modern breeding systems tend to ensure that genetic introgression from such relatives is not a significant factor in variation. This is less true for plants, although where there is introgression from wild forms it is usually intentional. Geneticists use wild forms to breed for specific economic characteristics, rather than to maintain the diversity inherent in the larger gene pool.

Sheep, goats, chickens and pigs arrived in Africa fully domesticated and although local races have developed there is no further genetic interaction with their wild relatives. In contrast, domestication remains a dynamic process for indigenous African fauna, both in terms of interbreeding with wild populations and continuing experimentation with new species. The donkey was almost certainly domesticated in Africa and there is evidence for interbreeding with wild ass populations in historic times. With the probable elimination of the last Somali wild asses this process has come to an end. On the other hand, the guinea-fowl is part of the indigenous avifauna of Africa which has been only partly domesticated. In west-central Africa, guinea-fowl are kept in the compound, grow fat and have little tendency to fly away, but in eastern and southern Africa they are still caught in the wild.

Taming, on the other hand, implies temporarily adapting a wild species to human requirements without altering its

genetic makeup. The evolution of a social niche for pets may be a prelude to domestication, although cachet can attach to taming wild animals so that the taming process becomes an end in itself. The iconographic records of Ancient Egypt document a remarkable skill in controlling animals, especially birds. The Romans in North Africa are shown using trained cheetahs for hunting while hyena-taming is found across Sahelian Muslim Africa, usually as a type of circus act. Taming also implies some selection, as many animal species revert to wild behaviour patterns once adult. Evidence from the ethnographic literature suggests that experimentation continues in sub-Saharan Africa, and there are `new' domesticates, wild-caught animals initially `finished' in captivity such as the giant rat (*Cricetomys*), the grasscutter (*Thryonomys*) and the African Land Snail (*Achatina*) but now being selectively bred in captivity.

A comparable process occurred with many plants which were cultivated before being domesticated. Cultivation is here defined as altering their location or growth habit in some way to make them more useful to human beings. The simplest manner is transplantation. Forest yams are uprooted and replanted near the homestead. Seeds from fruit trees such as *Canarium schweinfurthii* are dropped near the compound and protected from fire. Cereal grains are gathered from the wild and scattered so that they can be more easily collected the following year. Palm trees (such as the dum palm, *Hyphaene thebaica*) are coppiced to harvest the leaves annually. Although these processes are assumed to have been more common in the past, when human population densities were lower, they continue today, as accounts of the `pseudo-cultivation' of *Paspalum scrobiculatum* in Guinea show.

The number of indigenous African plant domesticates is much greater than for animals and in many cases their exact taxonomy remains problematic. Important genera, such as the Dioscoreaceae, from which come the many species of commercial yams, remain in confusion in part because of the continuing interaction with wild species.

Table 1 gives some examples of indigenous Africa plants and animals that have been cultivated or tamed as opposed those truly domesticated.

**Table 1.** Cultivation versus domestication: some African examples

| | **Cultivated/Tamed** | **Domesticated** |
|---|---|---|
| **Plants** | *Dioscorea praehensilis*, aerial yam (*Dioscorea bulbifera*), Futa Jalon fonio (*Brachiaria deflexa* var. *sativa*), koko vine (*Gnetum bucholzianum*), African olive (*Canarium schweinfurthii*), *Polygala butyracea* | Sorghum, bulrush millet, finger-millet, tef, African rice, cowpeas, Bambara nuts, Guinea yam, Hausa potato(*Solenostemon rotundifolius*), rizga (*Plectranthus esculentus*), oil-palm |
| **Animals** | Guinea-fowl, spur-wing goose, giant rat (*Cricetomys*), grasscutter (*Thryonomys*), Land Snail (*Achatina*), marine turtle (*Chelonia mydas*), bees | Cattle, donkeys, pigeons, guinea-fowl |

N.B. Where recorded, `English' names are given, but many of these are local and not well-known; the scientific name is therefore also given.

## Species, landraces and breeds

The argument concerning minor species can also be taken to extend to cultivars or breeds of major economic species. Many of the world's major economic cultigens have regions of high genetic diversity, often close to where they were first domesticated. This agrobiodiversity has often been conserved incidentally, simply because smallholders remain on the periphery of high-input agriculture. The diversity of potatoes in the Andes or of cattle-like species in south-east Asia are cases in point. Plant and animal breeders increasingly recognise this and indeed often treat areas of conserved

agrobiodiversity as a free genetic resource. The intellectual battle to conserve this diversity is now largely won in the case of major species simply because of the importance of the headline species. This does not mean that the appropriate methods to conserve landraces *in situ* have been developed nor that the resource created by local breeding strategies is justly rewarded. But the conservation of local races can no longer be mapped simply against the larger problem of the conservation of minor species.

## Between wild and domestic: a dynamic frontier

Development specialists, research station scientists and anthropologists all have a substantial investment in the distinction between the wild and the domestic. Sets of well-established domesticates permit the research specialisations, projects and diagrams of dichotomies favoured by this type of literature. Plants or animals that are domesticated in some locations and not others, and the management of wild plants or animals make for fuzzy categories and do not lend themselves to well-structured genetics. For this reason, species that cross over between the wild and the farm, such as fonio, *Digitaria exilis*, tend to be neglected. Where well-bred plants form weedy crosses with their wild relatives, such as in the case of West African pearl millets, considerable efforts go into eliminating these rogue plants.

In reality, this dynamic frontier is built into farming and pastoral systems across the world and its fluidity is a response to changing environmental and economic conditions. Table 2 lists some species of plants and animals that illustrate variable domestication according to geography and where the `domestic' types are constantly subject to outcrossing with `wild' relatives.

**Table 2.** Between the wild and the domestic: some examples

| | | |
|---|---|---|
| **Plants** | Tubers: | *Dioscorea bulbifera, D. dumetorum, D. sansibarensis* |
| | Cereals: | *Brachiaria deflexa, Paspalum scrobiculatum* var. *polystachyum, Oryza glaberrima* |
| | Sedges: | *Cyperus esculentus* (tiger-nut) |
| | Pulses: | *Macrotyloma geocarpa*, *Psophocarpus tetragonolobus, Sphenostylis stenocarpa* |
| | Potherbs: | *Portulaca oleracea, Bidens pilosa, Amaranthus hybridus* |
| | Tree-crops: | Tamarind, oil-palm, *Moringa oleifera*, carob |
| **Animals** | Donkey, Bactrian camel, guinea-fowl, ostrich, elephant, Chinese and European geese, reindeer, yak, Bactrian camel, vicuña | |

## Tolerated Weeds

Weeds have generally had a bad press in professional literature. Harlan and de Wet (1965), who collected statements about weeds, contrast those from professional agronomists (`obnoxious plants known as weeds', `a nuisance') with those of enthusiastic amateurs (`a plant whose virtues have not yet been discovered', `weeds ... condemned without a fair trial'). Weeds typically colonise disturbed habitats and cultivated fields represent a special case of such a habitat. Recent research suggests that many major economic crops have co-evolved with weeds and that those weeds are retained in non-intensive farming systems and harvested for food or other uses. Such weeds have been renamed `companion-crops' or `anecophytes' to reflect this changed status. African farming systems include many such species, especially greenleaved potherbs and these make an important contribution to diet.

It has been argued that some species of animal fill a corresponding niche in relation to human society. Rats, pigeons, sparrows and rabbits (in the Antipodes) have been advanced as candidates in this respect. The analogy is not precise since almost all of these are regarded as pests. However, the European house-rat has only begun to spread in Africa subsequent to European contact and in some regions is encouraged through leaving out scraps so that it will be available as an emergency food reserve.

## Does it matter?

It could be argued that, since these various minor species have been thrown off the express-train of history, they did not possess the biological attributes necessary to enter the world economic system. In other words, their limited importance is justified. The history of domestication can be taken to show that species which do not conform to the social and technical niches available in their period are eliminated. Such eco-Darwinism rides roughshod over the actual process of crop domestication. A crop of major world importance such as maize depended on the generations of unknown Meso-American farmers working with the apparently unpromising *teosinte*. From this perspective the failure of such a species to produce returns within a short research cycle would be reason enough for rejecting it.

This makes for self-fulfilling prophesies; since certain crop/livestock species are defined as `minor', statistics on their prevalence are either not collected or of doubtful value. This absence of data then becomes a reason for proscribing further research. Another more banal discouragement may be at work; describing crop repertoires in detail involves long lists of scientific names with no easily remembered English equivalents and no entries in readily available textbooks. Practical development workers can often be heard to dismiss this type of research as a sort of antiquarianism.

Nonetheless, research in Africa has shown that `minor' crops often play a major role in household nutrition. Studies reported in Schippers and Budd (1997) indicated, for example, that in south-west Cameroon indigenous potherbs constitute up to 50% of a household's vegetable intake, and that there is as yet no tendency for them to be replaced by exotic species. A ranking exercise to compare the role of indigenous vegetables in the economy of five African countries identified several of considerable regional importance that are so little-known as to have no common English name.

In a similar vein, although less acknowledged, is the problem that African governments, even those with an explicit poverty-focus, are not willing to promote species seen as `backward' or that seem to project an image that is `not modern'. Recent criticism of a report on donkey utilisation in poor areas of South Africa by ANC officials suggests that not all the values of the preceding government have been summarily dismissed. Similarly, the practice of eating pets and work animals at the end of their useful lives, as is common with dogs and donkeys, is often categorised as repugnant to `modern' values.

## Arguments for promoting minor species and races

The strongest argument for promoting minor species is simply that since people continue to use them, this constitutes a recognition of their value sufficient to suggest that research priorities should be re-oriented. However, a more proactive case can be made in terms of both food security and economics.

Minor crops are strongly associated with marginal environments: regions where extreme heat, poor soils and access problems make the large-scale production of world crops and livestock uneconomic. They play a dis-proportionately large role in food security systems; plants that will grow in infertile or eroded soils and livestock that will eat degraded vegetation are often crucial to household nutritional strategies. They usually demand reduced labour inputs and are resistant to disease while also providing nutritional diversity. This is especially important in regions where increasing dependency on purchased cereal staples such as maize can lead to vitamin-deficiency diseases.

At the same time, minor species are important to the maintenance of agrobiodiversity. Traditional agricultural systems combine home gardens with the sequential combination of annuals and perennials with tree crops. Studies in West Java found more than 230 species of plant within the overall cropping system (Christanty *et al.*, 1986). In addition

these systems include livestock, aquaculture and harvestable insects and are found to encourage a greater diversity of bird species than regions of monocropping (for example, paddy rice).

Another more strictly economic argument for greater attention to minor species is that poor people have a comparative advantage in their production. As world production of major crops and livestock becomes more hi-tech, farmgate prices do not keep pace with the price of inputs for smallholders (McNeely, 1995 and references therein). The world system constantly reduces their ability to compete as individuals, although they may be drawn into wage-labour in agro-industrial enterprises. They *can* compete, however, by producing crops and livestock for specialised consumers, both through ethical trading and the exotic products market. This discovery is not limited to the developing world; farmers in Europe and America are increasingly turning to designer foods as the recent spread of ostriches and quinoa demonstrates. Minor species can also help poor farmers spread risk and diversify their output against fluctuations in major cash crops.

## Wonder crops and magical breeds

**A contradictory aspect of agricultural development that hardly seems to change is the way rapid waves of enthusiasm develop for wonder crops and magical livestock breeds. The productivity of some tree, crop or animal is seen to give spectacular advantages compared with the indigenous species. Eucalyptus, Gmelina, Leucaena, vetiver grass and exotic livestock breeds have all come and gone, none recording a fraction of the original success hoped for them. That such entities should exist seems contrary to agricultural ecology, which suggests that too dominant a crop (in the sense of promoting monoculture) will excite equally enhanced interest from parasites and diseases. But such enthusiasms are not really technically driven, but rather reflect the internal politics of development agencies, constantly under pressure to come up with solutions by the time of the next annual report. Farmers are usually too sensible to uproot existing crops in favour of some fashionable nostrum, planting only enough to test them and, from a sceptic's viewpoint, to ensure that funds continue to flow from visiting developers. More damage is probably done by encouraging the adoption of exotic livestock breeds. Although initially impressive, individual animals often turn out to have either unacceptably high veterinary costs or to die, sometimes taking the existing flock/herd with them.**

## Summary

Recent research on the repertoires of both crops and animals suggests that there exists an important gap between the priorities of development and research agencies and the way small farmers, both in Africa and elsewhere in the world, treat such species. The most important aspects of this are:

- Farmers use a wider range of crops and livestock than are usually enumerated in standard texts.
- They regularly experiment with `new' species.
- Crops and livestock leave and enter domestication, a process that should not be conceptualised as one-way.
- Species can remain tamed or cultivated for millennia until domestication becomes appropriate.
- Research focuses almost entirely on species of interest to Western donors and promotes a vision of agriculture that is far less fluid and responsive than the existing smallholder systems.
- Exotic crops and livestock are heavily promoted as having significant production advantages over existing species, but when inadequately adapted, almost always have high long-term costs and may impoverish smallholders.

A consequence of this situation is that very often the main promoters of neglected species are individual enthusiasts or amateurs and this sometimes acts as a further deterrent to major agencies.

Neglected species are almost always found in `difficult' areas comprising combinations of poor soils, unreliable rainfall, hilly topography and degraded vegetation. High proportions of the poor live in these areas, and neglected species are often the only ones capable of coping with these conditions and thereby contributing to their livelihoods.

There is a sense in which the reduction in diversified systems represents a version of the `tragedy of the commons' writ large. In biodiverse resource management systems communities manage private and common pool resources in an integrated fashion over long periods. High-input single-species systems can produce more from a unit area for a defined market over a shorter time-span and it is often therefore in the interest of individuals to produce them. But in doing so they may weaken joint management systems by withdrawing from them or, even worse, by seeking to privatise parts of the resource.

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# WOMEN – users, preservers and managers of agrobiodiversity

*Through their daily work, rural women have accumulated intimate knowledge of their ecosystems, including the management of pests, the conservation of soil and the development and use of plant and animal genetic resources.*

*It is estimated that up to 90 percent of the planting material used by poor farmers is derived from seeds and germplasm that they have produced, selected and saved themselves. This means that small farmers play a crucial role in the preservation and management of plant genetic resources and biodiversity.*

*In smallholder agriculture, women farmers are largely responsible for the selection, improvement and adaptation of plant varieties. In many regions, women are also responsible for the management of small livestock, including their reproduction. Women often have a more highly specialized knowledge of wild plants used for food, fodder and medicine than men.*

## GENERAL PROFILE

As the twenty-first century approaches, rural women in developing countries hold a key to the future of the earth's agricultural systems and to food and livelihood security. They are responsible for the selection of seed, management of small livestock and for the conservation and sustainable use of plant and animal diversity. Rural women's roles as food providers and food producers link them directly to the conservation and sustainable utilization of genetic resources for food and agriculture. Centuries of practical experience have given women a unique decision-making role and knowledge about local crop and farm animal management, ecosystems and their use.

The poorest farming communities are those that live in marginal and heterogeneous environments that have benefited least from modern high-yielding plant varieties. Up to 90 percent of the crops grown by poor farmers come from seeds and planting material that they have selected and stored themselves.

These subsistence farmers cannot afford external inputs such as fertilizers and pesticides, veterinary products, high-quality feeds and fossil fuel for cooking and heating. They rely on maintaining a wide range of plant and animal varieties adapted to the local environment. In this way, they are able to protect themselves against crop failure and animal losses, to provide a continuous and varied food supply, and to ward off hunger and malnutrition. In many areas, the majority of smallholder farmers are women.

### Some trends and figures relating to agrobiodiversity

- **30 percent of animal genetic resources at the breeding stage are categorized as a high risk of loss.**
- **Of the 250 000 to 300 000 known plant species, 4 percent are edible, but only 15 to 200 are used by humans.**
- **Three plant species (rice, maize and wheat) contribute nearly 60 percent of the Calories and proteins that humans derive from plants.**
- **The rural poor depend upon biological resources for an estimated 90 percent of their needs.**

## GENDER RESPONSIVE POLICIES, AGREEMENTS AND SUPPORT

Important international policies and legal agreements acknowledge the key role that women play, especially in the developing world, in the management and use of biological resources. Despite this increased recognition at international levels, little has yet been done to clarify the nature of the relationship between agrobiological diversity and the activities, responsibilities and rights of men and women. Women's key roles, responsibilities and intimate

knowledge of plants and animals sometimes remain "invisible" to technicians working in the agriculture, forestry and environmental sectors, as well as to planners and policy-makers.

The lack of recognition at technical and institutional levels means that women's interests and demands are given inadequate attention. Moreover, women's involvement in formalized efforts to conserve biodiversity is slight because of widespread cultural barriers to women's participation in decision-making arenas at all levels.

Modern research and development and centralized plant breeding have ignored and, in some cases, undermined the capacities of local farming communities to modify and improve plant varieties. With the introduction of modern technologies and agricultural practices, women have lost substantial influence and control over production and access to resources, whereas men often benefit more from extension services and have the ability to buy seeds, fertilizers and the necessary technologies.

***Giving due recognition***

*Both the Convention on Biological Diversity (UNEP, 1993) and* FAO's Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture *(1996) acknowledge the role played by generations of men and women farmers, and by indigenous and local communities, in conserving and improving plant genetic resources. They affirm the need for women to participate fully in conservation programmes and at all levels of policy-making.*

*Two key objectives of Chapter 24 of Agenda 21 (UNCED, 1992) are to promote "the traditional methods and the knowledge of indigenous people and their communities, emphasizing the particular role of women, relevant to the conservation of biological diversity and the sustainable use of biological resources" and to ensure "participation of those groups in the economic and commercial benefits derived from the use of such traditional methods and knowledge".*

## MEN AND WOMEN HOLD DIFFERENT SETS OF KNOWLEDGE

Through their different activities and management practices, men and women have often developed different expertise and knowledge about the local environment, plant and animal species and their products and uses. These gender-differentiated local knowledge systems play a decisive role in the in situ conservation, management and improvement of genetic resources for food and agriculture. It is clear that the decision about what to conserve depends on the knowledge and perception of what is most useful to the household and local community.

Women's and men's specialized knowledge of the value and diverse use of domesticated crop species and varieties extends to wild plants that are used as food in times of need or as medicines and sources of income. This local knowledge is highly sophisticated and is traditionally shared and handed down between generations. Through experience, innovation and experimentation, sustainable practices are developed to protect soil, water, natural vegetation and biological diversity. This has important implications for the conservation of plant genetic resources.

## "SCIENTISTS"AND DECISION MAKERS IN THE SELECTION AND IMPROVEMENT OF PLANT VARIETIES AND ANIMAL BREEDS

In smallholder agriculture, women farmers have been largely responsible for the selection, improvement and adaptation of plant varieties. The selection of varieties is a complex, multifaceted process that depends on choosing certain desirable characteristics (for instance, resistance to pest and diseases; soil and agroclimatic adaptability; nutritional, taste and cooking qualities and food processing and storage properties).

In many regions, women are also responsible for the management and reproduction of small livestock. Again, the choice of preferred breeding traits is dictated by adaptation of certain breeds to local conditions, resistance to disease and available feeds.

The fact that plants and animals are often produced for a variety of purposes further complicates the selection process since multiple traits are sought.

For example, sorghum may be grown for its grain and stalk, sweet potato for its leaves and root, and sheep may

provide milk, wool and meat. Moreover, to create a favourable microenvironment and manage space and time better, several plant species that complement each other are frequently intercropped and mixed farming (crop, livestock and agroforestry) is often practised.

Recognition of this sophisticated decision-making process is gradually leading breeders and researchers to realize that a community will adopt and select new and improved seeds for food crops and animal breeds if they have been tested and approved by men and women farmers.

In the Andhra Pradesh State in India, individual women farmers and sanghams (women's cooperatives) helped entomologists of the International Crops Research Institute for the Semi- Arid Tropics (ICRISAT) to carry out a successful pigeon pea programme to develop improved pest-resistant lines. Researchers examined women's traditional pea varieties and offered several lines that were resistant to the main enemy, the pod borer, and came closest to the farmers' seed preferences. The women assessed their performance not only in terms of yield but also on the basis of ten different criteria, including leaf production, pod borer damage, taste, wood biomass, quality, market price and storability. Three of the four improved lines were rated by the women as being superior to their local varieties and were then grown alongside their own peas, which they retained for their superior taste. Furthermore, a mix of varieties was maintained to reduce pest attack.

## FARMERS' RIGHTS

Through their daily activities, experience and knowledge women have a major stake in protecting biological diversity. However, at national and local levels rural women are still hampered by a lack of rights to the resources they rely on to meet their needs. In general their rights of access to and control over local resources and national policies do not match their increasing responsibilities for food production and management of natural resources.

Given that men and women farmers' knowledge, skills and practices contribute to the conservation, development, improvement and management of plant genetic resources, their different contributions should be recognized and respected as farmers' rights. These are "rights arising from the past, present and future contribution of farmers in conserving, improving and making available plant genetic resources, particularly those in the centres of origin/diversity". The purpose of these rights is to "ensure full benefits to farmers and support the continuation of their contributions" (FAO, 1989).

The concept of farmers' rights was developed to counterbalance "formal" intellectual property rights (IPR). These formal mechanisms of recognition give little consideration to the fact that, in many cases, such innovations are only the most recent step in a long process of inventions that have been developed over millennia by generations of farmers, particularly women, throughout the world.

## HOW TO ADDRESS GENDER AND AGROBIODIVERSITY

*A long-term strategy for the conservation, utilization, improvement and management of genetic resources diversity for food and agriculture requires:*

- Recognition that there are gender-based differences in the roles, responsibilities and contributions of different socioeconomic groups in farming communities.
- Recognition of the value of men's and women's knowledge, skills and practices and their right to benefit from the fruits of their labour.
- Sound and equitable agricultural policies to provide incentives for the sustainable use of genetic resources, especially through *in situ* conservation and improved linkages with *ex situ* conservation.
- Appropriate national legislation to protect "threatened" genetic resources for food and agriculture, guarantee their continued use and management by local communities, indigenous peoples, men and women, and ensure the fair and equitable sharing of benefits from their use.
- Improvement of women farmers' access to land and water resources, to education, extension, training, credit and appropriate technology.
- Participation of women, as partners, decision-makers and beneficiaries.

The challenge for future generations is to safeguard agrobiodiversity by protecting and promoting the diversity found in integrated agricultural systems, which are often managed by women. The maintenance of plant and animal diversity will protect the ability of men and women farmers to respond to changing conditions, to alleviate risk and to maintain and enhance crop and livestock production, productivity and sustainable agriculture.

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## Glossary

***Ex situ* conservation:** *Literally, "out of place"; not in the original or natural environment, e.g. seed stored in a genebank.*
**Genebank:** *Facility where germplasm is stored in the form of seeds, pollen or tissue culture.*
***In situ* conservation:** *Literally, "in (a plant's) original place".*

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# Livestock and Livelihoods

Over the years, many different kinds of animals (i.e., horses, pigs, cattle, goat, camels, elephants, llamas, alpaca, vicuña, reindeer, etc.) have been domesticated in different regions of the world for different reasons. It is estimated that the earliest domestication of animals took place over 14,000 years ago. The first animal to be domesticated was the dog, essentially as a companion animal.

Some animal species have traveled from their original centers of domestication to other parts. They have successfully adapted themselves to the conditions and the needs of people there. Examples of these are cattle, horses, sheep, goats, poultry, pig, chicken and ducks. In the case of some species, it is believed that perhaps, domestication happened more than once at separate locations. This is what is believed of the *Bos taurus* (humpless cattle), which is believed to have been domesticated from the Auroch in the region around Turkey and then had another round of domestication in north Africa.

People in the deserts, on the other hand, domesticate camels for transport purposes. Likewise, camels provide milk, meat, hair, leather, and manure. Furthermore, they are symbols of wealth and status, and may be traded in exchange for other goods.

## Livestock Breeds

Breeds have developed slowly over a long process taking many thousands of years. This was done through a selection process, which was both natural and driven by human needs. Through the natural process, only those species, which could withstand a particular agroecological zone, survived. On the other hand, humans carefully selected species based on physical and production traits to meet their local needs and requirements. Therefore, the needs of a farmer in the cold grasslands of the Steppes in Russia were quite different from the needs of farmer of the grasslands of India or Pakistan. Today, there are some 6,000 to 7,000 known breeds of domesticated animals spread all over the world. The careful process for selection of different traits is largely responsible for the difference in performance and appearance of the breed from its wild progenitor, as well as from other breeds of the species.

## Livestock Livelihood Systems

Certain distinct patterns of livestock farming arose from the region of domestication, the need for domestication, and specific demands of the local communities.

**Breeds selected by these herders were essentially ones which could stand the stress of migration, droughts and periodic food and nutritional shortages.**

### Pastoral Systems

A large number of animals were domesticated in the grasslands of west and central Asia. These were mainly the herbivorous species that ate grass (i.e., sheep , goat, cattle, horse and camel). In these areas, crop farming was risky and fraught with uncertainties while livestock proved a suitable alternative. Early cattle, sheep and goat herders were often migratory. They herded their animals from place to place in search of pastures. When the pressure on grasslands became excessive, they migrated out in search of fresh pasture or moved into new territory.

As their lives and livelihoods depended on animals and animal rearing, these herders have kept some of the finest animals and breeds for generations. Even today, it is estimated that 15% of the cattle in the developing world are kept by pastoralists especially in the semi-arid parts of Africa, west Asia, India and Pakistan.

## Forest-based Systems

Communities who lived in forested areas first domesticated tree species. In the tropics, animals like the elephant, water buffalo, pigs and chicken were domesticated for food, manure, draught and sport. However, not all wild forest species were suitable for domestication, and many species were in a state of semi-domestication. They reverted back to their undomesticated state when human care was withdrawn.

The Mithun breed of sheep was domesticated by communities who live in the forested regions of northeast India is an example. The forest imposes unique challenges and only animals that can withstand these could be successfully domesticated. The challenges include being able to withstand attacks by natural predators; cope with food shortage; and resist diseases. The Mithun sheep represent status, wealth, and serve as capital and currency for the people of these communities. However, the Mithun are not really kept in the same intensive way as cattle are in the developed parts of the world.

**Religious preferences and social taboos also determine the selection of species and breeds of animal. In India, cattle breeds are not selected for beef as there is a religious ban on the consumption of beef. On the other hand, these very same breeds (Ongole and the Kankrej or Gujerat) are raised in Australia and the Americas as beef breeders under the ranch lot systems.**

## Crop-based Livestock Rearing Systems

A major revolution in livestock farming happened thousand of years ago when crop farming and livestock rearing were brought together under mixed-crop livestock farming systems. Under these systems, by-products from agriculture (crop residue and straw) were used to feed animals. In exchange, animals had to work. Their waste (dung) was used as fertilizer. It was this great revolution that led to food surpluses and helped societies go beyond the level of mere subsistence.

Many interesting patterns of mixed crop livestock rearing evolved in the different countries of the world. These patterns were in response to development, emerging needs and changing environments. Through this process, many interesting breeds have developed.

## Modern Systems of Animal Rearing

Livestock have evolved and migrated around the world. Livestock breeds were taken to the grasslands of the Americas and Australia where livestock production intensified under the ranch lot systems The development of the railways, cold storage systems and refrigerated ships accelerated the development of this kind of livestock rearing, which led to fairly undesirable social and environmental consequences (i.e., large tracts of virgin forests were brought under pasture).

## Modern Farming Systems

Intensification of livestock production has relied upon uniformity in the genetic composition of the livestock. For example, almost all the pigs reared under commercial farming systems in Europe and North America belong to two or three breeds. Ninety percent of all north American dairy cattle and 60% of all European cattle belong to only one breed, the Holstein. Furthermore, it is estimated that by 2015, the genetic diversity within this breed will come from only 66 individual animals. Organized poultry farming across the world relies on a few multinational companies who have developed a handful of breeds for their supply of stock.

## The Need for Agricultural Biodiversity

A narrow genetic base as developed by commercial farming systems poses many inherent dangers. This narrow base carefully selected for a particular trait may be completely unsuitable to the emerging problems of the future. These include diseases and the increased demand for diverse livestock products. On the other hand, a wide genetic base makes it possible to carry out productive livestock farming under diverse conditions.

Most of the world's poor live in marginalized areas where it is not possible to manage livestock farming under intensive conditions. Livestock is reared to cater to a number of personal needs and demands.

Livestock rearing patterns are intricately woven into a delicate balance with other systems in their area. Specific species and breeds are associated and identified with their socio-cultural place in society. Thus, the introduction of a program or new breeds or species of animals tend to upset the balance which has evolved slowly over many years. Wide genetic diversity provides these people to continue to live a life of social, cultural and economic independence and dignity.

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# Good ideas turned bad?
# A glossary of rights-related terminology

Many of us often have to struggle with words and concepts that are used as though they have one single and simple meaning, while in reality they hide strong bias and very specific worldviews. Not surprisingly, they are usually biased towards the worldviews of those in power. There have also been well-intentioned words and concepts when coined but that have been corrupted over time through inappropriate usage, thereby acquiring more complicated connotations and implications. When we use these words, we often unwillingly but unavoidably become trapped in political and philosophical frameworks which block our ability to challenge the power that backs those views.

In the following pages, GRAIN takes a critical look at some such key concepts related to knowledge, biodiversity and intellectual property rights. Many of these words and phrases look innocent enough at a first glance, but on deeper examination, we can see how they have been twisted, manipulated, usurped, devalued and/or denatured. Some are used to constrain us and lock us into a particular way of thinking, and others are used against us. This is not an exercise aimed at drawing final conclusions, but an invitation to deconstruct some definitions and start the search for new terminology and ways of thinking that may help us untangle us from some of the conceptual traps we are stuck in.

As readers will see, one key concept is missing: rights. After some discussion, we concluded that this concept is so central to current debates, so loaded with implicit values, and its bias so deeply ingrained in our minds, that much longer and careful consideration is needed before we can attempt a useful discussion on the subject. We expect to include a discussion on 'rights' in a later issue of Seedling. Meanwhile, your comments are welcome.

## ACCESS

The term "access" simply means a right to use or visit. In the context of biodiversity it suggests either admittance to bio-rich areas for bioprospecting, or the permission to use such resources or the traditional knowledge associated with them for research, industrial application and/or commercial exploitation. Initially heralded as a safeguard against biopiracy, the expectation was that access rules and regulations would help to keep control of biological resources and knowledge in the hands of communities. Any decision on access would require prior informed consent from the relevant communities. But access regimes have turned into mere negotiating tools between governments and commercial interests. The potential (market) value of biodiversity and its associated knowledge in the development of new medicines, crops and cosmetics has transformed access into a tug of war between countries. In this way, access has become synonymous with biotrade.

Take the way in which access is currently being discussed within the CBD's Ad Hoc Open-ended Working Group on Access and Benefit Sharing. Governments must now respond to Rio+10's call to negotiate an international regime on access and benefit sharing, on the basis of the (voluntary) Bonn Guidelines adopted by the parties to the Convention in April 2002. The CBD does not define "access", but envisages several dimensions to it:

- Access to plant genetic resources and traditional knowledge of these resources from the South
- Access to technology transfer from the North
- Access to benefits derived from the use of genetic material.

Sadly but predictably, the preoccupation is only with the first dimension, without any reciprocal and/or balanced attention to the two others. Moreover under the CBD, countries are bound to "facilitate" access, not restrict it. Access to plant germplasm is receiving the same treatment in FAO's International Treaty on Plant Genetic Resources.

What is troublesome in all these discussions is the pro-IPR (intellectual property rights) approach. Access

negotiations in many cases are obliged to accommodate the international legal regimes on IPRs as prescribed by WTO's TRIPs Agreement and WIPO. This is unacceptable. If we are presented the argument 'no patents, no benefits', we must respond with 'if patents, no access'. No amount of 'benefit sharing' can make up for the loss of access by communities to their local resources and knowledge.

## BENEFIT SHARING

Benefit sharing was originally seen as a way to bring equity and justice to a world in which industrialised countries and their transnational corporations had long been plundering the biodiversity and traditional knowledge of communities in the South. In the early 1990s, it became one of the three central pillars of the CBD, which calls for "the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources". Later, the parties to the CBD developed guidelines on how to go about it, and similar wording was incorporated in FAO's International Treaty on Plant Genetic Resources. Benefit sharing, it was argued, would put a stop to biopiracy and the custodians of biodiversity – local communities – would get a fairer deal and a bigger say in how to manage those resources.

More than a decade later, it seems that the benefit-sharing discussion is moving in quite the opposite direction. Governments and corporate lawyers negotiate benefit-sharing agreements while local communities sit on the sidelines. Money dominates the agenda and the multiple benefits of biodiversity at the local level are all but forgotten. Despite some talk about capacity building and empowerment, most approaches to benefit-sharing are dominated by the commercial bottom-line: 'no patents, no benefits'. Instead of supporting the collective forms of innovation that sustain the knowledge and practices of local communities and the biodiversity that they generate and maintain, benefit sharing is increasingly becoming a tool for pushing IPRs, promoting 'biotrade' and turning biodiversity in another commodity for sale (see box).

It is time to go back to the basics: this main issue is to strengthen the control of local communities over the biodiversity they nurture (and that nurtures them) in order to improve the benefits they derive from it for their livelihood systems. Any benefit sharing scheme that doesn't take this as a central element is bound to contribute to the problem rather than providing a solution.

## FARMERS RIGHTS

What Farmers Rights are depends to a large extent with whom you talk. A farmers' organisation in the Philippines defines it as an issue of farmers' control over their seed, land, knowledge and livelihoods, while an article in the Hindu Business Line describes it as the right for farmers to have access to transgenic crops. The International Seed Federation has little respect for the concept, saying that: "Farmers' Rights were introduced rather emotionally, without careful consideration (...) and have led to endless discussions". The Farmers Rights Information Service set up by the M.S. Swaminathan Research Foundation explains its existence on the grounds that indigenous groups and farmers also need to gain economic rewards from the exploitation of biodiversity along with commercial interests.

The official definition laid down in Article 9 of the FAO International Treaty on Plant Genetic Resources for Food and Agriculture doesn't help us much further. It says that countries should protect and promote Farmers Rights by giving farmers an equitable share in the benefits, and by letting them participate in decision-making. But these 'rights' are limited by the country's "needs and priorities" and are "subject to national legislation". Even the age-old right of farmers to save and exchange farm-saved seed is not clearly guaranteed, but made subject to "national law and as appropriate".

Farmers' Rights has been a central battle issue for many NGOs and farmers' organisations, including GRAIN, for most of the past decade. The central objective was – and continues to be – to ensure control of and access to agricultural biodiversity by local communities, so that they can continue to develop and improve their farming systems. Rather than a simple financial compensation mechanism, we pushed for Farmers Rights to be socio-economic rights, including the right to food, land, to decent livelihoods, and for the protection of knowledge systems. Not much has been achieved at the international level between governments. But it is a battle that continues for many farming communities at the local level.

## HERITAGE

Heritage is a nation's or people's historic legacy that is deemed worthy of preservation. Inheritance is something that is passed on from one generation to the next, suggesting that heritage is outside the purview of buying and selling. This is what the FAO had in mind when the concept of "common heritage of mankind" was developed in relation to plant genetic resources. By acknowledging the 'heritage' status of seeds and plants, the idea was to keep them in the public domain, free of restrictive and exclusive property rights. But the concept was then revised to accommodate the "sovereignty" principle enshrined in the CBD, which meant giving heritage a price tag. The sanctity of seeds in farming cultures as something inalienable and to be shared has long been violated by ever-increasing privatisation, particularly through the abuse of patents and plant breeders' rights. This is an ironic situation in which the IPR system, which so hankers for this heritage, is sounding its death knell. Across the globe people are fighting to keep heritage and what it needs to thrive alive. The international farmers' organisation Via Campesina has launched a campaign to defend seeds as peoples´ heritage for the service of humankind. This global campaign was launched at the World Social Forum in Porto Alegre, Brazil in 2003, where thousands of participants committed themselves to defending seeds as collective heritage, the basis of cultures, and the foundation of farming and food sovereignty.

## IPRs

There are many ways to encourage innovation and there are many ways for people to guard against the misuse of their creative works. But, over the course of the last century, these functions have increasingly become the domain of the courts and the various legal systems that they govern, such as copyrights, patents, trademarks, plant breeders' rights, geo-graphical indications and industrial designs. These laws are supposed to maximise the public interest: society gets access to creative works and inventors/authors get a reward for their efforts and investments in the form of temporary monopoly rights. It was agreed that each country needed to be able to limit the scope of the laws and the rights they afford according to their own particular conditions and interests. But recently the courts in some countries have increasingly confused these legal systems with property law, and the scope and monopoly of rights conferred is getting totally out of hand. What's worse, some governments, led by the US and supported by big business, are pushing to make this situation the norm around the world, They are even pushing for a single global patent system based on this distorted model.

The growing use of the term "intellectual property rights" (IPRs) is part of the problem. IPRs came on the scene in 1967 when the World Intellectual Property Organisation was set up to bring the various legal systems under a single umbrella. The concept of IPRs is tied to a neo-liberal worldview that says that everything in the world – material goods, creative works, even DNA – can and should be privatised: i.e. parcelled up, owned and governed by a set of legal monopoly rights. If people do not own things and are not able to accumulate more ownership over things, there can be no progress; commons and collective processes create nothing but tragedy and upset the efficient functioning of 'free' markets. But, in practice, we see that property rights only serve the interests of the few. They facilitate the concentration of wealth by expanding the control of property owners and by devaluing and dispossessing people of 'unclaimed' wealth, such as the lands of indigenous peoples, or traditional plant varieties.

IPRs, as they exist today, also favour a very particular form of innovation – that of private individualised authorship that is generally controlled by big industry and suits the needs of commercial mass production. IPRs undermine the more important collective processes of innovation at the heart of agricultural biodiversity, culture, science, and community. For instance, while patents and plant varieties reward the seed industry for making subtle modifications to existing plant varieties, they obstruct the collective forms of plant breeding that generations of farmers have used to produce the earth's tremendous agricultural biodiversity. We are now at the point where the legal systems designed to enhance innovation are doing precisely the opposite: strangling innovation, locking up ideas, and ripping people off.

Fortunately, there is a growing global movement of resistance to this trend. Farmers are fighting the criminalisation of seed saving and the patenting of life. Digital innovators are struggling to preserve and expand the space to freely create and use software. Activists and scientists are fighting against obscene pharmaceutical patents and looking to alternative, 'open' models of research that avoid patents altogether.

## PROTECTION

The English dictionary defines "protect" as to shield from harm or danger; shelter, defend and guard. But the interpretation of protection can also imply confinement, coercion, constraint, repression, limitation, restriction, monopoly and prohibition. So protection can not be understood without reference to what we want to defend, in whose favour, and at whose expense. Without this, we can easily destroy what we are supposed to be protecting, as is the case with IPRs. These are supposedly used as shields to protect knowledge, but are actually instruments to make profit from so-called "scientific" research. The economic horizon is its value measurement: nothing else. Not much is being protected except someone's wallet.

Part of the problem is that protection means very different things in intellectual property law and in ordinary usage. In the intellectual property sense, protection means protecting property over something in a very specific way, but in ordinary usage it has a much broader meaning. This has proved particularly problematic in the discussions on protecting traditional knowledge at WIPO (see p 13). When human knowledge is transformed into property in convenient IPR-sized bites, it exits the commons leaving social rights unprotected. To truly protect human knowledge – scientific, traditional, indigenous or whatever – several conditions must be met. First, we need to assign it greater value and create the conditions for that knowledge to flourish, such as by preserving cultural diversity and expressions, and conserving ecosystems diversity. Second, knowledge must flow free without limitations, monopolies or prohibition. Last but not least, this freedom must be applied to all types of knowledge, which means no IPRs in any form.

## SOVEREIGNTY

Sovereignty implies self-governance. International law states that sovereignty means each country has "supreme control over its internal affairs". Back in 1958, the UN General Assembly established a Commission on Permanent Sovereignty over Natural Resources, followed by an eight-point resolution in 1962. But sovereignty did not become an important concept in relation to biodiversity until the drafting of the CBD. During the 1980s, discussions in the FAO on the politics of plant genetic resources had centred around the principle that they were a 'common heritage of mankind.' The dramatic change in the perceived 'ownership' of biodiversity brought in by the CBD was said to be to allow states and their constituent populations to take decisions on how biological resources within their jurisdiction should be used, conserved, exchanged and shared. The conceptual shift towards sovereignty was supposed to recognise peoples' contributions (especially in the South) to the development of biodiversity, and include them in decisions on how to manage and share the benefits from the fruits of their labours.

More than a decade later, how is sovereignty being exercised? In biodiversity-rich countries around the world, it is governments and state agencies that are wielding the power. They seem to have hijacked the concept. State sovereignty is neither an absolute right, nor was it meant to grant any kind of ownership over genetic resources to governmental authority. Breathing new life into sovereignty necessarily mandates the empowerment and enfranchisement of communities. Farming groups are attempting to do this by promoting the concept of "food sovereignty", which implies the right of the people of each country to determine what they eat.

## SUI GENERIS

In Latin, sui generis means "of its own kind", something unique, something special. It implies, especially in Spanish, something exceptional or strange. The concept of sui generis legislation was first introduced in the negotiations on intellectual property within the GATT agreement, as a way to grant intellectual property over plants instead of patents, which had met with widespread and strong rejection worldwide. Although sui generis legislation was initially designed exclusively for plant varieties, the concept has been gradually expanded to cover property claims over traditional knowledge and other cultural expressions.

There is a lot of conceptual and historical twisting behind the idea of sui generis legislation. The first and most fundamental twist was in its very inception in WTO's TRIPS agreement. By saying that the exclusion from patents was

sui generis (unique, different), it implies that patents over life are the norm, despite the fact that exactly the opposite is true. A second twist is that the way it is defined in TRIPS means that sui generis is really a mirage: the only 'alternatives' allowed are still patent-like IPRs, just modified slightly to adapt them to plants.

Despite these basic flaws, the sui generis idea remained unquestioned for a decade, and in the meantime we have witnessed or entangled ourselves in numerous contradictions as part of many often courageous but hopeless searches for a 'better' IPR system. This has been the case for many groups fighting against intellectual property through WIPO, a body that was specifically and exclusively created to defend intellectual property. After so many years of fruitless battles, we should perhaps turn the argument on its head. The fact is that IPRs are an extreme case of sui generis legislation. As such, they should be drafted, applied and interpreted under the severe scrutiny of and the strict limitations set by societies and their different fundamental, non-sui generis norms. From this standpoint, the overwhelming conclusion would be that intellectual property should not be granted over life or knowledge.

## KNOWLEDGE

Have you ever noticed that almost every concept or device that is permanently attached to an adjective becomes degraded and devalued? Like organic agriculture, sustainable development, participatory breeding, alternative technology, protected democracy, market economy. Traditional knowledge is no exception.

Traditional knowledge is knowledge, just like mathematics, biology or sociology. What makes it distinct is that it has been carefully and patiently created, built, nourished, circulated and promoted by common, non-powerful people: small farmers, fisherfolk, hunter-gatherers, traditional healers, midwives, artisans, traditional poets, and many others. Because the majority of these people belong to rural cultures or have close links with rural cultures, such knowledge is intimately linked to the understanding of natural processes. It is a form of knowledge that is continuously evolving, integrating new knowledge into a rich pool that has been tested and enriched over centuries.

We don't go around talking of "mathematical knowledge" or "sociological knowledge". The reason we always hear about "traditional knowledge" is that this way we can diminish a form of knowledge that could become subversive, because of its collective nature and its autonomy from the circles of power. The labelling also allows the same circles of power to excuse themselves from understanding a type of knowledge which is way too sophisticated to fit their current models. Most of all, it conveys the message that traditional knowledge is fixed, mummified, and unfit for modern times. Once traditional knowledge has been portrayed as a second-class knowledge, it becomes easier and cheaper to turn it into a commodity.

That is what we are seeing these days. The result of centuries of on-going human creativity is now being sold in pieces, with the active assistance of WIPO and WTO. But just as you cannot sell or buy number five, nor can you sell or buy people's knowledge of plants or nature, or any knowledge for that matter. What is really being done is crushing or violating the right of many peoples of the world to continue freely creating, promoting, protecting, exchanging and enjoying knowledge. Can you imagine a world where no one except a few corporations could use the number five?

## TRUSTEESHIP

Trusteeship refers to a legal responsibility to supervise and administer some kind of property or asset – as in a 'trust fund' – on someone else's behalf. It comes from the Anglo-Saxon legal tradition. It was introduced into the political debate over plant genetic resources in the early 1990s as a means to protect the world's stock of ex situ germplasm collections from both physical destruction and legal misappropriation. The way it was set up meant that the international agricultural research centres of the CGIAR were granted the responsibility to maintain the seed collections held in their gene banks 'in trust' for the benefit of the international community. This responsibility was granted to them by the members of FAO's Commission on Plant Genetic Resources – that is to say, national governments. The trust agreement, originally signed in 1994, was meant to shake off doubts about who owns the materials in the CGIAR's gene banks. It formally instructs the centres to preserve their germplasm collections in perpetuity and keep them free from IPRs. On the surface, it seems like a noble effort. The world's most important

institutional collections of genetic diversity for a number of food crops are supposedly going to be kept safe and sound (in deep freeze), and put to proper use (by scientists), for the public good. The key word here is "public". The seed collections held in trust are considered"international public goods" which should not be privatised and should benefit everyone. But the whole system – from the text of the FAO-CGIAR agreement to the way it is implemented – carries a number of hidden weaknesses. Neither the CGIAR centres nor the CGIAR itself have the legal capacity to prevent people from getting patents or other forms of IPRs on the material in trust. The centres distribute seed samples, but they cannot police what happens to them, either in the lab or in the courts. Nor can FAO or the CGIAR stop researchers from getting IPR on the components or derivatives of these materials. Sometimes sensitivities blow up.

In 2000, Thai rice farmers, NGOs and politicians became furious when they learned that samples of Jasmine rice were sent from the International Rice Research Institute (a CGIAR centre) to scientists in the US without the required material transfer agreement stating that IPRs were prohibited. In 2001, Peruvian scientists raised a stink about how the International Potato Centre (another CGIAR institute) mishandled the trust agreement when it ferried yacon samples from Peru to Japan. But most importantly, the very people who provided all these diverse and unique plant materials to the trust pot – local farming communities and indigenous peoples throughout the developing world – were never consulted about whether they wanted the seeds put in this system, whether they trusted the CGIAR centres, who they thought should benefit, whether they considered the seeds to be international public goods and whether they wanted to play a role in the whole thing.

There's no reason to doubt the good intentions behind the system. But the political reality of it is that the authority to take decisions has been abrogated from the farmers who contributed the seeds in the first place. This is what's wrong and it needs to be righted. (Did someone say something about 'farmers' rights'?)

## Jargon buster

**CBD** – the Convention of Biological Diversity was the result of prolonged international pressure to respond to the destruction and piracy of the biodiversity of the Southern hemisphere. After years of debate, the Convention was agreed upon in 1992 and came into force in 1993. Now adhered to by 188 nations, the CBD was hailed as an important watershed in international efforts to promote biodiversity conservation, and was applauded for giving formal recognition to indigenous and local communities for the central role they play in biodiversity conservation. Ten years on, much of the hope has evaporated.

**CGIAR** – the Consultative Group on International Agricultural Research – a group of donors established the CGIAR in the early 1970s to fund agricultural research around the world. It does this via 16 International Agricultural Research Centres, which now call themselves "Future Harvest" Centres comprising more than 8,500 scientists and support staff working in more than 100 countries.

**FAO** – the United Nations Food and Agriculture Organisation. The only international negotiating forum that has ever seriously attempted to take on the issue of Farmers' Rights – at least it did for a while. Also home of the International Treaty on Plant Genetic Resources, which was drawn up to protect farmers' crops and ensure their conservation, exchange and sustainable use. But its core provisions on access and benefit sharing only apply to a small and specific list of crops and its value to farmers remains unclear

**GATT** – the General Agreement on Tariffs and Trade, see WTO below.

**TRIPS** – Under the WTO's Trade Related Intellectual Property Rights Agreement (Article 27.b), countries are obliged to provide intellectual property protection for plant varieties at the national level either through patents or "an effective sui generis system" or both. TRIPS negotiations have been stalled for quite a while, and many developed countries are negotiating special closed deals with governments in the South instead. These TRIPS-plus deals establish much stronger requirements for IPRs than TRIPS itself and are being introduced through a range of bilateral, regional and subregional agreements. They are making so much headway that TRIPS may soon be obsolete.

**WIPO** – World Intellectual Property Organisation. A rising star in the international negotiating scene as the US and other patent-pushing countries are looking to it as the body to establish a world patent regime (see Seedling, October 2003, p 11)

**WTO** – Established in 1995, the World Trade Organisation is a global agency that transformed the GATT into an imposing body with the power to define the rules of global trade, enforce them and punish renegades. At its heart are a whole series of WTO agreements from agriculture to investment, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. The WTO is one of the main forces of corporate globalisation.

## Sharing a few crumbs with the San

For thousands of years, San bushmen have eaten the Hoodia cactus (left) to stave off hunger and thirst on long hunting trips. But in 2002, the Hoodia became the centre of a biopiracy row. A UK company Phytopharm patented P57, the appetite suppressing ingredient in the Hoodia, claiming to have 'discovered' a potential cure for obesity. It then sold the rights to license the drug for $21 million to Pfizer, the US pharmaceutical giant, which hopes to have the treatment ready in pill form by 2005. But while the drug companies were busy seducing the media, their shareholders and financiers about the wonders of their new drug, they had forgotten to tell the bushmen, whose knowledge they had used and patented.

Phytopharm's excuse appears to be that it believed the tribes which used the Hoodia cactus were extinct. Richard Dixey, the firm's chief executive, said: "We're doing what we can to pay back, but it's a really fraught problem... especially as the people who discovered the plant have disappeared". Having woken up to the fact that the San are alive, well and organising a campaign for compensation, Dixey backtracked fast and a benefit sharing agreement was drawn up between Phytopharm, the South African Council for Scientific and Industrial Research (CSIR), which was responsible for leading Phytopharm to the Hoodia plant (and misleading the company about the extinction of the San). Ironically, CSIR's failure to consult with the San early in the commercial development of Hoodia considerably strengthened the bargaining arm and political leverage of the San, resulting in a high-profile case followed throughout the world. But even in this 'best case' benefit sharing scenario, the San will receive only a fraction of a percent – less than 0.003% - of net sales. The San's money will come from the CSIR's share, while profits received by Phytopharm and Pfizer will remain unchanged. Not only are Pfizer and Phytopharm exempt from sharing their king-sized portions, but also are protected by the agreement from any further financial demands by the San.

There are also other concerns. Chief amongst them is that the agreement is confined almost exclusively to monetary benefits, which hinge on product sales and successful commercialisation. Yet commercialisation is far from certain, highlighting the need for a more comprehensive and holistic approach to benefit-sharing that is not exclusively financial, is not contingent on successful drug development, and provides immediate and tangible benefits to the San. Additional worries include the fraught questions of administering the funds, of determining beneficiaries and specific benefits across geographical boundaries and within different communities, and of minimising the social and economic impacts and conflicts that could arise with the introduction of large sums of money into impoverished communities. A critical moral dilemma relates to the patenting and privatisation of knowledge. In communities such as the San, the sharing of knowledge is a culture and basic to their way of life.

**Sources:** Antony Barnett, "In Africa the Hoodia cactus keeps men alive. Now its secret is 'stolen' to make us thin", The Observer (London), 17 June 2001; Rachel Wynberg (2002), Sharing the Crumbs with the San.

GRAIN. 2004.

# Traditional Knowledge and Patentability

## 1. Introduction

Traditional knowledge is information, skills, practices and products—often associated with indigenous peoples—which is acquired, practiced, enriched and passed on through generations. It is typically deeply rooted in a specific political, cultural, religious and environmental context, and is a key part of the community's interaction with the natural environment.

At the global level, minimum standards and criteria for patent protection are established by the WTO's Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs Agreement). Although the TRIPs Agreement does not directly address traditional knowledge, the subject matter requirements and the nature of the rights conferred to patent owners do have implications for indigenous groups in the protection of traditional knowledge. These are further explored below.

Article 27 of the TRIPs Agreement requires member countries to make patents available for innovative products or processes in all fields of technology, provided that the minimum criteria of novelty, inventiveness and industrial applicability are satisfied. Article 27.3(b) also requires protection for plant varieties, either under a patent system, or through other *sui generis* protection[i]. In industrialized economies, patents are a tool for rewarding innovative endeavours with a profitable temporary monopoly, and the patent grant serves as a powerful incentive to undertake research and to commercialize its results. Since the TRIPs Agreement allows members to grant patents, plants and other life forms, a strong incentive exists for research to be conducted in biodiversity-rich areas of the world, particularly since plant-based therapies, domestic seeds and their associated research and inventive effort have emerged as an important element of the success of modern medical/agricultural biotechnology. It is here that the incentive effects of patent rights connect most directly with traditional knowledge, which includes medicinal/agricultural practices based on knowledge of the natural environment—especially plants—to treat members of the community, usually as part of survival, common uses, rituals and sacred practices.

## 2. What are the issues?

There are two main issues in the relationship between the TRIPs Agreement and traditional knowledge.

### *a. Property Rights, the Culture of Ownership and Traditional Knowledge*

Within some indigenous groups, traditional knowledge is systematized and regulated by certain members of the group. Frequently, however, traditional knowledge is not "owned" by anyone, in a Western sense of the word. It is used and developed for the benefit of the entire community, and the idea of exclusive proprietary use of such knowledge for individual profit is objectionable to many traditional knowledge holders.

Further, opponents of patent protection for traditional knowledge have argued that such protection will ultimately undermine the processes by which the knowledge has historically been acquired, preserved and used in the indigenous community. That is, the historical basis for development of traditional knowledge was an understanding that it would be used for the community's benefit. The concepts of individual profit and exclusive ownership may erode that understanding, resulting in the arrested development of the knowledge base. The same concern has been raised with respect to the protection of traditional knowledge through copyright and trademarks.

### *b. Appropriation of Traditional Knowledge*

Another issue at the intersection of traditional knowledge and TRIPs-style patent protection is the appropriation of traditional knowledge by researchers, scholars and institutions from outside the community with neither the

consent of the community, nor agreements to share benefits arising from the use of the knowledge. These actors are usually, but not always, from the developed world. Even when access to traditional knowledge has been authorized, the critical issue is whether the communities that are the source of that knowledge have been compensated at all and, if so, whether the levels of compensation were fair. Too often they are not fairly compensated, though they are the primary source of at least *some* of the intellectual capital and raw materials used in developing the patentable product or process.

Traditional communities are generally at a disadvantage when dealing with "bioprospectors"—those who search for and harvest medicinal plants, agricultural plant varieties and genetic resources for commercial purposes, and who require the communities' help and knowledge. Often the communities have no understanding of the commercial value of the knowledge they are asked to disclose, nor do they have the skills to negotiate fair terms for such disclosure should there be an opportunity to share in the economic benefits of any resulting commercialization of the knowledge.

It should be noted that valuable services may be rendered whether or not a patent is ultimately granted. For example, traditional knowledge may simply inform researchers of what might not be a viable research path. However, even such negative knowledge has some economic value since it can give a firm a head start in the research phase of product development. Judicial decisions in some developed countries have recognized the value of these so-called "blind alleys" in calculating monetary damages for misappropriation of proprietary interests.

## 3. Alternatives to the TRIPs model

The TRIPs Agreement is only one of many existing institutional models for addressing the protection and fair treatment of traditional knowledge. Indeed, one of the key difficulties in advancing this objective is the multitude of actors and institutions that have partial, sometimes overlapping approaches and mandates, and the lack of coordination among them. The WTO was discussed above, and this section deals in more detail with the new Treaty on Genetic Resources for Food and Agriculture, the UN Food and Agriculture Organization (FAO) and the Convention on Biological Diversity. Others include the World Intellectual Property Organization (WIPO) (addressing legal options for the defensive and positive protection of traditional knowledge), the World Health Organization (issues of traditional medicine), the United Nations Educational, Scientific and Cultural Organization (addressing protection for folklore and cultural heritage), the United Nations Conference on Trade and Development (addressing the protection of traditional knowledge in relation to the TRIPs Agreement) and the United Nations Sub- Committee on Human Rights (examining human rights implications of the TRIPs Agreement, including issues of traditional knowledge protection). If the goal is an effective and fair multilateral system, this scattering of institutional responsibility will be one of the foremost obstacles.

Two alternate existing models to protecting and fairly treating traditional knowledge are surveyed in this section: the Convention on Biological Diversity (CBD) and the FAO's International Treaty on Plant Genetic Resources for Food and Agriculture.

### *a. The Convention on Biological* Diversity

There is an ongoing debate about the relationship between the patent requirements of the TRIPs Agreement and the substantive obligations of the Convention on Biological Diversity (CBD). The CBD, among other things, provides for the sovereign rights of a country over its plant and animal life, as well as its genetic resources. The CBD also provides that access to genetic resources should be subject to prior informed consent of the authorities of the countries (including the consent of traditional communities) and that there should be fair and equitable sharing of the benefits that flow from the commercialization of traditional knowledge or products that incorporate traditional knowledge.

These last two provisions in particular are not provided for in the TRIPs Agreement. In the course of the ongoing review of the Agreement's Article 27.3(b), it has been suggested that a precondition for granting of a patent should

be a proof of the existence of prior informed consent and benefit-sharing agreements where the patent involves the use of traditional knowledge, as well as a the disclosure of origin of biological resources used or incorporated in patents for products or processes.

Most of these proposals have come from developing countries, but there is no consensus among them on the wisdom of renegotiating 27.3(b), since there are a number of risks as well as potential benefits. For example, the current negotiations could well result in the deletion of the exceptions to patentability and narrowing down of definition of what is to be understood as a *sui generis* system. In such cases most developing countries would agree that they were worse off than under the flexible ambiguity of the existing language.

Developed countries have objected to these proposals, arguing that they would unduly burden the patent process and that the TRIPs Agreement is the wrong forum for this type of protection for traditional knowledge. In part this argument stems from a conviction that traditional knowledge is not and should not be covered by the TRIPs Agreement. Countries supporting this position identify a number of obstacles to intellectual property protection for traditional knowledge, including the difficulty of identifying ownership (most traditional knowledge is held by the community at large), the long period of time the knowledge has existed (intellectual property rights are protected for a limited time), and the requisite legal standards for intellectual property protection (such as novelty and non-obviousness in patent law) which some traditional knowledge may not easily satisfy. The counter-argument is that, administrative difficulties notwithstanding, TRIPs *should* cover traditional knowledge which, like intellectual property, is the product of intellectual activity, innovation, creativity, ingenuity and a rudimentary form of R & D.

More generally, opponents of traditional knowledge protection in the TRIPs Agreement argue that the basis for intellectual property protection is increasingly utilitarian, while traditional knowledge protection would have to account for the social and religious aspects of that knowledge base in the traditional community. Thus, the argument is that the goals of the CBD can be facilitated by protecting traditional knowledge differently from modern intellectual property, rather than viewing the goals of the CBD and TRIPs in a holistic fashion.

### b. *The International Undertaking on Plant Genetic Resources and the International Treaty on Genetic Resources for Food and Agriculture*

In 1983, the International Undertaking on Plant Genetic Resources (IU), a multilateral instrument administered by the Food and Agriculture Organization (FAO), declared that plant genetic resources and plant-related innovations are the common heritage of mankind. The IU preserves the principle of open access to international gene banks which hold seeds in trust for public benefit. These gene banks provide access to samples in their collections for research purposes, but preclude users from acquiring intellectual property rights in any materials distributed. The strong emphasis placed on intellectual property rights in leading developed countries to stimulate research and encourage private investment in creative activity prevented those countries from signing the IU.

In 2001, a new treaty on plant genetic resources was created: the International Treaty on Plant Genetic Resources for Food and Agriculture (IT). This treaty, which is supported by many developed and developing countries, establishes a new system of access to seeds of specified food and feed crops that comprise the bulk of human nutrition. In exchange for access to these seeds, private parties who create commercially viable products from these banks must pay a percentage of their profits into a trust account, unless the product is made freely available for use in further research and breeding. The funds from the trust account are to be used to facilitate benefit-sharing to farmers in developing countries, and the conservation of plant genetic resources. In this regard, this new treaty accords "public domain" status to specific genetic material and seeks to establish a means to preserve the earth's genetic riches.

The new IT treaty addresses traditional knowledge issues in several respects. First, it provides for farmers' rights and their traditional knowledge in farming practices. Article 9.2 of the IT treaty provides that it is the responsibility of national governments to take appropriate measures to protect farmers' rights which include, *inter alia*: "(a)

protection of traditional knowledge relevant to plant genetic resources for food and agriculture; (b) the right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture." It is, however, unclear whether these rights are undercut by the TRIPs Agreement in light of the next paragraph: "Nothing in this Article shall be interpreted to limit any rights that farmers have to save, use, exchange and sell farm-seed/propagating material, subject to national law and as appropriate."

Second, it is unclear whether traditional knowledge is subject to information databases on plant genetic resources which are part of the new multilateral system. If they are, then traditional knowledge with respect to genetic resources may have been cast into the public domain under the terms of the treaty. If so, proposals to protect traditional knowledge either through the grant of intellectual property rights, or through a *sui generis* system, will have to occlude knowledge which is covered by the IT system (assuming the treaty is ultimately ratified).

Third, the new IT treaty does not specifically provide for benefit sharing to go to the indigenous communities directly. Although the objective is for farmers in developing countries to benefit from the system, it is not clear what mechanism will ensure that this in fact occurs.

## 4. Other models

A variety of other legal mechanisms for the protection of traditional knowledge have been proposed. Prominent among these are proposals for a *sui generis* regime consisting either of a benefit-sharing system or a "misappropriation model." The benefit sharing system would require some of profits made from the commercialization of traditional knowledge to be remitted to the "owners" of the knowledge. A misappropriation model would imply the revocation of patents and other intellectual property rights over traditional knowledge obtained without the consent of the title holders of that knowledge.

Ongoing patent harmonization efforts at the World Intellectual Property Organization (WIPO) may make it difficult to address the protection of traditional knowledge using the patent system. The Substantive Patent Law Treaty currently under negotiation will represent a multilateral agreement on the granting of patents. There is currently a controversy over whether it should contain requirements on disclosure of origin, and general exceptions from patentability based on preserving public interest (to be decided by national level authorities). If this is not addressed during negotiations (a definite possibility) it will eliminate—at least in the foreseeable future—the possibility of national-level requirements that patent applicants disclose the origin of plants or other genetic material, and certify prior informed consent for use of traditional knowledge. Further, countries that now include this provision in their domestic patent laws may be forced to strike the provision as a condition of membership in the treaty.

## 5. Implications for sustainable development

Sustainable development in the context of traditional knowledge and patents has both institutional and substantive aspects. With regard to substantive issues, the developing countries' ability to regulate access and use of genetic resources and protection of traditional knowledge is critically important to development on a number of levels. It is a prerequisite to the economic returns that may accrue under benefit-sharing arrangements—arrangements that may allow traditional communities the financial resources to choose to maintain their traditional lifestyles. Depending on the arrangement in question, it may also end up by paying traditional communities to maintain biodiversity by acting as stewards.

On the institutional side, the shape of the actual benefits sharing arrangements will be key. It was argued above that certain types of arrangements, depending on the community where they are introduced, may have the effect of stifling the traditional process of informal innovation, which would work against the benefit of the community as a whole. In general, any system of benefit sharing will have impacts on the existing social structures and the distribution of power and resources within them. The fact that traditional societies have a multitude of different social structures makes this consideration difficult to address when designing a benefits sharing system, but no less important from a sustainable development perspective.

Some developing countries have already enacted domestic laws dealing with the protection of traditional knowledge. There are also important legislative efforts that have taken place at regional levels. As well, the Plan of Implementation of the World Summit on Sustainable Development (WSSD) (paragraph 42(j)) calls on countries to, "subject to national legislation, recognize the rights of local and indigenous communities who are holders of traditional knowledge, innovations and practices," and "develop and implement benefit-sharing mechanisms on mutually agreed terms for the use of such knowledge, innovations and practices."

However, without some international agreement that recognizes and affords protection to this body of knowledge, unilateral efforts alone will not sufficiently harness the value of traditional knowledge for development objectives. In fact, even multilateral arrangements between developing countries will not suffice, since the exploitation of the knowledge and resources takes place largely in developed countries. The absence of an international agreement will affect opportunities for developing countries and traditional communities to control, manage and benefit from traditional knowledge. This was recognized to be the case for genetic resources as a whole in the WSSD Plan of Implementation, which called on countries to negotiate, under the framework of the CBD, "an international regime to promote and safeguard the fair and equitable sharing of benefits arising out of the utilization of genetic resources."

It has been widely recognized that the issues of traditional knowledge and patentability need to be addressed as a key component of sustainable development. The complications of many ongoing overlapping processes, and the complexity of the issues involved, do not diminish the final value of addressing those issues in a comprehensive manner, and in a way that promotes equity, social values and environmental integrity.


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[i] A *sui generis* system implies a special system. *Sui generis* means "of its own kind." In this case it would be a system specifically designed to protect plant varieties.

# Seeds of Life: Women and Agricultural Biodiversity in Africa

Agricultural development worldwide has caused, as one of its down-sides, the replacement of native plant species by marketable crops and a parallel reduction in the diversity of the seed stock. The disappearance of plants with potential medicinal uses, particularly in areas of high biodiversity like tropical rain forests, has been headlined in recent years; but crowding out of the natural diversity of edible species by standard, and sometimes genetically altered, cash crops — and the replacement of "landraces" (indigenous plant types) by commercial farming — constitute an equally serious problem. Efforts are now being made to constitute reserves and pools of threatened varieties of food crops. Indigenous knowledge of edible plants is one key "pool" of biodiversity in Africa — and one in which women play a vital role.

## Bean farming in Kenya

Bean farming among the Kikuyu in Kenya provides a case in point. Available evidence indicates that in pre-colonial times a large variety of different bean species was cultivated in the Kenyan uplands. Beans moreover constituted a critical element of the diet of rural people, furnishing a rich source of protein to complement maize consumption and other available foodstuffs. In particular, the varieties of indigenous black beans termed "njahe" in Kikuyu (largely *Lablab niger* and *Dolichos lablab* by their scientific names, and "lablab beans" in English), which were cultivated by women, constituted a good proportion of the harvest. Njahe had, moreover, special meaning for women, as the bean was considered to increase fertility and to have curative virtues for post-partum mothers. It was at the same time a quasi-sacred food. It grew on the Ol Donyo Sabuk mountain, the second most important dwelling place of the Creator in Kikuyu religion, and it was widely used in divination ceremonies. Beans in Kenya are predominantly a small landholder crop, largely farmed by women to feed their families. Traditionally, women tended to grow multiple varieties on the same field — and to conserve multiple seed stocks — as a hedge against disease and unpredictable climate. Local dishes, like "githeri" and "irio," also were based on multiple types of beans.

These patterns began to change in colonial times. The British administration was principally interested in increasing maize production, which provided the least expensive supply of food to feed railroad construction workers, and in introducing other cash crops like cotton and sisal to ensure tax payments. The strategy developed for advancing this agenda included providing financial incentives and favorable pricing for maize cultivation, on the one hand; and, on the other, introducing new varieties of white and red beans with export potential (to Europe in particular) in order to replace the njahe and other "native" species. Though a considerable variety of bean species was experimented with over the years by the colonial agricultural extension service, few proved adapted to Kenyan conditions or acceptable in local diets. Those that did — Canadian kidney, rose coco and *Phaseolus vulgaris*, in particular — gradually took over the market and began pushing njahe out of production. The colonial agricultural extension service also carried out purification campaigns to eliminate multicropping of mixed beans and to ensure a practice of "one variety per location" — generally an exportable variety. Pure or sorted beans were priced at two or three times above mixed crops.

## The costs of monocropping

The phenomenon had real consequences for nutrition, for agricultural biodiversity in the Kenyan highlands, for soil fertility, and for women farmers themselves. Replacement of beans by maize in local diets began a downward spiral in the food intake of the rural population which, while scarcely attributable only to this factor, has continued unabated. At the same time, elimination of many of the multiple varieties of beans cultivated in pre-colonial times had, for parallel effect, impoverishment of the agricultural genetic stock, developed over thousands of years of human agriculture in East Africa. Intensive "maize mining" and neglect of the nitrogen-fixing properties of legumes like njahe resulted in the progressive impoverishment of soils. Bean monocropping led in turn to higher susceptibility of these crop stands to

disease. Finally, since bean cultivation constituted an important element in the economic activity of women and their capacity to nourish their families, the pressure to produce income and abandon beans inevitably contributed to the increasing out-migration of women to urban areas.

Colonial policies were in effect extended into the period of Kenyan independence, by default if not by design. Continued preoccupation with cash crop and export production, monopoly of these activities by men, and economic pressures from taxes and the need to pay school fees all kept attention away from women's roles in bean production and the conservation of seed diversity. Not until the 1970s did the prejudice against traditional bean species begin to relax, as Kenyan agricultural policy underwent gradual re-Africanization.

## Examples across Africa

The situation described in Kenya is scarcely an isolated phenomenon. Across Africa, similar stories could be evoked — stories of the gradual impoverishment of seed stocks under the pressure of cash cropping and of the parallel negligence of women's roles in agriculture and their key function as guardians of biodiversity. In fact, Africa is one of the world's regions with the lowest quotient of original to imported seed stock – a characteristic typical elsewhere of zones of settler implantation, like North America and Australia. Seed stocks and germ plasm constitute a kind of botanical repository of indigenous knowledge. Because of their responsibility for family subsistence, women have for millennia been central to the breeding of food crop species, the preservation of seeds and the domestication and use of wild edible plants. Concerns with susceptibility to disease and insurance against crop failure under climatic stress and unpredictability have led them to diversify these stocks and cultivation patterns.

- In Burkina Faso and throughout the West African Sahel, for example, rural women carefully collect the fruit, leaves and roots of native plants like the baobab tree (*Adansonia digitata*), red sorrel leaves (*Hibiscus saddarifa*), kapok leaves (*Ceiba pentandra*) and tigernut tubers (*Cyperus esculentus L*) for use in the diet of their families, supplementing the agricultural grains (millet, sorghum) that provide only one part of the nutritional spectrum and may fail in any given year. More than 800 species of edible wild plants have been catalogued across the Sahel.
- In southern Sudan, women are directly responsible for the selection of all sorghum seeds saved for planting each year. They cull seeds and preserve a spread of varieties that will ensure resistance to the variety of conditions that may arise in any given growing season.

## The role of women farmers worldwide

Equivalent stories can be recounted about gender and agricultural biodiversity in other regions of the world as well. In agricultural societies around the globe, women have tended to be the custodians of biodiversity.

- Researchers from the Wageningen Agricultural University of the Netherlands have found that women in the Kalasin region of northern Thailand play a critical role in managing the interface between wild and domesticated species of edible plants. They have both brought new species of wild plants under cultivation in recent years and spurred their communities to carefully regulate collection rights in the face of increasing commercialization.
- Women in the Dalwangan and Mammbong communities, Bukidnon province, Mindanao (the Philippines) have played an active role in constituting a "memory bank" of indigenous germplasm with agricultural researchers, because they share the concern for diversity. "I cultivate different kinds [of sweet potatoes], as many as I can get cuttings of," one farmer commented, "because each has its use and none is proof to all disasters."
- In northern India, an elderly woman farmer puts the matter succinctly as she selects seeds for storage: "It takes a sharp eye, a sensitive hand and a lot of patience to tell the difference between these seeds. But these are not the things that are honored any more."
- In the United States, genetic modification of tomatoes by agro industry has led to species that have a long "shelf life" — i.e., ability to ripen in transit or in grocery stores after being harvested green — and even a

square form that facilitates packing in crates. These characteristics make tomato-farming a more profitable activity and one easier to carry out on a large scale, but have had for parallel consequence poorer taste and loss of genetic diversity. A minor market has sprung up in "heirloom tomatoes" — species preserved in many cases by women gardeners and now conserved and reproduced for the organic customer.

## Turning the tide

Is there still time in countries such as Kenya? Yes, but not to waste. The diminishing diversity of seed stocks puts food security at risk, because of the greater vulnerability of a narrow band of species to climate change and other environmental events. And it seems unlikely that the situation can be turned around without paying much closer attention to the means by which traditional farmers have nurtured seed stocks and indigenous species, and the key role that women have played in this enterprise.

The njahe bean itself has nonetheless recouped a part of the terrain lost over the last century. With the abandonment of export ambitions for white beans, African tastes for red and black varieties have begun to reassert themselves. But dried beans — and the female labor that traditionally ensured their volume and diversity — remain subsidiary in the Kenyan economy. Increased sensitivity to issues of biodiversity — triggered by the rain forest and the example of disappearing species with medical significance — has sown new seeds of hope in this realm, however, both for Africa and for other developing regions. The International Center for Tropical Agriculture (CIAT) in Cali, Colombia is coordinating a multiyear participatory research program on gender roles in agriculture and participatory plant breeding (Participatory Research and Gender Analysis: "PRGA" , on the web at **www.prgaprogram.org** ). One branch office has been established in Uganda for the African Highlands Initiative, an exploitation of participatory gender research in East Africa. At the same time, the West African Rice Development Association (WARDA), headquartered in Bouaké, Ivory Coast, has given increasing attention to the preservation of biodiversity among rice farmers of the Sahel and has sponsored research into related practices in southwestern Mali. (See **www.cgiar.org/warda** )

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# Indigenous Knowledge and HIV/AIDS: Ghana and Zambia

It has always been difficult to reach poor people with development aid, particularly in health where most resources benefit the middle classes in urban hospitals. For the rural poor, and increasingly also for the urban poor, often the only affordable and accessible form of health care is provided by traditional healers. Zambia with an estimated 20-25 percent of the population HIV-positive has only 900 western- educated doctors (600 of whom are foreign) but has 40,000 registered traditional healers for a population of 10 million. Ghana, with 5 percent of the population being HIV-positive, has 1,200 western educated doctors but an estimated 50,000 traditional healers for a population of 20 million. Thus, the ratio of doctor to traditional healer is 1:44 in Zambia and 1:42 in Ghana. Given the central cultural role of traditional healers in communities, they provide one of the best hopes for treating and stemming the spread of AIDS. But healers rely on medicinal plants and there has been a significant decrease in the abundance of many important medicinal plant species as their habitat are lost through deforestation, cultivation, overgrazing, burning, droughts, desertification, etc. This problem has been exacerbated by the unmanaged local and international demand for medicinal plants. Furthermore, traditional healers have identified as an important issue, the loss of indigenous knowledge regarding traditional medicine, which forms part of the cultural heritage of local communities and is usually transmitted orally. This knowledge is often undervalued by the younger generations, at least in part because traditional medicine seldom brings high economic returns to the practitioner.

In recognition of the importance to preserve and protect this ethnomedical knowledge, and the plant species on which it is based, the governments of Zambia and Ghana, with support from the World Bank, are in the process of establishing a bridge between environment and health in fighting HIV/AIDS. In Zambia the executing agency is the Traditional Health Practitioners Association of Zambia (THPAZ) through the Environmental Support Program (ESP) under the Ministry of Environment and Natural Resources. In Ghana, the effort will be part of the Northern Savanna Biodiversity Conservation Project (NSBCP) under the Ministry of Land, Forestry and Mines. Basically, the two projects have the same approach although they differ in design: in Zambia the initiative has been retrofitted into an already existing program while in Ghana the activities will be part of on-going project design. What follows is first a short description of the AIDS component involving traditional healers under the Zambian ESP; second, a comparison of the sociocultural findings particularly concerning gender differences related to traditional medicine in the two countries; and third, some of the difficulties experienced during the process of establishing this cross-sector initiative involving agriculture, environment, health, and rural development.

Under the Zambian initiative, "Protection and Sustainable Use of Biodiversity for Medicinal Value: An Initiative to Combat HIV/AIDS" there are three main activities. The first activity, "Conservation of Biodiversity for HIV/AIDS Prevention and Treatment" includes the establishment of botanic gardens, forest reserves for medicinal plants, and a herbarium with medicinal plants. Some of the seeds, cuttings and tubers for planting will come from Spiritual Forests, which have considerable biodiversity and contain rare species of plants and trees, which have been preserved because of the traditional rules, norms, and taboos associated with them. The second activity "Training and Capacity Building" is directed towards the traditional healers and includes a long list of topics from behavior modification in relation to HIV/AIDS, understanding ecosystems, nutrition, toxicology, basic virology, epidemics, and immunology. In addition to the environmental and medical aspects there will also be legal training so that healers do not infringe the law, such as the Witchcraft Act, and get a better understanding of human rights. The third activity "Dissemination of Information/Knowledge on Biodiversity and HIV/AIDS" will set up a communication strategy to be implemented through newsletters, radio programs, TV, drama/plays and leaflets. This activity will also include an electronic database on medicinal plants and publication of a handbook for traditional healers to be used in their practice. All training materials, programs, and publications will be in the major local languages and a basic literacy program will be added to make the (often) -illiterate healers capable of registering their patients, and documenting their indigenous knowledge.

Whereas gender analysis has been essential for project design in both Zambia and Ghana the role of women are very different in the two countries. Generally the gender division of labor has been stronger in Ghana than in Zambia. This has had an effect on the position of female traditional healers as well as their ability to participate in project activities. Some of the sociocultural differences are analyzed here. In Zambia, traditional healers have received donor help to be organized on a national basis, and 60 percent of the registered traditional healers are women. The number of women healers is even said to be growing in response to the increasing number of AIDS patients. People call HIV/AIDS "Kalaye noko," meaning "go and say goodbye to your mother," because most people die in their villages in their mothers' homes. Although women in Ghana are also the ones to care for the ill, the contrast is striking when it comes to practicing healing. In Ghana, there is no functional national traditional healers' association, and the three northern regions have less than one fifth of the estimated healers' registered. Of these (few) registered members, less than 10 percent are women except for one minor sub-region where an active healer has managed to raise the figure to 49 percent. However, the low figure in Ghana is more a reflection of local beliefs than of the actual number of women healers. Also, the Bank-assisted initiative might have unintentionally cemented already existing gender bias by, for example, only training the registered healers, who are overwhelmingly male. According to one female healer in Ghana, women, if they openly practice traditional medicine "are termed witches and every misfortune is blamed on them; in most cases these women are disowned and sent out of their societies. For this reason it is only the queen of witches who is known to heal, because she is so powerful that it is impossible for any member of the society to challenge her."

In both countries it was extremely rare to find traditional healers who cultivated medicinal plants, and when it did happen, it was almost exclusively funded by donors. In Zambia, women healers often referred to a spirit guiding them to the medicinal plants, which they collected and prepared for medicine themselves. In Ghana, there was substantial gender bias related to the collection of plants, preparation of medicine, and even to sexuality, which had a positive influence on males but a negative influence on women. Fewer female healers in Ghana were married than were male healers, which one female healer explained by saying that she would not be able to heal if her husband was living with her. Neither would healers, who used traditional African religious rituals in the healing process, send their daughters into the bush to get the plants, because "people would think they were witches." And husbands would not let their wives help to make the medicine "because the medicine would not work" if prepared by a woman. An obvious rationale for this taboo was patrilineal location and succession which meant that a woman at marriage would move to her husband's house, and the family's secret knowledge on plants and its medical use, would thereby be in danger of being uncovered by another family. Healers in Ghana were also reluctant to teach their daughters traditional medicine, but little girls also have eyes and ears, and many women practice medicine, although not openly. That obviously had a negative influence on women's options for income generation through their practice. Only traditional birth attendants (TBA) were almost exclusively women, and most TBAs received some remuneration for their services. But most traditional healers earn their main income from farming and remuneration for healing was in farm products. In Zambia, the declining economy had forced many healers to give up payment in kind, and healers had increasingly turned to (their individual) standard payments for each disease. The highest price was always a cure for infertility, which had to be paid at the arrival of an infant son. The strong division of labor in Ghana gives a unique opportunity through the project to support women and families in HIV/AIDS prevention and poverty reduction, thereby enhancing the prospects of success for the project as a whole. The longterm goal of biodiversity conservation could seem abstract to communities suffering from food shortages and hunger; however, short-term income generation through the cultivation and selling of medicinal plants and vegetables leading to improvements in, particularly, children's health could have a catalytic effect on the success of the project.

Traditional healers, both male and female, expressed an eagerness to be trained to improve their practice. In Ghana, the mass communication program on HIV/AIDS had succeeded in disseminating information on transmission of the disease from one person to another via blood, sexual intercourse, infected needles, and so forth. But communities' knowledge on how it is transmitted was not always complete or accurate. Some communities referred to the danger of eating or bathing together with an AIDS infected person; even shaking hands or using the same clothes was mentioned as a possible way to be infected. None of the communities admitted that there were any affected

individuals in their village, and in both Zambia and Ghana, severe stigma was attached to a person with AIDS. Thus, people were less likely to admit infection and treat HIV/AIDS as a common, but serious, disease. Poverty and cultural norms also make Africa the continent with the highest proportion of women to men infected with AIDS. In the fight against AIDS, traditional healers need training as they provide health care for about 70 percent of the population. And TBAs, according to the World Health Organization, deliver 95 percent of babies in the rural areas, which makes them particularly critical care-givers but also renders them more vulnerable to HIV/AIDS. In the long run, the health infrastructure provided by the traditional healers and their organizations could provide the distribution network for AIDS medicines when they become available at a reasonable price. Traditional healers have a unique position as educators and potential distributors of AIDS medicine—for example in handling patients' doses. No African government has the resources or health personnel in the numbers needed to fight the AIDS epidemic.

Governments in Ghana or Zambia do not support traditional healers financially as they do their (modern) medical associations, and in neither country is traditional medicine part of the curriculum at medical faculties. In this respect, African countries are far behind countries such as China and India where alternative medicine is an integrated part of modern medicine practiced at hospitals. However, Ghana and Zambia both have staff in their Ministries of Health to coordinate policies to traditional healers, and both governments want healers to be registered. Ghana has shown a positive attitude towards the conservation of medicinal plants and has acknowledged traditional healers by passing a Traditional Medicine Practice Act in 2000. In Zambia, on the other hand, it was when more than one-fifth of the population became infected with AIDS that traditional healers were invited to become part of the Technical Committee on Natural Remedies for HIV and Other Related Diseases, placed directly under the Head of State. The Ministry of Environment and Natural Resources, under which the ESP is located, was initially very reluctant to involve civil society in natural resource management, and particularly THPAZ, which is the country's largest NGO. Traditional healers were considered to be irrelevant to modernity and therefore to be excluded from development. A similar reluctance was initially found in the World Bank where traditional healers' practices were often perceived as lacking scientific validation, and hence legitimacy. This view was also widespread among western doctors, although traditional health practice predates modern medical practice just as the use of herbs and medicinal plants predates the present pharmacological practice. Gradually, however, this attitude has changed and today it is acknowledged that initiatives like the ones in Zambia and Ghana are benefiting the poor directly and have considerable potential in treating AIDS-related diseases.

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# The Contribution of Indigenous Vegetables to Household Food Security

A lot of effort has been invested by the Government of Uganda to produce enough food for Uganda's population and a surplus for export. However, the indigenous vegetables, often referred to as traditional vegetables, have been underrated in favor of introduced exotic vegetables (Rubaihayo, 1995). Hence, the potential of traditional vegetables has not been exploited.

Traditional vegetables are perishable, low yielding and their value as commercial crops has not been explored. Yet, the majority of local farmers cannot always produce exotic vegetables because of the unavailability of seeds and/or high production costs of these vegetables. Unfortunately, the resource-poor urban and rural population often find it difficult to purchase exotic vegetables from local markets because of the high costs. They therefore, depend on traditional vegetables as a regular side dish or sauce accompanying the staple foods such as maize, cassava, sweet potatoes, banana, millet, sorghum and yams (Rubaihayo, 1994). The staple foods provide Calories needed for body energy but are very low in other nutrients while the traditional vegetables have a very high nutritive value. They contain vitamin A, B, and C, proteins and minerals such as iron, calcium, phosphorus, iodine and fluorine in varying amounts but adequate for normal growth and health. For example, vitamin A which is required to prevent blindness especially in children is found in all dark green leafy traditional vegetables such as *Amaranthus* (dodo), *Solanum aethiopicum* (Nakati), *Manihotesculenta* (cassava leaves) and *Ipomea batatas* (sweet potato leaves). On the other hand vegetables like *Solanum indicum* subsp.. *distichum* (Katunkuma) are believed to control high blood pressure. The traditional vegetables, therefore, meet the major protein-calorie nutritional needs especially in children, the sick, elderly, expectant and lactating mothers (FAO, 1988).

Unfortunately, the consumers have not been sensitized to appreciate the role of the traditional vegetables in fulfilling the above human needs.

Most of the traditional vegetables are produced throughout the developing world mainly in kitchen and home gardens. Because of the importance of these gardens, an international Workshop on Household Garden Projects was held in Bangkok, Thailand in May 1991 to consolidate lessons learned from experience with household garden projects. The workshop analyzed the relevance and effectiveness of household food production as a development intervention, targeted at the most nutritionally and economically disadvantaged people and identified viable implementation strategies of household gardens (Midmore et al., 1991).

The purpose of this paper is to prompt policy makers and development managers to reassess and give more weight to the neglected production and consumption of traditional vegetables so as to enhance nutrition, income generation and food security for small scale households. The views expressed in this paper are a result of interviews with several people from many countries including Uganda, Ethiopia, Kenya. Tanzania, Zimbabwe, Zambia, Rwanda, Cameroon, Nigeria, Ghana, Ivory Coast, Gabon, Senegal, etc. although there is more focus on the Uganda situation.

***Kitchen gardens.*** Kitchen gardens are common in urban centers and their suburbs. They are normally made up of very small plots of usually pure stands of traditional vegetables as part of the garden of the residence. The vegetables are produced cheaply in these gardens using compost rather than commercial fertilizers (Midmore et al., 1991).

The commonly grown traditional vegetables include *interalia* Leafy *Amaranthus* species, *Basellaalba*, *Solanumaethiopicum*, *Solanum gilo*, *Solanum indicum sub sp distchum*, *Cqapsicum* species *Colocasiaesculenta, Phaseolus vulgaris, Gynendropsis gynandra, Vigna unguiculata, Bidens pilosa, Manihot esculenta, Corchorus olitoris, Solanum nigrum, Abelmoschum esculenta, Cucurbita maxima*, and *Acalypha biparlita.* Exotic vegetables such as *Brassica oleracea, B. oleracea* and *Daucus carota* are also commonly grown. The yields of some fresh vegetables in Uganda are shown in Table 1.

***Home gardens.*** Home gardens are found in villages. The plots are larger than those of kitchen gardens and a number of vegetables and other crops are mixed are mixed together including fruits, vegetables, medicinal plants, staple foods and shade trees. The home gardens in villages surrounding the suburbs of the urban centers are often planted with cabbages, cauliflower, carrots, Amaranthus lividus (grown in swamps and water logged soils), *Solanum gilo*, Solanum indicum subsp. dischum mostly as monocrops. These vegetables are sold in the neighboring urban and their suburbs markets.

**Table 1. Dry matter yields of common vegetables in Uganda**

| Crop | Yield/ha | Reference |
|---|---|---|
| Cowpea | 11.1 t/ha. | Ocaya, unpubl. |
| Cabbage | 24 t/ha. | Jabber, unpubl. |
| Amaranthus sp. | 20 t/ha. | Rubaihayo, 1994 |
| Solanum aethiopium | 7.5 t/ha. | Rubaihayo, 1994 |

## The contribution of indigenous vegetables to household food security

The home gardens of traditional vegetables in the rural setting are characterized by intercropping systems and volunteer plants during the rainy seasons. In many developing countries, where these gardens predominate, the contribution of traditional vegetable gardening as a food production strategy has been overlooked by policy makers and extension staff in favor of exotic vegetables which are mainly produced for commercial purposes (Rubaihayo, 1994). Unfortunately, the resource-poor rural households do not benefit from the remarkable increase in exotic vegetable commercial production due to the costly inputs of agricultural chemicals needed for their successful production. Therefore, it is extremely important to develop research and production strategies that directly enable the poorest of the poor to produce not only traditional vegetables but also staple foods.

Although the contributions from these gardens to family welfare are supplementary in nature, such modest contributions are very important to those who have very little in the rural and urban areas. These poor people often have access to only under-utilized marginal land and others have very small pieces of land. Intensive home and kitchen gardening can turn this land into a productive source of food and economic security by using narrative agricultural practices and the traditional vegetables that are already locally adopted.

***Importance of traditional vegetables.*** A large proportion of the Ugandan population do not consume adequate amounts of traditional vegetables to meet their daily requirement of vitamins, minerals and proteins. Even what is consumed has a large proportion of these nutrients destroyed or lost during preparation and cooking. There is reduced effectiveness in ensuring food security all year round due to the fact that very few traditional vegetables are cultivated, with the majority being collected from the wild or fields and plantations. In some of the ecosystems they are regarded as weeds and are often weeded out and are not available during the dry season (Rubaihayo, 1994). But this situation can be reversed through concerted efforts by the government to educate the general population and extension services to cover traditional vegetables and increase research to produce improved cultivars, processing, marketing and storage methods. This would lead to the increased consumption of traditional vegetables and their contribution to food security will be enhanced.

Family gardens are far more common in less well-to-do households, and constitute the major or the only source of food between harvests or when harvests fail. They provide a critical source of energy and protein, especially to weaningage children, the sick and elderly. Some of the traditional vegetables can continue to be productive even during the dry season although at a reduced rate due to stunted growth. Habitat destruction and migration to urban areas mean that wild foods are no longer available to these resource-poor rural farmers. Moreover, the commercialization of agriculture has displaced many indigenous crops that used to ensure a balanced rural diet (Rubaihayo, 1992).

It is important to appreciate that traditional vegetables, especially the leafy ones like Amaranthus, (dodo, Bugga) Solanum aethiopicum (Nakati) etc. can be handy under emergency circumstances and hardships arising out of civil conflicts and natural disorders that result in the displacement of communities. These traditional vegetables come into production with a short time soon after the onset of rains and can be harvested in three to four weeks after planting. These leafy vegetables could then be followed by crops like beans which take two to three months as cultivated relief food, so that purchased foods are a temporary or supplementary measure (Rubaihayo 1995b).

***Women and traditional vegetables.*** In Uganda, though rural women are responsible for feeding their household, yet they have limited access to resources. Household gardening offers women an important means of earning income without overtly challenging cultural and social restrictions on their activities. Home and kitchen gardens can enhance women's purchasing power and food production capacity which has a direct impact on household nutrition, health and food security.

Where traditional vegetables have been commercialized such as, Malakwang (Hibiscus spp.) Nakati (Solanum aethiopicum), Egobe (vigna unguiculata), Entula (Solanum gilo), Katunkuma (Solanum indicum subsp. Disticum), Doodo (Amaranthus dubious), Bbugga (Amaranthus lividus) particularly around the city of Kampala and in other urban areas, it is mainly the men who cultivate them. Middle men purchase these vegetables from the farmers (men) and transport them to the markets, and in the market women buy them and retail them to the general public. The sale of traditional vegetables in women-accessible markets do not only provide food security to those with purchasing capacity but the trading women are able to educate their children and, dress and provide their household with essential items in the home thus avoiding abject poverty.

***Home and kitchen gardens and the environment.*** Although there has not been an extensive study of the effects of traditional vegetable gardening on the environment, it is generally believed that household gardens conform to ecologically sound land management systems. Household food production uses organic farming practices which are friendly to the environment. The traditional style of household gardens is also critical in conserving diverse plant genetic resources (Midmore et al., 1991).

## Conclusion

Traditional vegetables are a common household food and make a substantial, though rarely appreciated contribution to the food security of the rural people in many African countries. Therefore, extensive education about their importance as a nutritionally balanced food and as a direct and indirect source of income, particularly for the resource-poor families, must be undertaken by African governments.

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# Food security and biodiversity

The husbandry of domesticated species and the harvesting of wild plants and animals are the mainstay of human food production. 840 million people in the world do not have enough to eat –and the population is growing. This means that food production will have to increase 50% by 2020. Biodiversity is part of the solution, in that it provides the genetic information used in plant and animal breeding. Furthermore it makes vulnerable livelihoods more resilient by providing risk spreading options across a range of domesticated and wild species rather than relying on a few staples that may become susceptible to disease, pests, climate changes, and market collapse. It also provides diversity for a varied diet.

## Biodiversity pyramids

The greater part of the world's food supply depends on a very limited number of plant and animal species. About 7,000 plants (2.6% of all plant species) have been collected or cultivated for human consumption. Of these, a mere 200 have been domesticated and only a dozen contribute about 75% of the global intake of plant-derived Calories: bananas, beans, cassava, maize, millets, potatoes, rice, sorghum, soya, sugarcane, sweet potatoes and wheat. On the animal side, more than 95% of world consumption of livestock protein derives from poultry, cattle and pigs. There are about 1,000 commercial fish species, but in aquaculture fewer than 10 species dominate global production. Human food production therefore rests on the tips of pyramids of biodiversity, leaving the majority of species little-used and undomesticated.

Long-domesticated species tend to be highly diverse: for example, there are some 25,000 cultivars of wheat, more than 1,300 breeds of sheep, and over 20 varieties of common carp. In recent years, however, this variety has been reduced by genetic erosion. It is estimated that the number of wheat cultivars in China has dropped from 10,000 to 1,000 in 50 years; that over 90% of cabbage, field maize and pea varieties no longer exist; and that over 30% of livestock breeds are at risk of extinction. The causes of this genetic erosion are many, but replacement of local varieties as a result of the spread of modern agriculture is the most consistently cited reason.

### Biodiversity and nutrition

**The quality of food, especially in terms of supplying essential vitamins and other nutrients, is central to achieving food security and avoiding nutritional diseases. Although staple crops and stock provide most protein and energy requirements, they are often deficient in other nutrients. In rice-consuming countries, for example, common nutritional deficiencies include: iron, vitamin A, iodine, thiamine, riboflavin, calcium, vitamin C, zinc, fat, and ascorbic acid. Many of these nutrients are supplied by foods gathered from wildlands and fallows, upon which millions of people rely. They include green leafy vegetables which are cooked and eaten along with the meal, and which can provide important iron and vitamin A supplements. Other such 'minor' products include nuts, oils, insects, mini-fish, birds, roots/tubers providing a range or fats, vitamins, minerals, and oils.**

This loss of agro-biodiversity presents risks to food production, in three main ways:

- a narrowing of future options, through the loss of genetic information and genetic material that could be introduced into domesticated crops and stock through breeding;
- an increased susceptibility to disease and pests because fewer varieties and species are grown over large areas, which may also lead to pesticide (and even fertiliser) dependence;
- the destabilisation of ecosystem processes, through disrupting soil formation, predator-prey cycles, etc.

**Proportion of food from wild products, for poor, medium and relatively wealthy households**

| Survey title | Date | Very Poor | Middle | Better off |
|---|---|---|---|---|
| Wollo – Dega, Ethiopia | 1999 | 0-10% | 0-10% | 0-5% |
| Jaibor, Sudan | 1997 | 15% | 5% | 2-5% |
| Chitipa, Malawi | 1997 | 0-10% | 0-10% | 0-5% |
| Ndoywo, Zimbabwe | 1997 | 0-5% | 0 | 0 |

*Source: Save the Children fund (ANA)*

These risks apply particularly to poor farmers who have little access to technology or genebanks for solutions, but they also apply to commercial breeders who depend on the diversity inherent in local crops and breeds, as well as in wild relatives of domesticated species, for future breeding programmes. Many varieties that have been developed locally, such as the 3–5,000 potato cultivars in the Andes, offer a vital starting point in future breeding programmes. Proportion of food from wild products, for poor, medium and relatively wealthy households.

Crop and livestock biodiversity hotspots (areas with high genetic diversity), together with *ex situ* gene-banks, are the main repositories of genetic information. As a result they are at the centre of a conflict over ownership, because genetic resources have been treated as 'global goods', and multilateral agencies which develop gene-banks have sent seeds, semen and other materials to researchers anywhere in the world. The Convention on Biological Diversity (CBD) urges nations and communities to assess their biodiversity and establish their rights to its exploitation, but access to genetic resources that were gathered before the CBD came into force remain largely unregulated.

## Small-scale and subsistence agriculture

Many poor farmers, especially those in environments where high-yield crop and livestock varieties do not prosper, rely on using a wide range of crop and livestock types. This helps them maintain their livelihood in the face of pathogen infestation, uncertain rainfall, fluctuation in the price of cash crops, socio-political disruption and unpredictable availability of agro-chemicals. So-called 'minor crops ' (more accurately, companion crops) play a disproportionately large role in food production systems at the local level. Plants that will grow in infertile or eroded soils, and livestock that will eat degraded vegetation, are often crucial to household nutritional strategies. In addition, rural communities, and the urban markets with which they trade, make great use of companion crop species, especially green-leafed potherbs.

Fallow fields and wildlands can support large numbers of species useful to farmers. In addition to supplying Calories and protein, wild foods supply vitamins and other essential micro-nutrients. In general, poor households rely on access to wild foods more than richer ones (see table), although in some areas pressure on the land is so great that wild food supplies have been exhausted.

Government and donor policies to promote food production through monocultures may overlook these resources, distort farmers' decision-making and threaten biodiversity. A common problem has been the introduction of new varieties, or species, with high input- needs, and then subsidising chemical inputs. Programmes for maize production in drought-prone environments of southern Africa, for example, have deterred the use of a wide range of local crop varieties. And redirecting Indus River water to irrigated agricultural schemes, caused salination of the river's mangrove delta which changed from a diverse and highly productive region, supporting a large human population, to a sparsely vegetated area dominated by a single species, *Avicennia marina*.

## Ecosystem disruption: introductions and agro-chemicals

Despite the benefits to local farmers of biodiversity- rich agriculture systems, indigenous varieties often have co-evolved pests and pathogens and may therefore have relatively low yields. In this sense, the introduction of crop species from outside their centre of origin has been extremely beneficial, and much agricultural development has relied upon it. But some introductions, accidental and intentional, have had significant impacts on local ecosystems, often with major implications for food security.

A common pattern is for a newly-introduced crop to be initially successful and then show declining yields, either through attack by evolving local species or from the introduction of a pest or pathogen from its region of origin (see BB7).

A different ecosystem balance that needs to be maintained for food production is in the soil, where invertebrates and microbes are central to decomposing dead materials and recycling nutrients as part of soil formation processes. Furthermore, there are important plant-soil relationships which should not be disrupted: certain soil fungi form mycorhizal associations on plant roots which enhance nutrient uptake from the soil; Rhizobium bacteria produce nitrogen-fixing nodules on plant rootlets. Applications of organic fertiliser, such as manure in mixed farming systems, tend to fortify these interactions and increase soil fertility, but loss of organic matter and/or large applications of inorganic fertilisers can lead to reduced soil fertility and pollution of waterbodies.

## Breeding and biotechnology

A large part of the success of the Green Revolution can be attributed to genetic biodiversity that was harnessed to breed new, high-yield crop varieties. Modern plant breeding often aims for wide adaptability and tries to develop varieties that are insensitive to daylight length (and can therefore grow anywhere). It has often been directed to producing varieties that respond to fertiliser applications, and may be grown where pesticides and irrigation are available. The result is an increase in production, but a narrowing of the number of varieties grown. This can make them less accessible to poor farmers, and lead to the various problems noted above. A careful balance needs to be struck.

Part of the solution to addressing this clutch of problems is through participatory approaches to plant breeding and selection of new varieties. These attempt to decentralise plant breeding and incorporate the priorities and constraints of farmers more closely into the selection of new varieties. Farmers test them, often with low- level or no fertiliser, adopting them only if they outperform local varieties grown under the same conditions. In western India, participatory plant breeding has helped to conserve plant genes by crossing indigenous rice varieties that are more heterogeneous than those resulting from centralised breeding.

The most well-known and controversial examples of biotechnology are transgenic crop varieties, or genetically modified organisms (GMOs). These are the product of the transfer of genes from one organism to another, often resulting in genetic exchange between unrelated species (e.g. daffodil genes into rice). Most GMOs offer herbicide tolerance or insect resistance and are commonly directed at commercial farming in the North. The potential of GMOs to outcross with wild relatives of crops is prompting concerns: if a trait from a GMO conferred adaptive advantage on a wild relative it could alter the plant populations that act as a reservoir of genes for cultivated species in the future.

## Conclusions

- Programmes of collection and characterisation of indigenous crop, livestock and fish stock varieties should be supported and extended, paying particular attention to their ability to yield under low-input conditions. In conjunction with this, economic incentives and institutional barriers to maintaining crop, livestock and fish biodiversity, and biodiversity-rich farming systems must be reviewed.
- Support should be given to developing countries in their efforts to assess their genetic resources, establish systems for its use which brings benefits to the country, and ensure that the benefits from international and national breeding programmes reach rural communities. Many rural communities were involved in the production of a broad genepool of domestic and semi-domesticated populations in the first place, and recognition of this contribution is important.

- Plant and livestock breeding needs to be decentralised, and efforts made to include local needs and constraints into the criteria for selection of new varieties. This will reduce the risk of imposing high-input varieties on farmers that do not have the resources to pay for them.
- All introductions of alien species, varieties and breeds, especially from other continents, should be subject to increased vigilance, through risk and impact assessments to ensure environmentally sound and sustainable food production, and pose no threats to human health.
- The potential risks of GMOs underline the importance of establishing adequate biosafety procedures. However, the capacity to implement the provisions of the CBD Biosafety Protocol is weak, and needs substantial strengthening in many developed and developing countries.
- Priority should be given to projects seeking environmentally-friendly ways of improving soil fertility, and reducing pesticide applications (e.g. through biological control approaches).
- Development programmes must ensure that areas providing wild foods remain productive and accessible.
- A global policy is urgently required on who owns the genes in international and national genebanks, and these policies must clarify the CBD principles of intellectual property and benefit sharing.

## Further information

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Groombridge, B.& M.D. Jenkins 2000. *Global biodiversity. Earth's living resources in the 21st century.* Cambridge:WCMC & Hoechst.

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reference to other Biodiversity Briefs is denoted as (see BB#).

## Web site

All Biodiversity Development Project (BDP) documents can be found on the web site:
**http://europa.eu.int/comm/development/sector/environment**

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# Community Seed Banks for Semi-arid Agriculture in Zimbabwe

The process of agricultural modernization in Zimbabwe has marginalized many farmers and increased social and economic inequalities. Green Revolution technologies brought about genetic erosion and disappearance of ecogeographically adapted crop cultivars, thus limiting choices for farmers. Farmers' knowledge of seed selection, treatment and storage have simultaneously been lost in the process of adopting improved crop cultivars.

**The practice of biodiverse farming system defines productivity as the capacity to provide stable supplies of sufficient quality foods and other products in harmony with social and cultural realities. Three elements are essential for optimizing sustainable productivity of a farming system:**

- **agro-ecosystem biodiversity;**
- **integrated resource management; and**
- **traditional local knowledge**

Traditional local agricultural development depends on agroecosystem micro-adaptation. Crop adaptations follow complex patterns according to soil, water, climate, topography, social and cultural diversity, which also affect crop production and use. This has direct implication for intervention or technology development. Small-holder farmers have shown great interest in technological innovations and new seeds.

## What Should Be Done to Ensure Seed Security for Small-Holder Farmers in Marginal Areas?

Interventions must be made available to enable communities to access seeds, conserve, document and enhance their resources and knowledge. In this context, a community seed bank intervention was integrated with the traditional community farming systems in semi-arid agriculture.

## Objective of a Community Seed Bank

Community seed banks aim to serve and fulfill the rights of rural communities in on-farm conservation of agricultural biodiversity, recovery and restoration of both the materials and related knowledge and utilization of their plant genetic resources. The facilities serve as back-up systems for which lost and endangered materials are revived, and also serve as drought mitigation and management strategy at community level.

## Structure of a Community Seed Bank

The structure of the community seed bank is designed after intensive consultation with farmers, taking into consideration their preferences and expectations of the services that it should provide.
Most facilities constructed in Zimbabwe constitute the following compartments:

### Germplasm Conservation Room

This room is used to conserve all locally or acquired germplasm for safekeeping, while sub-samples of the same material are deposited at the National Genebank.

### Selected and Preferred Crop Cultivars Conservation Room

Materials, which have been evaluated on-farm and selected for bulking by the farmers, are stocked in this room. These materials consist of new varieties or those locally-available that have gone through participatory plant breeding (PPB) bythe farmers. In addition, the room keeps materials, which are intended for bulking in quantities of up to 30 kg.

### Seed Storage and Distribution Room

All multiplied seed for distribution and supply purposes are housed in this room.

### Farmer Meeting Room

This is a function room where the stakeholders hold their meetings, consultations and trainings.

### An Office

Day to day transactions are conducted in this room.

## Management of the Community Seed Banks

A management committee, involving farmers within the project areas, is formed. The committee is responsible for aspects such as:

- determining the crops and crop cultivars to be multiplied;
- identifying farmers who will be in-charge of multiplying seeds;
- estimating the seed demand by crop and variety;
- coordinating seed distribution and supply to farmers;
- facilitating germplasm collection and rescue missions in the area;
- determining the quantity of seed reserves required by crop variety;
- treating, packaging and storing seed materials; and
- mediating the flow of germplasm between the National Genebank and the communities.

The farmers coordinating committee is responsible for implementing these activities and decision-making.

### Farmer Training

The training is designed for the capacity building of farmers to competently manage community seed banks.

Issues covered in the training programs include:

- importance of germplasm and the need for conservation through use;
- gender dynamics in agricultural biodiversity conservation (seed selection, treatment, storage and use);
- importance and value of indigenous knowledge systems/practices as it relates to agricultural biodiversity;
- community rights;
- seed multiplication procedures through the concepts of farmers' field school;
- seed selection, drying and storage techniques; and
- benefit sharing (seed exchange through seed fairs which facilitates gene flow) between and among farmers.

## Benefits of Community Seed Banks

1. The seed banks have become a facility and the center for seed requirements of farmers in semi-arid agriculture. They have enhanced and kept alive the tradition of nurturing diversity through such aspects as:

- access to seed of farmers' choice;
- farmers' capacity building in producing desired seed of specific crop cultivars;
- providing strategic seed reserve in drought years;
- production of good quality seed;
- ensuring farmers' seed security at household level;
- on-farm germplasm conservation through utilization;
- farmer training in the modalities and rudiments of seed production;
- seed selection, treatment and storage;
- establishment of linkages with national seed systems; and
- exchange of germplasm, information, innovations and technologies between and among farmers, extension agents and researchers.

2. The new agricultural biodiversity of seed allowed the diversification of crops that can easily adapt to climate, soils and rainfall patterns. The actual impact of diversification follows a gradual approach, as incorporation of a new variety is a slow process. It takes several growing seasons before coming up with a result and it does not guarantee that the new seed will persist.
3. Knowledge and information is exchanged about the traits and characteristics of new varieties.

**Recommendations**

Community seed bank intervention is recognized as a far-reaching strategy to reduce the effects of seed insufficiency among smallholder farmers in semi-arid agro-ecological zones of Zimbabwe. Availability of diverse germplasm in seed banks and the link with the National Genebank enhances the accessibility of seed for food production even during years of droughts. However, further research is recommended in areas related to the following aspects:

- on-farm characterization and evaluation of materials collected and stored at the seed bank in order to understand their attributes;
- monitoring of seed viability of stored materials by crop and variety;
- determination of the longevity of stored germplasm by crop and variety;
- development of regeneration timeframes of stored materials by crop and variety;
- inventory of characteristic preferences of farmers by crop and variety;
- determination of moisture levels ideal for seed storage under such conditions; and
- determination of quantities of strategic seed reserve required as drought mitigation and management strategy.

The above aspects need systematic methodological approaches to be developed in order to have technically formulated practices that are farmer user-friendly.

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# **The Central Role of Agricultural Biodiversity:** Trends and Challenges

Predominant patterns of agricultural growth have eroded biodiversity in agroecosystems including plant genetic resources, livestock, insects, and soil organisms. This erosion has caused economic losses, jeopardizing productivity and food security, and leading to broader social costs. Equally alarming is the loss of biodiversity in "natural" habitats from the expansion of agricultural production to frontier areas.

**Traditional agroforestry systems commonly contain over 100 annual and perennial plant species per field. Farmers often integrate leguminous trees, fruit trees, trees for fuelwood and types that provide fodder on their coffee farms. The trees also provide habitat for birds and animals that benefits the farms. A shaded coffee plantation in Mexico supports up to 180 species of birds that help control insect pests and disperse seeds.**

The conflicts between agriculture and biodiversity are by no means inevitable. With sustainable farming practices and changes in agricultural policies and institutions, they can be overcome. Biodiversity maintenance must be integrated with agricultural practices - a strategy that can have multiple ecological and socioeconomic benefits, particularly to ensure food security. Practices that conserve and enhance agricultural biodiversity are necessary at all levels.

**Ethnobotanical studies show that the Tzeltal Mayans of Mexico can recognize more than 1,200 species of plants, while the P'urepechas recognize more than 900 species and Yucatan Mayans some 500. Such knowledge is used to make production decisions.**

This paper discusses the ecosystem services provided by agricultural biodiversity, and highlights principles, policies, and practices that enhance diversity in agroecosystems.

**N. Vavilov, a renowned Russian botanist carried out systematic plant collection, pioneering research, and conservation of crop diversity starting in the early 20th century. Vavilov developed a theory of the origin of domesticated crops and launched numerous worldwide expeditions to collect crop germplasm. He established an immense seed bank in St. Petersburg which now houses some 380,000 specimens from more than 180 locations in the world. Vavilov also identified major areas of high concentrations of crop diversity around the world, most of which are in developing countries.**

## Changing Trends in Agricultural Development and Biodiversity Links

**High yielding varieties (HYVs) - or "miracle seeds" - are now planted on high percentages of agricultural land - 52% for wheat, 54% for rice, and 51% for maize. The use of HYVs has increased production in many regions and sometimes reduced pressure on habitats by curbing the need to farm new lands.**

### Agricultural Biodiversity Loss: Conflicts and Effects

The links between agriculture and biodiversity have changed over time. Increase of agricultural production and productivity, in the last 30 years, stems from both expansion of cultivated area (extensification) and the increased output per unit of land (intensification). It was achieved through technological inputs, improved varieties and the management of biological resources, such as soil and water. Ecosystem services provided by agricultural biodiversity have degraded and therefore undermine ecosystem health.

These general trends in agriculture and biodiversity have been shaped by demographic pressures, including high population growth rates, the migration of people into frontier areas, and imbalances in population distribution. Additional influential forces are the predominant paradigms of industrial agriculture and the Green Revolution, beginning in the l960s. These approaches generally emphasize maximizing yield per unit of land, uniform varieties, reduction of multiple cropping, standardized farming systems (particularly generation and promotion of high-yielding varieties), and the use of agrochemicals. Seed and agrochemical companies have also influenced these trends.

Although the predominant patterns of agricultural development in the last several decades have increased yields, they have also significantly reduced the genetic diversity of crop and livestock varieties and agroecosystems, and have led to other kinds of biodiversity losses.

**Although people consume approximately 7,000 species of plants, only 150 species are commercially important, and about 103 species account for 90 percent of the world's food crops. Just three crops - rice, wheat, and maize - account for about 60 percent of the Calories and 56 percent of the protein people derive from plants. Livestock is also suffering from genetic erosion. The Food and Agriculture Organization of the United Nations (FAO-UN) figures show that:**

- **At least one breed of traditional livestock dies out every week in the global context;**
- **Of the 3,831 breeds of cattle, water buffalo, goats, pigs, sheep, horses and donkeys believed to have existed in this century, 16 % have become extinct and 15 % are rare;**
- **Some 474 of livestock breeds can be regarded as rare, and about 617 have become extinct since 1892; and**
- **Over 80 breeds of cattle are found in Africa, and some are being replaced by exotic breeds. These losses weaken breeding programs that could improve hardiness of livestock.**

As forms of biodiversity are eroded, food security can also be reduced and economic risks increased. Evidence indicates that such changes can decrease sustainability and productivity in farming systems. Loss of diversity also reduces the resources available for future adaptation.

## Increased Vulnerability to Insect Pests and Diseases

**Among renowned examples of crop vulnerability to pests and diseases are the potato famine of Ireland during the 19th century, a winegrape blight that wiped out valuable vines in both France and the United States, a virulent disease (Sigatoka) that damaged extensive banana plantations in Central America in recent decades and devastating mold that infested hybrid maize in Zambia.**

Genetic homogenization of varieties increases vulnerability to insect pests and diseases, which can devastate a crop, especially on large plantations. History has shown serious economic losses and suffering from relying on monocultural uniform varieties.

There has also been a serious decline in soil organisms and soil nutrients. Beneficial insects and fungi also suffer from heavy pesticide inputs and uniform stock - - making crops more susceptible to pest problems. These losses, along with fewer types of agroecosystems, also increase risks and can reduce productivity. In addition, many insects and fungi commonly seen as enemies of food production are actually valuable. Some insects benefit farming - for pollination, contributions to biomass, natural nutrient production and cycling, and as natural enemies to insect pests and crop diseases. Mycorrhizae, the fungi that live in symbiosis with plant roots, are essential for nutrient and water uptake.

The global proliferation of modern agricultural systems has eroded the range of insects and fungi, a trend that lowers productivity. Dependence on agrochemicals, and particularly the heavy use or misuse of pesticides, is largely responsible. Agrochemicals generally kill natural enemies and beneficial insects, as well as the “target” pest.

This disruption in the agroecosystem balance can lead to perpetual resurgence of pests and outbreaks of new pests-as well as provoke resistance to pesticides. This disturbing cycle often leads farmers to apply increasing amounts of pesticides or to change products-a strategy that is not only ineffective, but that also further disrupts the ecosystem services and elevates costs. This “pesticide treadmill” has occurred in countless locations. Reliance on monocultural species and the decline of natural habitat around farms also cut beneficial insects out of the agricultural ecosystem.

## Additional Losses-Habitats, Nutrition and Knowledge

Agricultural expansion has also reduced the diversity of natural habitats, including tropical forests, grasslands, and wetland areas. Projections of food needs in the coming decades indicate probable further expansion of cropland, which could add to this degradation. Modifying natural systems is necessary to fulfil the food needs of growing populations, but many conventional forms of agricultural development, particularly large-scale conversion of forests or other natural habitats to monocultural farming systems, erode the biodiversity of flora and fauna. Intensive use of pesticides and fertilizers can also disrupt and erode biodiversity in natural habitats and ecosystem services that surround agricultural areas, particularly when these inputs are used inappropriately.

Other direct effects of reduced diversity of crops and varieties include:

- Decline in the variety of foods adversely affects nutrition;
- High-protein legumes have often been replaced by less nutritious cereals;
- Local knowledge about diversity is lost as uniform industrial agricultural technologies predominate; and
- Institutions and companies in the North have unfair advantages in exploiting the diverse biological resources from the tropics.

## Confronting the Causes

**Humanity faces a major challenge to overcome conflicts and build complementarities between agriculture and biodiversity. Meeting this challenge requires addressing root causes of agricultural biodiversity loss, and thus calls for changing practices, paradigms, and policies, as well as commitments by governments and institutions.**

Devising effective solutions requires confronting the causes of agricultural biodiversity losses. Proximate causes vary under different conditions, but generally pertain to the use of unsustainable technologies and degrading land-use practices, such as relying on uniform varieties and the heavy use of agrochemicals. Yet more deeply, the roots underlying the erosion of agricultural biodiversity are tied to demographic pressures, disparities in resource distribution, the dominance of industrial agricultural policies and institutions that support and contribute to inappropriate practices, pressures from businesses that promote uniform monocultures and chemicals, the depreciation and devaluation of diversity and accumulated local knowledge, and market and consumer demands for standardized products. Of these driving forces, perhaps the most perplexing are demographic pressures leading to extensification of farming into frontier areas. Changing these patterns requires transforming land-use policies, as well as broader socioeconomic changes that give the rural poor more economic and educational opportunities. These longer-term challenges need concerted attention over time.

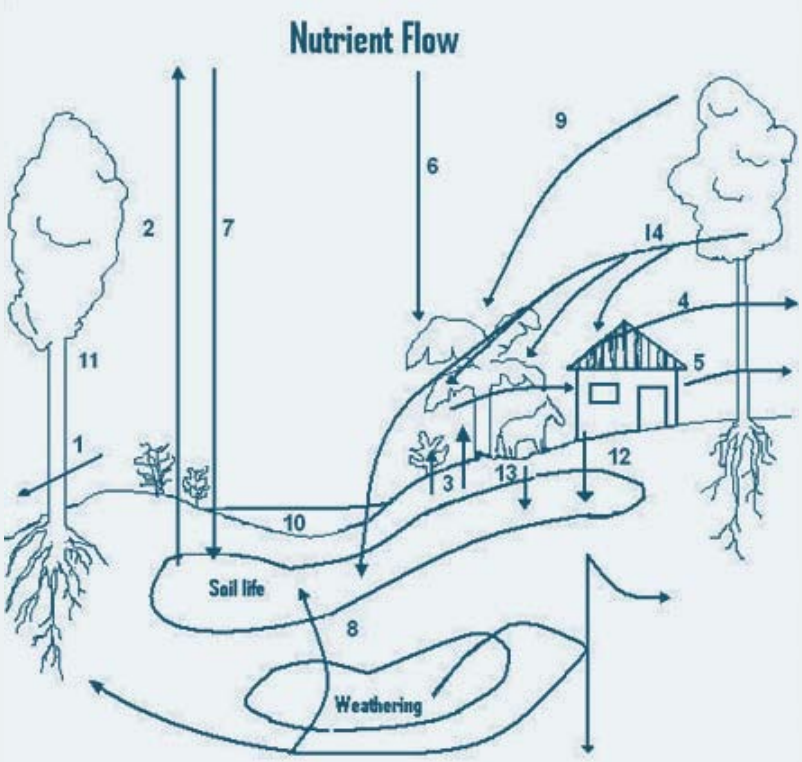
## Diversity through Sustainable Agriculture: Principles and Practices

To achieve such transformations for the conservation and enhancement of agricultural biodiversity, the following strategic principles are critical:

1. Application of agroecological principles helps conserve, use and enhance biodiversity on farms and can increase sustainable productivity and intensification, which avoids extensification, thereby reducing pressure on off-farm biodiversity;
2. Participation and empowerment of farmers and indigenous peoples, and protection of their rights, are important means of conserving agricultural biodiversity in research and development;
3. Adaptation of methods to local agroecological and socio-economic conditions, building upon existing successful methods and local knowledge, is essential to link biodiversity and agriculture and to meet livelihood needs;
4. Conservation of plant and animal genetic resources — especially *in situ* efforts — help protect biodiversity for current livelihood security as well as future needs and ecosystem functions;
5. Reforming genetic research and breeding programs for agricultural biodiversity enhancement is essential and can also have production benefits; and
6. Creating a supportive policy environment – including eliminating incentives for uniform varieties and for pesticides, and implementing policies for secure tenure and local rights to plant genetic resources – is vital for agricultural biodiversity enhancement and for food security.

Practices for soil fertility/health and nutrient cycling also make use of agricultural biodiversity. Good examples include:

- compost from crop residues, tree litter, and other plant/organic residues;
- intercropping and cover crops, particularly legumes, which add nutrients, fix nitrogen, and "pump" nutrients to the soil surface;
- use of mulch and green manures (through collection and spread of crop residues, litter from surrounding areas, and organic materials, and/or under crop);
- integration of earthworms (vermiculture) or other beneficial organisms and biota into the soil to enhance fertility, organic matter, and nutrient recycling; and
- elimination or reduction of agrochemicals —especially toxic nematicides — that destroy diverse soil biota, organic material, and valuable soil organisms.




**Possible losses**
1 Erosion
2 Volatilization
3 Leaching
4 Export (market/gifts)
5 Removal of wastes

**Natural grains**
6 Rain
7 N fixation
8 Weathering
9 Sediment/dust
10 Blue-green algae

**Management options**
11 Woody species
12 Feeding concentrates/minerals
13 Recycling (via livestock, compost, biogas, slurry, etc.)
14 External inputs

*Source: ILEIA, 1992. Farming for the Future: An introduction to Low-External-Input and Sustainable Agriculture. Netherlands.*

These kinds of soil-management practices have proven effective and profitable in a variety of farming systems. Agroforestry illustrates "best practice" of using agricultural biodiversity that also generates multiple benefits. In many contexts, the integration of trees into farming systems is highly efficient, and the trees have multiple functions, such as providing fuel, fodder, shade, nutrients, timber for construction, and aiding soil conservation and water retention. (In West Sumatra, agroforestry gardens occupy 50 to 85 percent of the total agricultural land.) Complex forms of

agroforestry exhibit forest-like structures, as well as a remarkable degree of plant and animal diversity, combining conservation and natural resource use.

Agroforestry systems in traditional forms also shelter hundreds of plant species, constituting valuable forms of in situ conservation. Many of the practices noted here serve multiple purposes. For example, intercropping provides pest and soil management as well as enhanced income. For example, an estimated 70-90 percent of beans, and 60 percent of maize in South America are intercropped with other crops. Farmers in many other parts of the world have recognized such diversity as valuable sources of soil nutrients, nutrition, and risk reduction — essential for livelihoods as well as other economic values.

It is a common misperception that agricultural biodiversity enhancement is feasible only in small-scale farms. In fact, experience shows that large production systems also benefit from incorporating these principles and practices. Crop rotations, intercropping, cover crops, integrated pest management techniques, and green manures are the most common methods being used profitably in larger commercial systems, both in the North and in the South. These situations illustrate sustainable approaches to intensification. Examples are found in tea and coffee plantations in the tropics, and in vineyards and orchards in temperate zones. In most large-scale settings, the change from monocultural to diverse systems and practices entails transition costs, and sometimes trade-offs or profit losses for the first two or three years. However, after the initial transition, producers have found that agroecological changes are profitable as well as ecologically-sound for commercial production and that they present new valuable opportunities.

## Using Participatory Approaches

The incorporation of farmers' local knowledge, practices, and experimentation is advantageous in efforts in agricultural biodiversity and sustainable agriculture. Experiences have shown that full involvement of local farming practices in agricultural R&D — through participation and leadership of local people — has had beneficial outcomes. It is also important to draw upon farmers' own informal methods of experimenting with unfamiliar cultivars and practices.

In Mexico, for example, researchers worked with the local people to re-create chinampas- multicropped, species-diverse gardens developed from reclaimed lakes which were native to the Tabasco region and part of Mexico's pre-Hispanic tradition. A similar project conducted in Veracruz also incorporated the traditional Asiatic system of mixed farming, mixing chinampas with animal husbandry, and aquaculture. These gardens also made more productive use of local resources, and integrated from plant and animal waste, as fertilizers. Yields of such systems equalled or surpassed these of conventional systems.

In Burkina Faso, on the other hand, a soil-conservation and integrated cropping project in Yatenga province was based largely on an indigenous technology of Dogon farmers in Mali for building rock bunds for preventing water run-off. The project added innovations bunds along contour lines — and revived an indigenous technique called "zai," which is adding compost to holes in which seeds of millet, sorghum, and peanut are planted. These crops are in a multicropping system.

In such efforts, the full participation of women has significant benefits. As managers of biodiversity in and around farming systems in many areas of the world, women can make important contributions and have a promising role in research, development, and conservation of agricultural biodiversity.

In Rwanda, for example, in a plant-breeding project of CIAT (International Center for Tropical Agriculture), scientists worked with women farmers from the early stages of a project on breeding new varieties of beans to suit local peoples' needs. Together, they identified the characteristics desired to improve beans, run experiments, manage and evaluate trials, and make decisions on the trial results. The experiments resulted in stunning outcomes: the varieties selected and tested by women farmers over four seasons performed better than the scientists' own local mixtures 64-89 per cent of the time. The women's selections also produced substantially more beans, with average production increases as high as 38 percent.

The development of participatory approaches requires deliberate measures, training, and time to change the conventional approaches of agricultural R&D.

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The development of participatory approaches requires deliberate measures, training, and time to change the conventional approaches of agricultural R&D.

## Policy and Institutional Changes

Although many institutions are already actively involved, more coordination work is needed at all levels to ensure effective reforms and agricultural biodiversity conservation policies that benefit the public, especially the poor. Policy changes that attack the roots of problems and ensure peoples' rights are needed. Ideas needing further attention include:

- ensuring public participation in the development of agricultural and resource use policies;
- eliminating subsidies and credit policies for high-yielding varieties (HYVs);
- fertilizers, and pesticides to encourage the use of more diverse seed types and farming methods;
- policy support and incentives for effective agroecological methods that make sustainable intensification possible;
- reform of tenure and property systems that affect the use of biological resources to ensure that local people have rights and access to necessary resources;
- regulations and incentives to make seed and agrochemical industries socially responsible;
- development of markets and business opportunities for diverse organic agricultural products; and
- changing consumer demand to favor diverse varieties instead of uniform products.

**Efforts to conserve and enhance agricultural biodiversity must also address the underlying policies that accelerate its loss. Broader policies and institutional structures focussed on agricultural biodiversity conservation drive practical, field-level changes. Many policy initiatives and institutions have already been established to address these issues.**

Building complementarity between agriculture and biodiversity will also require changes in agricultural research and development, land use, and breeding approaches.

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# Gender in Agricultural Biodiversity Conservation

Development responses will be more equal, efficient and sustainable when gender is mainstreamed in agricultural biodiversity conservation strategies.

**Gender** refers to the social roles and relations between women and men which are socially constructed, and can change and vary over time and according to geographic location and social context. **Gender mainstreaming** is the process of assessing the implications for women and men of any planned action. It is integrating women's and men's concerns and experiences in the design, implementation, monitoring and evaluation of policies and programs in all political, economic and social spheres so that both will participate and benefit equally.

## Benefits of Gender Mainstreaming

**Equality.** Many United Nations (UN) systemwide mandates, and commitments of UN Member States exist to achieve gender equality and removing gender based discrimination. This has been recognized as a necessary means to reach the Millennium Development Goals of reducing to half the number of poor and hungry by the year 2015. Chapter 15 of Agenda 21 and the Convention of Biological Diversity (CBD) recognize that different user groups within rural societies have differential constraints and opportunities in the conservation and use of plant genetic resources

**Efficiency.** Societies that discriminate on the basis of gender pay a significant prize - in terms of increased poverty, slower economic growth, weaker governance and lower quality of life. For example, a World Bank review found that 74% of 54 completed agricultural projects with gender-related action were rated satisfactory for overall outcome, compared with 65% for the 81 projects that did not include gender-related action.

**Sustainability**. It has been noted that women are intimately linked to the environment because of concern for their communities and for future generations, and some argue that women stand at the core of the sustainability paradigm. In order to design sustainable development policies and projects it is crucial that the different roles and responsibilities of women and men are understood for sustainable implementation of activities.

## Gender in Agricultural Biodiversity Conservation

Some key areas where gender makes a difference in the conservation of agricultural biodiversity are discussed below.

In the Kurichiyas community in Kerala, India, men make decisions about growing certain paddy varieties due to religious concepts (of purity and pollution) that prevent women from participating in the selection and storage of paddy seeds. Men are normally responsible for monocropping systems and women for more diversified systems such as home gardens. Such diverse systems are referred to as community "living gene banks" that are used for in situ conservation of a wide range of plant genetic resources.

## Role in Seed Selection

The gender factor in seed selection varies. In some areas, men are fully responsible for crop selection, while in other areas, this task is entirely assumed by women. In other cases, shared responsibility exists.

## Access to Resources

Because of their shared responsibilities, women are often responsible for subsistence (low value) crops and men for cash (high value) crops. If a "woman's crop" is added value to, it may become a "man's crop".

When French beans became more lucrative in Kenya, men usurped either the land allocated for or the income derived from production. When the Acacia timber value increased in parts of West Africa, men started to plant Acacia trees in women's or shared gardens and cropland.

## Knowledge Systems and Access to Networks

Women and men participate differently in formal and informal community-based organizations, and use different networks for exchange of seeds for agricultural biodiversity. In Nepal, for example, traditional varieties are brought into an area by the bride upon marriage. Women exchange mainly with women and men exchange mainly with men.

As a result of formal schooling and migration, indigenous knowledge among men declined in Kenya while women retained a high and widely shared level of knowledge and even acquired men's knowledge as roles and duties changed. However, the knowledge of the older generations often is no longer passed on to the younger generations.

## Method

The descriptors -or preferred traits-of local agricultural biodiversity of women and men farmers provide a productive, innovative and systematic understanding and monitoring of gender factors in agricultural biodiversity conservation. Descriptors are dynamic and may change depending on the terms of trade, cultural transformations, or overall variations in opportunities and constraints as perceived by the farmer. The quantitative and qualitative details will provide more knowledge of the men and women and the division of their labor. In addition, the descriptors will reveal the women's and men's perceived utility of the variety and its distribution.

Even if men may have the decision-making authority in most farming systems, the fact is that women may have more intimate and detailed knowledge about crops and varieties which indicate superior experience. Agro-morphological and socio-economic characteristics can be scored together with farmers. Qualitatively, the analysis can be broadened to include the descriptions used or dropped over time when describing a given variety. The level of knowledge about the characteristics of a variety is not only correlated to the experience in handling it (knowledge and division of responsibilities), but the type of descriptors chosen will also identify the perceived benefits.

Women have been found to consider many interrelated and detailed criteria including taste, color, size, texture, cooking time, crop yield, ease of processing and access, grain formation and the resistance to pests and insects. In contrast, a male farmer often looks for a more limited range of purposes related to his sphere of responsibility, such as high yield and a good market price.

**SOCIO-ECONOMIC AND GENDER-SENSITIVE [SEGS] INDICATORS**

**SEGS data required:**

- **The type and number of descriptors used for a given natural resource by women as compared to the baseline.**
- **The type and number of descriptors used for a given natural resource by men as compared to the baseline.**

**SEGS indicators:**

- **The ratio between the number of descriptors used by women for a given natural resource, as compared to the number of descriptors used by men for a given natural resource, as compared to the baseline.**

Just as landraces have evolved over time and been selected on the basis of the preferred traits in the farmers' fields, *in situ* conservation will only succeed if women and men farmers are involved in conservation activities. Their involvement will be possible only if they benefit from the process. However, it is not easy to involve all stakeholders especially as women may have constraints which restrict their participation. One way to deal with this is to design strategies to overcome these constraints. Preparatory-conferences prior to a community workshop, provision of child-care facilities at training sessions, or the holding of trainings close to women's homes are efforts worth considering to encourage participation of all stakeholders.

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# Losing Ground:
# Gender Relations, Commercial Horticulture, and Threats to Local Plant Diversity in Rural Mali

**SECTION V. GENDER, BIODIVERSITY LOSS, AND CONSERVATION**

In a Bamana farming community in central Mali, two male elders, Nene and Shimbon Jara, reported that their fathers were among the first people in the region to produce exotic fruits and vegetables for sale. They said that, in the early 1960s, these enterprising men began to cultivate crops such as bananas and tomatoes in the low-lying stream areas around the community. Their activities were a response to a growing demand for fresh produce on the part of elite urban dwellers in the nearby capital city, Bamako. Over the years, other young men entered into the domain by clearing and incorporating what Nene referred to as 'unused areas.' Market gardening (the cultivation of fruits and vegetables for sale) has now become a key means to generate personal income in the community.

While the comments that Nene and other older men offered provide an important perspective on the development of commercial gardening activities in the community, they contrast with the historical insights provided by local women -– especially when it comes to the idea that the garden lands were 'unused.' Indeed, older women reported that, prior to men's development of the low-lying areas for commercial gardening activities, women had in fact cultivated traditional crops and collected wild plants in at least some of those areas. For example, Wilene Diallo, the community's oldest woman, said that she and the other village wives used these areas to cultivate traditional vegetable crops for their sauces. A middleaged contemporary market gardener, Mamari Jara, noted that big changes have occurred in the gardening domain during his lifetime. What was once a woman's activity is now largely a man's affair, and commercially valuable, largely exotic crops have eclipsed traditional garden crops and plants in gardening niches.

This chapter examines the changing nature of gardening activities in a Bamana community in rural Mali. Using ethnographic field data collected between 1992 and 1998, it describes the transformation of gardening from a production-for-use activity associated with women to a commercial enterprise in which men predominate. It documents the contours of the contemporary commercial gardening sector, showing that men are the principle actors and revealing their prevailing focus on non-local fruit and vegetable crops. The paper addresses the implications that this shift in horticultural production has on women's ability to meet household obligations in terms of sauce production, and identifies a series of potential threats to local plant diversity and overall environmental stability that are likely to arise as a result of the process.

## The Setting

Niamakoroni is a farming community located on the Mande Plateau in South-central Mali, approximately 35 kilometres from Bamako. The nucleated settlement consists of a series of closely clustered adobe brick structures and associated shade trees. According to community elders, the settlement was founded at the close of the 19th century when a lineage segment from a nearby community settled there in order to gain access to new farmland. Contemporary residents of Niamakoroni, like their ancestors before them, assert a Bamana (Bambara) ethnic identity.

As is the case in most Bamana communities, the people of Niamakoroni live in a small, tightly knit rural community (Becker 1990, Lewis 1979, Toulmin 1992). During 1993- 94, the community had a total resident population of 184. Descent in Niamakoroni is traced patrilineally and control over productive resources is generally corporate in nature. Age and sex are important characteristics in social, political, and economic contexts, with elders dominating juniors and men typically holding more power than women. Becker (1990: 315) refers to this as 'a patrilineal gerontocracy.' The dominant residence pattern is patrilocal (women move to their husbands' residences upon marriage), and marriages are frequently polygynous. In the community, the primary domestic group (residential and food production and consumption unit) is called a *du* (*duw*, plural), in the Bamana language (*Bamanankan*).

Niamakoroni's *duw* are multi-generational, joint families in which junior males and their spouses and families typically live and work under the authority of the group's eldest male, the *dutigi*. As senior members of their lineage groups, *dutigiw* have access to arable uplands and the authority to direct the labour of those who live with them in the subsistence realm. The members of each *du* live close to one another and share meals throughout the year.

Women in the community are responsible for food processing and cooking, as well as for all household maintenance tasks. Men typically have few domestic obligations aside from building and maintaining houses (see also Creevey 1986; Thiam 1986). This clear gender division of labour characterizes the wider agrarian economy as well.

## Gendered Domains in the Food Economy

Most of the relatively sparse rains (900-1200 per year) in Niamakoroni fall in a short three to four month span from June through September. People depend upon rain-fed agriculture for subsistence, and therefore work diligently during these few short months in order to meet most of their food needs. Each rainy season, the vast majority of able bodied, working-age villagers focus their productive energies on the cultivation or collection of food crops and plants, which they refer to as *ka balo* (for life) activities.

Very clear gender relations of production and domains of experience and knowledge mark this food production process. The men in each household work collectively in their group's main upland field (*foroba*), which is located in bush areas at least a few kilometres from the settlement. Here, they produce a suite of staple crops including sorghum (*nyo - Sorghum bicolor*), millet (*sanyo — Pennisetum glaucum*), corn (*kaba - Zea mays*), cowpeas (*sho — Vigna unguiculata*), peanuts (*tiga - Arachis hypogaea*), and Bambara groundnuts (*tiganinkuru - Voandzeia subterranea*). As is the case over most of the region, sorghum and millet account for the most acreage (PIRL 1988).

Women, on the other hand, are responsible for the cultivation and collection of plants that make up the sauces that accent men's grain crops in the daily meals. During the rainy season, married women in each domestic group work individually in upland fields assigned to them by the *dutigiw* to produce *nafenw,* or 'sauce-things.' In most cases, women intercrop peanuts (*tiga - Arachis hypogaea*), cowpeas, kenaf (*dajan - Hibiscus cannabinus*), roselle (*dakumun* or *dabilenni - Hibiscus sabdariffa*), okra (*gwan - Abelmoschus (Hibiscus esculentus*), and sorghum. There is a clear focus in their cropping patterns on traditional leaf and vegetable items that complement the staples produced on the *forobaw*. The vast majority of women's crops are destined for direct consumption although, from time to time, some items are sold to generate income that is typically used to purchase commercial sauce ingredients such as boullion cubes, vegetable oil or salt (Wooten 1997).

In addition to cultivating relish crops in upland fields during the rainy season, throughout the year women also gather various wild or semi-wild plant resources from their fields or from bush areas for use in their sauces. For example, they gather and process the leaves of the baobab tree (*Adansonia digitata*) to make a key sauce ingredient and use the fruit of the shea nut tree (*Butryospermum parkii*) to make cooking oil and lotion for skin care. As reported elsewhere in the region (Becker 2000, 2001; Gakou et al. 1994; Grisby 1996), women maintain these productive trees in their fields, and make use of species in the bush areas around the community. A wide variety of wild and semi-wild greens are regularly used for their sauces.

This general pattern of distinct gender contributions to the food economy, with men providing grains and women providing sauces, is widespread among the Bamana (e.g., Becker 1996; Thiam 1986; Toulmin 1992). However, there is another typical production activity and niche associated with Bamana women: gardening. Accounts from across the Bamana region suggest that women regularly use low-lying areas near streams to establish and maintain homegardens, and to collect wild plants for sauce ingredients (e.g., Grisby 1996, Konate 1994). Indeed, *nako*, the Bamana word for garden, is often translated literallyas 'sauce-stream', which relates both to the type of produce and to the production site. Considering that, for generations, women in most Bamana communities have had the responsibility to produce *nafenw*, an historical association between the women of Niamakoroni and *nakow* (sauce-streams) seems entirely logical. Yet today, they do not typically garden in such areas around their village. Instead, they grow their sauce crops in upland fields and gather wild food plants in nearby bush areas. Over the past few decades, gardening, a domain that was once closely associated with women and the food economy, has become a man's affair and a commercial venture.

## Gardening for Cash: Meeting the Demands of Urban Consumers

In addition to labouring within the context of their respective *duw* for domestic consumption, individuals of all ages in Niamakoroni have the option to engage in independent commodity production activities that will earn them personal incomes. These are typically referred to as *ka wari nyini* (for cash/money) activities.

While a variety of income-generating activities occur in the community, people are uniform in viewing market gardening as the premier avenue available for income generation and potential accumulation. Men and women alike commonly identified market gardening as the preferred strategy for earning income, and note that urban consumers in Bamako, the capital city, provide the main market for the garden produce (see also Konate 1994: 122).

Bamako has grown dramatically since the French set up their administrative headquarters in the city at the end of the 19th century. In 1994, it was estimated to be home to more than 800,000 people (Diarra et al. 1994: 230), and more recent estimates place the number at just over one million. Furthermore, according to Diarra and colleagues (1994: 239), only seven percent of the population of Bamako is now engaged in agriculture or livestock production. Clearly, urbanization in Bamako, as in other contexts around the world, has been associated with a major shift in production and consumption patterns. There is now a well-established regional market for cereals, and most urban consumers depend on rural producers to supply their basic staples such as sorghum and millet. Moreover, there is an increasing demand for specialized horticultural produce.

Over the decades since the French colonial forces began to consume fresh fruits and vegetables produced in the colonies, Bamako's residents have become increasingly interested in acquiring and consuming exotic fruits and vegetables (République du Mali 1992, Villien-Rossi 1966). A number of factors have contributed to this consumption shift: the expansion of governmental nutritional campaigns that highlight the nutritional value of fresh fruits and vegetables; the emergence of a middle class that considers Western dietary patterns to be a sign of culture and wealth; and the growth in the number of foreign aid workers who wish to consume fruits and vegetables native to their home countries. Together, these create strong demand for specialized non-traditional horticultural items in the capital. Communities such as Niamakoroni that are within market distance of the capital are well placed in this overall context (see also Becker 1996; Konate 1994).

Market gardening is now a central component of the local livelihood system in Niamakoroni. In the mid-1990s, there were 22 distinct market gardening operations in the community, each with a discrete garden leader (*nakotigi)*. Married men managed the vast majority of garden operations (19 out of 22, or 86%). Each of the three women *nakotigiw* had the position of first wife within a polygynous unit. As such, they had all retired from direct engagement in the food production realm, and their activities were no longer managed by their respective *dutigiw*. Compared to other *nakotigiw*, these women operated relatively minor enterprises, working on small plots in peripheral locations. Most *nakotigiw* are helped by younger brothers or sons and daughters and, in some cases, wives. The *nakotigiw* establish cropping patterns, organize labour, make decisions regarding harvest and marketing, and sell the produce and distribute the proceeds as they see fit.

In the mid-1990s, Niamakoroni's 22 *nakotigiw* operated a total of 34 different garden plots ranging in size from 378 to 9720 m2 with an average of 3212 m2. The vast majority of these plots were located in low-lying areas immediately surrounding the community. Most were well delineated and fenced to protect them from livestock damage. The plots controlled by the three women gardeners were unfenced and were the smallest (378-650 m2). Moreover, their plots were located deep in the bush along relatively minor streams.

Market gardens produce a wide variety of vegetables and fruits, most of which are non-traditional exotics. The most common types of vegetables grown in Niamakoroni were tomatoes, bitter eggplant (*Solanum incanum*), common beans, hot pepper, and cabbage. Of these, tomatoes, and bitter eggplant were the most popular. At one point or another, all 22 *nakotigiw* cultivated these crops. Other vegetable crops included onion, European eggplant, green pepper, squash, and okra. Fruit crops also play a major role in these gardens. Often these fruit plantings occupy a large percentage of an enclosed garden area, mainly as pure orchards or, less frequently, integrated into a diversely planted garden. Except for the plots belonging to the three women *nakotigiw*, all garden plots contained at least some mature (productive) fruit plantings including banana, papaya, mango, and various citrus species. In all cases, banana was the most abundant

fruit crop. Papaya was the next most common and was cultivated by all nineteen male *nakotigiw*. All male *Nakotigiw* also had mango (*mangoro*) trees. Most gardeners had citrus stock including lemons, oranges, mandarins, tangelos, and grapefruits, where lemons were the most common. With the exception of bitter eggplant, hot pepper, and mango, these crops are non-traditional garden plantings. All of the garden crops, traditional and non-traditional alike, are in high demand in the capital city.

Gardeners frequently use a range of commercial inputs. All twenty-two *nakotigiw* purchase commercial vegetable seed for their market gardens. In interviews, they specifically mentioned purchasing tomato, cabbage, and bitter eggplant seed. Except for traditional crops such as bitter eggplant, the seed typically originates in France or Holland. Respondents uniformly reported that they buy seed at distribution sites in the capital where vendors (street-side table merchants and storefront operators) tend to specialize in hardware and agricultural supplies. In fact, there are several shops in the area catering specifically to market gardeners. These shops supply both the fully commercial market gardening operations that exist within the city itself, as well as rural market gardeners such as those in Niamakoroni. Several of Niamakoroni's gardeners stated that they purchase seed from *tubabu* boutiques (European-style stores) in the Dibida area. Expatriates, including some French businessmen, run many of the specialized garden supplies operations.

In addition to purchasing vegetable seed and seedlings, Niamakoroni's *nakotigiw* also regularly purchase orchard stock. All nineteen male *nakotigiw* reported that they purchase orchard stock, banana plantings, citrus seedlings or citrus grafting stock. The Badala market along the Niger River was their main source. They also mentioned obtaining items such as banana sprouts, orange tree seedlings, and tangelo grafts from the Badala vendors. Some of the male *nakotigiw* noted that they also obtained such items from *nakotigiw* in neighbouring communities where longer-established orchards exist. The three women *nakotigiw* had not planted any citrus trees in their plots and the bananas that they were cultivating had been obtained locally.

All 19 male *nakotigiw* said that they purchase chemical fertilizer for their plots. Fourteen also stated that they purchase animal manure (mainly chicken - *she nogo*). A few male *nakotigiw* also purchase chemical pesticides from time to time. The gardeners are usually unaware of the health risks of these materials and thus fail to protect themselves.

Gardeners were unanimous when asked about their production goals. All twenty-two *nakotigiw* indicated that they viewed their horticultural activities as a way to earn income. They noted that all of the produce from their gardens is destined for sale. Indeed, garden produce only very rarely appeared in the local diet and, when it did, it was either damaged or deteriorating. The bulk of the produce from Niamakoroni's gardens was directed to Bamako's markets. The produce was typically brought to a suburban site where urban market traders — mostly young women –- purchased it from gardeners or their helpers. There was always a stable cohort of buyers at these markets and, on some occasions, these buyers even travelled directly to the gardens to secure produce, which indicates the strong demand in the capital city.

In order to get a sense of the potential income levels from market gardening, a series of crop value estimates were made based on a systematic count of the number and assessment of the reproductive status of fruit plantings in each garden. The gross value of certain crops could be estimated by knowing how many productive trees there were, how much fruit a tree could yield in a year, and average sale prices. This analysis showed that the total value of the banana crop alone across all gardens during 1993-1994 was approximately US$35,000. The individual with the largest number of banana plantings (736) could have taken in approximately US$4,400 from this crop alone. The individual with the fewest banana plantings (36) could have earned US$216. The projected value of the total papaya crop for the year was approximately US$9,500. The individual with the most mature plantings (76) could have taken in about US$1,600 from this crop, whereas the individual with the fewest mature plantings (4) could have earned US$85.

These examples indicate that potential incomes from market gardening are relatively high for Mali, which has a very low per capita income (US$260 in the early 1990s, Imperato 1996). Based on proceeds from these two crops alone, if shared equally among all 184 Niamakoroni residents, the gross per capita income would be approximately US$244, or nearly the national average. However, figures are based on gross value and not net income. Furthermore, income generated through gardening is most definitely not distributed uniformly in the community. Rather, because the vast majority of garden leaders are married men, they are the primary benefactors of this relatively lucrative livelihood diversification strategy (Wooten 1997, n.d.).

## Contrasting Views on the Development of Commercial Horticulture

Clearly, market gardening is very significant endeavour in contemporary Niamakoroni. It is also very clearly a male-dominated commercial activity and one that focuses on an array of largely exotic, non-traditional crops. However, as the commentaries provided in the introduction indicate, gardening has not always been male dominated, market-oriented, and based on exotic plants. Moreover, not all people have quietly accepted market gardening, nor is it likely to affect everyone in the same way. Indeed, men and women in the community tended to narrate the story of the development of market gardening and current garden tenure patterns in quite different ways. The juxtaposition of their accounts highlights a significant change in the nature of gardening over time.

From an elder man's perspective, garden tenure in Niamakoroni shares a characteristic with the settlement of the community: first farmers made first claims. When the initial Jara settlers began farming in Niamakoroni, male lineage heads established themselves as guardians of the land (Wooten 1997). As such, male descendants of the founding Jara patrilineages retained the right to distribute upland tracts to the community's household heads. However, it appears that the original Jara claim did not necessarily include lowlands, which men at that time did not see as being central to the food production regime. Based on the commentaries provided by Nene Jara and Shimbon Jara, the two male elders, it seems that control over these areas fell to those who opened them for cultivation, in most cases to the first generation of market gardeners: their fathers.

Others subsequently joined the first wave of gardeners in the community as they began to see the advantages of garden cultivation. Young men entered into the domain by clearing what Nene referred to as 'unused areas.' In addition, over time, some young men who had worked for the original garden heads established their own operations, either by claiming 'unused' land or by obtaining a section of their fathers' or elder brothers' original holding after death or retirement. Later still, some individuals obtained plots from non-related individuals. Rent was not mentioned, although short-term, non-monetized loans of plots have been made. Nene and Shimbon noted that, most recently, a few women had begun gardening activities far out in the bush on lands that they said men deemed to be too distant for serious horticulture activities. The women cleared these areas themselves in order to garden.

Women offered quite a different perspective on the development of market gardening. Various older women reported that, prior to men's development of the low-lying areas for commercial gardening activities, women had in fact cultivated crops and collected plants in some of those areas. Wilene Diallo, the community's oldest woman, said that she and the other village wives used plots in these areas during the rainy season to cultivate traditional vegetable crops for their sauces (*naw)*. She also indicated that village women sometimes planted rice in low-lying areas during the rainy season. The rice produced was a traditional variety that was used in special meals or marketed. Wilene's assertion was echoed by a number of other senior women, and the pattern is also noted in published accounts about rural production patterns in other areas of Mali (e.g., various papers in Creevey 1986, Becker 1996).

Thus, before the first generation of market gardeners became established, it appears that women used at least some stream areas freely and without direct competition from men, and did so with the primary goal of producing local sauce crops. Such uncontested use of these areas may relate to the fact that a ready market for specialized horticultural produce had not yet developed, and that men perceived low-lying areas to be less desirable. A comment offered by one of Niamakoroni's contemporary male garden leaders supports this general position. With regard to the development of his own garden plots, Mamari Jara said that, perhaps a generation ago, he thought, some of the land was originally used by some of the village women to produce leaves and vegetables for sauces.

Mamari went on to say that, as market demand for horticultural produce grew, men in the community became more aware of the potential value of the low-lying stream areas and eventually displaced women in the cultivation of these areas. He said that they began to clear the areas and then proceeded to fence and claim them as their holdings. After all, he said, 'There was money to be made!' As he finished saying this, he and his younger brother Konimba laughed and added that, after all, 'Men are thieves!'

## Lost Ground, Threatened Resources

Whatever the exact historical particulars, it is clear that today women are largely excluded from the community's garden spaces. To establish their commercial enterprises, men have appropriated the physical space of the lowlands as well as the garden production niche itself. In the process, the women of Niamakoroni have lost important ground. Men's movement into the gardening domain has been facilitated by broader inequalities in local gender relations of production. According to Davison (1988: 3), gender relations of production are the 'socioeconomic relations between females and males that are characterized often by differential assignment of labour tasks, control over decision-making, and differential access to and control over the allocation of resources — including land and income'.

In Niamakoroni, as in most rural Africa settings, gender relations of production generally favour men. As noted above, it is a community in which descent is traced patrilineally and control over productive resources is generally corporate in nature with elders dominating juniors, and men typically holding more power than women. Married men have exploited their privileged position in this structure to establish themselves as market gardeners. They have laid claim to land where their mothers and wives once cultivated and collected plants for the household saucepot. This has important implications for women's contributions to the food economy and for their relative standing in the community.

Women's marginalization from the gardening niche in Niamakoroni limits their ability to produce traditional foodstuffs. The women endeavour to grow sufficient sauce crops on the upland fields allocated to them by their *dutigiw*, but their productivity there is limited. They have a wide range of domestic obligations that limit the time that they have available to cultivate these fields and, moreover, some of their traditional crops may not grow well in upland environments. The upland fields can only be cultivated during the rainy season, while sauces typically require fresh plant material throughout the year. Thus, even if the women are fortunate enough to secure a solid harvest of some sauce crops from their fields, they still need to locate additional local plant resources for their sauces. With access to the low-lying areas constrained, their ability to procure these items is hindered. Their marginalization from the gardening realm also limits their access to financial resources, which could be used to purchase some of the sauce ingredients that they are unable to secure locally.

Women's near exclusion from this important income stream may have broader implications as well. Numerous studies in Africa (e.g., Clark 1994; Fapohunda 1988; Gordon 1996) have shown that income autonomy can enhance an individual's status in various social settings. In particular, an independent income that parallels their husbands' earnings seems to provide a foundation for women's empowered negotiation within African families and communities. This certainly appears to be relevant in the Bamana context. As Turrittin (1988: 586) notes, 'control over their own economic resources is an important resource for women when bargaining with men.' She goes on to show how Bamana gender relations of production constrain women's opportunities to gain access to such resources through trading activities. Like the women of Niamakoroni, the female traders in Turrittin's study were unable to establish themselves in a prized income-generating niche. In both cases, men used existing gender relations of production to lay claim to a relatively lucrative enterprise. Their actions were supported by an established institutional framework in which men, as patrilineage members, have priority access to productive resources and economic opportunities.

It should be noted that this shift has not gone unnoticed or unchallenged by the women of Niamakoroni. In the course of interviews, several women voiced clear dissatisfaction with the situation. As one woman said, 'Men get all the gardens. They get all the money. Yet they don't give us anything, not even money for sauce or our babies.' Some women clearly resent the fact that what they conceive of as a traditional woman's sphere has now become part of a man's world. Moreover, it is important to keep in mind the fact that there were three female *nakotigiw*. Their gardens were very small and located at considerable distance from the village on relatively minor streambeds, but they had gardens nonetheless -– commercially oriented gardens at that. However, unlike most married women in the community, these women gardeners were senior wives who are retired from most of the regular duties associated with the household food economy. Their accomplishments, meagre as they might be, are not likely to be widely replicated.

In addition to the emergence of a series of social and economic challenges, women's exclusion from the garden realm may lead to detrimental shifts in a number of other important domains. The shift documented here points to changes in culinary patterns and to the possibility of declines in nutritional status (see also Daniggelis, this volume),

local plant diversity, and overall environmental stability. While these issues were not specifically evaluated in the study, the data presented do reveal a number of significant threats.

The expansion of men's market gardening may lead to a decrease in the availability of local plants for the diet. Men have pushed women and women's crops out of the gardening niche. In the process, many garden plants maintained by men and associated with urban consumers have replaced local plants linked with women and the saucepot in Niamakoroni gardens. Today's male market gardeners are not interested in maintaining women's sauce crops unless there is a suitable urban market for them, as is the case with bitter eggplant. Indeed, most men see most women's plants (especially traditional leaf crops and wild sauce plants) as weeds to be removed in favour income-earners such as tomatoes or bananas. The well-manicured market gardens now only very rarely contain traditional vegetables and wild or semi-domesticated plants.

In short, lacking access to traditional gardening and collecting areas, women have fewer options when it comes to making their sauces. While it is not documented as yet, a change in local culinary patterns may be underway as a result –- ironically, by growing and selling garden crops, male gardeners may be contributing to a decline in the nutritional value of their own meals.

Studies from a range of contexts reveal that shifts toward commercial agriculture can result in declining nutritional standards at the local level as nutritious traditional crops are replaced by non-food items, food items of lesser nutritional value, or by items that, while quite nutritious, are sold rather than consumed (von Braun and Kennedy 1994; De Walt 1993). Specifically, in light of research that shows the nutritional significance of traditional leafy vegetables in the diet (Chweya and Eyzaguirre 1999; Nesamvuni et al. 2001; Thaman 1995), the transformation in Niamakoroni may well lead to nutrient deficiencies and related health problems. Indeed, recent work in southern Mali has documented the nutritional importance of local plant resources typically associated with women. Nordeide et al. (1996) have shown that traditionally gathered and locally produced crops contribute valuable nutrients, particularly in rural settings like Niamakoroni. This kind of decline is especially likely because so little of the 'new' replacement garden produce ever finds its way into the local diet. The market gardeners view their operations as money earning endeavours and their produce strictly as a means to that end. Nor do they use their incomes to purchase food, nor do they provide their wives with cash that could be used to purchase traditional sauce ingredients or local medicinal herbs (Wooten 1997).

If studies of commercialization processes in other contexts are any indication, additional problems having both local and global repercussions are likely to arise in the longer term. In order to ensure the long-term viability of locally adapted plant resources, experts in plant genetic resource (PGR) management are calling for *in situ* conservation (Altieri and Merrick 1987; Qualset et al. 1997). This is seen as the most effective way to conserve genetic resources, insure their continued adaptation to local environments over time, and insure continued access to locally adapted resources. Research has shown that, while they may be small in size, women's homegardens around the globe typically hold a tremendous range of useful, locally adapted plants (Howard-Borjas 2002). Women use such spaces as experimental plots and as sites for rare plant conservation. In fact, it has been noted that African women's gardens may be one of the most significant reservoirs of local plant genetic material (Chweya and Eyzaguirre 1999). However, the potential for *in situ* conservation of plants traditionally linked to women in Niamakoroni is threatened by the expansion of commercial gardening. Without access to appropriate gardening niches, women lack the opportunity to maintain traditional plant resources *in situ*. While some of their traditional plants may be suitable for upland cultivation during the rainy season, there are many more wild or semi-domesticated plants that are adapted to the low-lying stream areas. Thus, this situation presents a challenge for the maintenance of viable locally adapted plants and, over time, to the continuity of local knowledge of these tried and true species. In short, without continuous management, it is possible that these species may erode locally.

Loss of plant genetic resources and associated knowledge at the local level would represent a significant loss to the wider realm of global plant biodiversity as well. In general, very little is known about the genetic characteristics of traditional African crops. In fact, until recently, they have been ignored by *ex situ* gene banks and commercial prospecting endeavours (for a discussion see Chweya and Eyzaguirre 1999). Thus, plants that slip into obscurity or become extinct at the local level run the risk of being lost completely.

The threat to local plant biodiversity is not limited to garden areas, however. There are a number of important secondary environmental effects related to the development of men's market gardening in Niamakoroni. Without access to lowlands for sauce production or other alternatives for income-generation, women are increasingly focusing their attention on the exploitation of other local, bush-based plant resources for food as well as for income generation in support of their domestic cooking obligations (Wooten 1997). Specifically, they are expanding their commercial production of charcoal, shea nut butter, and toothbrushes made from plants. In interviews, several women noted that they use the proceeds from these activities to secure sauce items for their household meals. All of these activities are dependent upon the use of wild native plant resources. Women's expanding use of such resources reveals what may represent a vicious cycle: without access to garden spaces, women may be over-exploiting bush resources to acquire income that they can use to obtain sauce ingredients that they can no longer produce locally.

Women were uniform in identifying charcoal as their primary commodity: like market garden produce, charcoal is a highly desirable product in urban Bamako. Charcoal production is an arduous process and generates relatively little in the way of returns (Wooten n.d.). However, because it is one of the very few income-generating activities open to women, charcoal pits are becoming very common. At the same time, there has been a noticeable decrease in mature woody growth around the village. Women's actions are likely to be increasing the rate of deforestation of key charcoal linked species. Indeed, women were already lamenting the fact that it was increasingly difficult to find appropriate species and volumes for charcoal production. They indicated that they were beginning to use younger and less desirable tree species in the process and to cut whole trees. A study in the region suggests that, because rural women have few durable land rights, they are not likely to invest in the long-term stability of such land-based enterprises (Grisby and Force 1993). This is ironic considering that studies in the area indicate that women are the primary users and benefactors of land-based activities (Driel 1990, Gakou et al. 1994). With increasing urban demand and few other options, it is likely that women will continue to exploit the woody resources necessary for charcoal production and that this process will contribute to deforestation in the area. In this case, it may not be long before women lose the meagre benefits of this marginal income-generating activity and become fuelwood-deprived themselves. Furthermore, with the continued loss of woody cover comes the possibility for increased soil compaction and erosion and associated environmental degradation (see official Malian reports cited in Becker 2001).

## Gender, Commercialization, and Threats to Local Plant Genetic Resources

In the face of mounting evidence of the rapid and escalating loss of plant biodiversity across the globe, a wide range of individuals and organizations are now devoting attention to the twin tasks of documenting and conserving local plant genetic resources. As a result, understanding of the diversity and significance of locally adapted plants has increased considerably over the last decade. This expansion has often come through a growing appreciation for the extensive body of local or indigenous knowledge in this realm of biocomplexity. However, as research in this area has progressed, it has become clear that there is often a substantial degree of differentiation within local populations with regard to knowledge about local plant biodiversity, for example depending upon ethnicity or mode of livelihood. In short, researchers have shown that there are frequently local plant 'knowledges' rather than a monolithic local plant knowledge.

Thus, in order to gain insights into these different realms of people-plant relations it is critical to identify relevant local specialists and to learn from them about the plant resources that they know best. Unfortunately, it has become increasingly apparent that a significant group of key knowledge holders have been largely ignored in this process. Despite their critical roles in various plant management arenas, women's knowledge of local plants has been sorely under-represented in research (for a review see Howard-Borjas 2002). The result is a skewed and incomplete picture of local knowledge of the plant world.

To address this lacuna, it is imperative to identify and document situations in which women have discrete responsibilities and knowledge of plant resources and to document the cases in detail. Moreover, it is critically important that close attention is paid to those cases in which women's plant resources and knowledge base are under threat. This case study offers a clear example of the type of process that can lead to the deterioration of women's access to plant resources and, subsequently, knowledge.

As women's productive spaces such as the homegardens of Niamakoroni are shifted over to commercially viable exotic crops and market garden production, traditional plant resources may decline and knowledge of these crops may be lost. This threat has been identified as a key concern by the International Board for Plant Genetic Resources and other organizations concerned with the long-term viability of locally adapted plant biodiversity. It is clear from the case of Niamakoroni that gender-linked commercialization dynamics can pose a threat to local plant biodiversity and that the loss of these resources can provoke further detrimental effects on the environment and on human welfare.

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