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Sustaining the Multiple Functions of Agricultural Biodiversity

Michel Pimbert

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Submitted material must be of interest to a wide audience and may combine an examination of broad policy questions with the presentation of specific case studies. The paper should conclude with a discussion of the policy implications of the work presented.

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- Use short sentences and paragraphs.
- Keep language simple.
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- Use a variety of presentation approaches (text, tables, boxes, figures/ illustrations, bullet points).
- Length: maximum 5,000 words

Abstract

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The Gatekeeper Series produced by IIED's Sustainable Agriculture and Rural Livelihoods Programme aims to highlight key topics in the field of sustainable agriculture and resource management. Each paper reviews a selected issue of contemporary importance and draws preliminary conclusions for development that are particularly relevant for policymakers, researchers and planners. References are provided to important sources and background material. The Series is published three times a year – in April, August and December – and is supported by the Swedish International Development Cooperation Agency (Sida).

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Executive Summary

Human communities worldwide have played a central role in shaping nature's diversity and its associated functions. Both natural processes and human management have generated and sustained a vast array of genetic, species and ecological diversity. Within agricultural systems this agricultural biodiversity fulfils a number of important roles, including:

• Providing food and livelihood security. Dynamic and complex rural livelihoods usually rely on plant and animal diversity, both wild and in different stages of domestication. Different types of agricultural biodiversity are used by different people at different times and in different places, and so contribute to livelihood strategies in a complex fashion.

• Ensuring productive and environmental sustainability. In addition to contributing to environmental sustainability, agricultural biodiversity helps sustain many production functions both in low external input and high input-output agriculture. Available evidence is summarised for the following functions: soil organic matter decomposition, nutrient cycling, pollination, pest control, yield functions, soil and water conservation, action on climate and water cycling, biodiversity conservation and influence on landscape structure.

• Supporting rural development. In addition to its contribution to food and livelihood security, agricultural biodiversity can provide the basis for ecotourism and the regeneration of localised food systems and rural economies.

However, throughout the world the diversity of agroecosystems is being rapidly eroded. This erosion is due to a range of factors, including the neglect of indigenous knowledge, institutions and management systems; the blueprint approach to development whereby monoculture systems and uniform technologies are promoted; the quest of the transnational corporations that market agricultural inputs and process food and fibres for commercial profits and control over production; inequitable access to, and control over, land, water, trees and genetic resources on the part of local people; market pressures and the undervaluation of agricultural biodiversity; and demographic factors.

The paper concludes with detailed actions urgently needed if this erosion of agricultural biodiversity is to be halted and reversed, and lists ways in which each of these actions can be achieved:

• Expand knowledge on the dynamics of agricultural biodiversity
• Increase effective use of agricultural biodiversity in food and fibre production
• Promote local adaptive management of agricultural biodiversity
• Support local participation in planning, management and evaluation
• Transform bureaucracies and professional practice to take on new roles that facilitate local people's analysis, planning, action, monitoring and evaluation
• Strengthen local rights and security of tenure
• Reform trade policies, markets and economic incentives

SUSTAINING THE MULTIPLE FUNCTIONS OF AGRICULTURAL BIODIVERSITY[1]

Michel Pimbert

Introduction

Human communities worldwide have played a central role in shaping nature's diversity and its associated functions. Recent scientific evidence suggests that virtually every part of the globe - from boreal forests to the humid tropics - has been inhabited, modified and managed for millenia (Gomez Pompa and Kaus, 1992). Both natural processes and human management have generated and sustained a vast array of genetic, species and ecological diversity. Within agricultural systems this agricultural biodiversity (Box 1) performs many closely interrelated socio-economic and environmental functions, including promoting food and livelihood security; maintaining productive and environmental sustainability; and contributing to resilient rural economies. But this agrobiodiversity is being lost at an alarming rate. This paper identifies some of the reasons for this loss and outlines some of the policy and institutional reforms needed to sustain agricultural biodiversity and agroecosystem functions.

Box 1. Key concepts and definitions

Agricultural biodiversity: the diversity of genetic resources (varieties, breeds, species; cultivated, reared or wild) used directly or indirectly for food and agriculture; the diversity of species that support production (soil biota, pollinators, predators, etc.) and those in the wider environment that support agroecosystems (agricultural, pastoral, forest and aquatic), as well as the diversity of the agroecosystems themselves.

Agroecosystems are those ecosystems that are used for agriculture, and comprise polycultures, monocultures, and mixed systems, including crop-livestock systems (rice - fish), agroforestry, agro-silvo-pastoral systems, aquaculture as well as rangelands, pastures and fallow lands.

Source: FAO, 1998a.

Agricultural biodiversity's contribution to food and livelihood security

The livelihood strategies of many rural people, regardless of whether their agroecosystems are predominantly pastoral, swidden or based on permanent cropping, often incorporate wild resources and high diversity. This helps to provide resilience in the face of

1 An expanded version of this paper was prepared for the FAO/Netherlands Conference on the "Multifunctional Character of Agriculture and Land", Maastricht 12-17 September 1999. The full text is available on the Internet at www.fao.org/mfcal/

adverse trends or shocks, and offers a greater choice of livelihood options.

Different types of agricultural biodiversity are used by different people at different times and in different places, and so contribute to livelihood strategies in a complex fashion. Understanding how this use differs according to wealth, gender, age and ecological situation is essential for understanding its contribution to the livelihoods of different members of a community. For example, wild resources are particularly important for the food and livelihood security of the rural poor, women and children, especially in times of stress such as drought, changing land and water availability or ecological change. These groups generally have less access to land, labour and capital and thus need to rely more on the wild diversity available. In India, the poor obtain 15-23% of their total income from common property resources, as compared with 1-3% for wealthier households (Jodha, 1986). However, this is not the exclusive preserve of rural households in developing countries. In Poland for example, wild bush and berry fruits are important for local consumption and for export, with *Vaccinium myrtillus* being the principal export species at present (over 30, 000 t/year) followed by *Rubus spp., Sorbus aucuparia, Sambucus nigra, Prunus spinosa* and *Rosa spp.* (Glowacki, 1988).

Many wild resources have significant economic value by preventing the need for cash expenditure and providing ready sources of cash to poor households, often yielding a better income than local wage labour (IIED, 1995). The cultural and spititual values of some elements of agricultural biodiversity are sometimes valued more highly than monetary values. Many rural communities designate certain biodiversity-rich areas of land or water as sacred. The spiritual values of sacred places are often inextricably linked to the functions that their associated agrobiodiversity may provide in maintaining the health of the ecosystem.

Diversity *within* species is also remarkable among those plant and animal species that have been domesticated for crop and livestock production by innovative rural people (Box 2). Worldwide, it is believed that the total number of mammalian and avian livestock breeds is between 4,000 and 5,000 (FAO, 1998b).

Agricultural biodiversity's contribution to productive and environmental sustainability

Low external input farming generally relies on high agricultural biodiversity so that practices are finely tuned to the local biophysical and socio-economic conditions of individual farmers, herders and fish culturists. Natural processes mediated by agricultural biodiversity are favoured over external inputs and by-products or wastes from one component of the agroecosystem become inputs to another (Box 3).

In more specialised high input farming, high agricultural biodiversity helps sustain many production functions such as soil organic matter decomposition, pollination and pest control. In the USA or Australia for example, farmers may manage cover crops primar-

Box 2. Diversity within species

There is high intra-specific genetic variation in the date palm oasis agroecosystems of Algeria, Chad and Egypt (Barakat, 1995). The principal varieties differ from one oasis to another. In general, there are more than ten varieties of date palms in each oasis, including different varieties of dry and semi-dry dates that mature in different months to meet the demands of local consumption and the market. Moreover, each genetic variety confers its own unique stamp on i) the taste of the date fruit and the wine made from it ii) the texture of the edible palm centre iii) the properties of the wood from the palm trunk iv) the mechanical qualities of palm leaves and fibres used for ceilings and fences, ropes and sacks and v) the nutritional values of date stones fed to camels.

In south east Mexico, women keep as many as nine breeds of local hen, as well as local and exotic breeds of turkey, duck and broilers in their back gardens. In selecting for the best breeds, they consider eleven different characteristics, including egg production, ease of sale, appearance, broodiness, heat and cold tolerance, growth rate and eating qualities (Intermediate Technology, 1996).

ily to save soil and water in intensive orchard production systems. However, the species chosen will usually perform other functions in the agroecosystem such as enhancing soil structure, improving soil fertility and nutrient cycling as well as playing a role in pest management by providing habitat heterogeneity and preserving a favourable balance between pests and predators. These examples highlight the multifunctional character of agricultural biodiversity and are a reminder that functions in Box 4 are only listed separately for convenience's sake.

Agricultural biodiversity also influences landscape structure by providing environmental services and functions, and human activity can transform whole landscapes over large areas. For example, many rural communities enrich their agricultural plots and forest

Box 3. Agriculture which harnesses biodiversity

The mulberry grove-fishpond system in the Pearl River Delta of China is a classic example of a multifunctional system. The white mulberry (*Morus alba*) tree produces organic substances (mulberry leaves etc) which are used to feed silkworms that, in turn, produce their silk and chrysalides. The fallen parts of the mulberry tree and the excrement of the silkworm are applied to the fishpond where they are converted into fish biomass. The excrement of the fish, as well as other unused organic matter and bottom mud are returned to the mulberry grove as fertiliser, after being broken by a diverse suite of benthic microorganisms. The agricultural biodiversity harnessed by the fish culturalists allows for the closing of nutrient cycles and efficient production in time and space. Fish polycultures are thus made up of species that dwell in the upper, medium and lower layers of the pond, as well as fish species with different feeding habits (e.g. plankton feeders, herbivorous fish, benthic mollusc feeders, and onmnivorous fish) (Ma, 1985; Zhong, 1982).

Box 4. Agricultural biodiversity's role in the agroecosystem

Decomposition and nutrient cycling. Decomposer communities are highly diverse and are central to nutrient cycling, organic matter dynamics and other ecosystem functions, although detailed knowledge of the extent and functions of this diversity is limited, especially in aquatic environments.

Biomass production and yield efficiency. Diverse agroecosystems (fish polycultures, mixed herds, intercrops, integrated agro-sylvo-pastoral) are generally highly productive in terms of their use of energy and unit land area (or unit water volume). This efficiency is largely a product of the systems' biological and structural complexity, increasing the variety of functional linkages and synergies between different components.

Soil and water conservation. Soil, water and nutrient conservation have been improved with the use of windbreaks, contour farming with appropriate border crops and cover crops in a wide range of agroecosystems.

Pest control. Predators, parasitic wasps and micro-organisms play a key role in controlling agricultural pests and diseases. For example, more than 90% of potential crop insect pests are controlled by natural enemies living in natural and semi-natural areas adjacent to farmlands (CAST, 1999). The substitution of pesticides for natural pest control services is estimated to cost $54 billion per year. Many methods of pest control, both traditional and modern, rely on biodiversity.

Pollination and dispersal. There are more than 100,000 known pollinators (bees, butterflies, beetles, birds, flies, and bats). Pollination mediated by components of agricultural biodiversity is an important function in a variety of terrestrial agroecosystems. About half of all plant species, including food-producing crop species, are pollinated by animals.

Biodiversity conservation. There is no strict divide between 'wild' and 'domesticated' species important for food and livelihoods. Whilst not necessarily the subject of conscious management by herders or farmers, many wild plant and animal species thrive in, or are dependent on, agroecosystems, especially structurally and biologically complex agroecosystems.

Climate. As a source of atmospheric constituents agricultural biodiversity contributes significantly to the chemical composition and properties of the atmosphere and thus has a marked influence on climate. In turn changes in climate have a strong feedback on agricultural biodiversity and its multiple functions, and thereby influences gaseous emissions by biological organisms.

Functions in the water cycle. Agricultural biodiversity plays a crucial role in cycling water from the soil to the atmosphere and back. It also has measurable impacts on water quality.

fallows with valued perennial plants. Through such enrichment practices, successional vegetation can become a site for economic production as well as for ecological rehabilitation (Dubois, 1990). Each of the major tropical forest regions has many economic woody plants that have been managed, probably for millennia, in enriched fallows.

These include rattan in East Asia, rubber in Sumatra, oil palm in West Africa, and edible fruits and nuts universally.

Agricultural biodiversity's contributions to rural development

In addition to its direct contributions to rural livelihoods, agricultural biodiversity may generate other rural development opportunities through ecotourism and a variety of income generating schemes. Many humanised landscapes are increasingly valued for aesthetic and historical reasons, such as the Asian-Pacific landscapes of terraced pond fields. These are both archaeological sites and living landscapes, continuing to be used and maintained by the people who created them. The ecotourism potential of these cultural landscapes is viewed as potentially important for rural development and local employment creation, both in the developed and developing countries.

However, as is often the case for classical tourism, ecotourism schemes tend not to be integrated with other sectors of the national or regional economy; and only a fraction of earnings generated actually reach or remain in the rural areas (Koch, 1997). Economic benefits and equitable rural development will only accrue with many wide-ranging reforms, such as restoration of land and water rights to local communities, support for new forms of tenure and rights of usufruct, strengthening of local groups and institutions, investment in technical and managerial skills and mandatory impact assessments of all ecotourism schemes (Koch, 1997).

Another potential engine for rural development is the extraction of biological diversity and indigenous knowledge for commercially valuable genetic and biochemical resources (biodiversity prospecting or bioprospecting). However, available evidence indicates that benefits shared with countries in which collections took place represent a small fraction of the annual R&D budget of the corporations involved (RAFI, 1994; Pimbert, 1997), despite the fact that these products embody the knowledge and resources of the local source communities.[2]

In a growing number of rural areas worldwide the diversity of local plants and animals is being harnessed for sustainable economic development. Ways of reintegrating locally adapted, traditional animal breeds (sheep, goats, cattle and bees), crop varieties (fruit trees, fodder plants and cereals) and 'wild' foods are being explored to generate local products, jobs, income and environmental care. For example, in the Willapa watershed of the Pacific North West (USA), oysters are now marketed locally rather than shipped out wholesale, alder is harvested from secondary forests for high quality wood products, fish and crab are marketed with the north-west image of wholesome foods, cranberry growers produce a wide range of products retaining more of the value added from food processing within the watershed (Maughan, 1995).

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2 It should be noted that despite frequent mention of benefit sharing agreements in commercial contracts between bioprospecting agents and sovereign states, the specific terms of benefit sharing are strictly confidential.

These forms of endogenous rural development seek to create viable and locally controlled economic activities based on locally adapted agricultural biodiversity, knowledge, skills and negotiated partnerships between civil society, government and the private sector, both in developed (Pretty, 1998) and developing countries (Women sanghams et al, 1999).

Underlying causes of agricultural biodiversity losses

Whilst rates of biodiversity loss vary in different ecological and economic settings, local livelihoods and environmental processes are increasingly threatened by the loss of genetic, species and agroecological diversity everywhere. Understanding the forces that have neglected or undermined the values and functions of agricultural biodiversity can help identify actions needed to sustain this key resource.

The neglect of indigenous knowledge, institutions and management systems

The knowledge required by rural people to manage and enhance agrobiodiversity is substantial. These systems became tuned to local needs over centuries, and detailed knowledge allowed people to adapt to social and ecological change. However, many modernising interventions and colonial administrations have ignored the importance of local knowledge and skills, resulting in an erosion of knowledge and an undermining of formal and informal institutions that were central for the sustainable management of agricultural biodiversity. These institutions include rules about use of biological resources and distribution of benefits, tenure, conflict resolution mechanisms and methods of enforcing rules, cultural sanctions and beliefs.

The dominance of blueprint paradigms and policies

One of the most fundamental causes of agricultural biodiversity loss has been the blueprint approach to development (Table 1). Typical expressions of this are industrial agriculture and Green Revolution farming and much contemporary forest, fishery and rangeland development that promote monoculture systems and uniform technologies, including high yielding seeds and animal breeds, agrochemicals, irrigation, mechanised equipment and large infrastructure developments. During and after the colonial period, these technologies, and the values associated with them, were extended from the North to the South, often in a classic top down manner (Table 1).

Table 1. Agricultural biodiversity management paradigms: blueprint and learning-process approaches

	Blueprint	Process
point of departure	nature's diversity and its potential commercial values	the diversity of both people and nature's values
keyword	strategic planning	participation
locus of decision making	centralised, ideas originate in capital city	decentralised, ideas originate in village
first steps	data collection and plan	awareness and action
design	static, by experts	evolving, people involved
main resources	central funds and technicians	local people and their assets
methods, rules	standardised, universal, fixed package	diverse, local, varied basket of choices
analytical assumptions	reductionist (natural science bias)	systems, holistic
management focus	spending budgets, completing projects on time	sustained improvement and performance
communication	vertical: orders down, reports up	lateral: mutual learning and sharing experience
evaluation	external, intermittent	internal, continuous
error	buried	embraced
relationship with people	controlling, policing, inducing, motivating, dependency creating. People seen as beneficiaries	enabling, supporting, empowering. People seen as actors
associated with	normal professionalism	new professionalism
outputs	1. diversity in conservation, and uniformity in production (agriculture, forestry,...) 2. the empowerment of professionals	1. diversity as a principle of production and conservation 2. the empowerment of rural people

(adapted from David Korten and Pimbert and Pretty, 1995)

This blueprint approach to the management of agricultural biodiversity is supported, subsidised and defended by an elaborate institutional structure, including many international donors and development agencies, international and national research institutions and national governments. Though attitudes are beginning to change, numerous policies, ranging from general agricultural development policies to pricing and credit schemes, directly or indirectly influence biodiversity in livestock production, agriculture,

forestry and fisheries. The most influential are incentive policies (eg. subsidies for agrochemical inputs, extension programs, credit policies and marketing standards) that support the adoption of capital and energy intensive industrial inputs and technologies. For example, extension programs in many countries have mandated the adoption of uniform varieties and the elimination of diversity. Policy incentives for people to clear forested land and establish farms in order to gain tenure in Brazil, Costa Rica and Indonesia have increased food production but have also induced biodiversity losses and unsustainable land use.

Corporate interests

Private companies, particularly transnational corporations (TNCs) that market agricultural inputs and process food and fibres, exert a strong influence on the type of agricultural biodiversity used in production. In many countries, including in the OECD countries, the R&D budget of these corporations dwarfs that of public sector research. As a result, corporate priorities and industrial strategies are increasingly reflected in research, development and distribution of seeds, livestock and other technologies that directly affect agricultural biodiversity. To date the evidence suggests that the corporate quest for commercial profits and control over production has promoted more, rather than less, genetic and ecological uniformity in agroecosystems. In particular, new biotechnologies such as pesticide resistant crops and seeds engineered to terminate germination after one growing season are potentially serious threats for agricultural biodiversity, at different temporal and spatial scales (Ho, 1997; UNEP-CBD, 1999). Moreover, market dominance combined with monopoly patents gives the life industry unprecedented control over the products and processes of agricultural biodiversity, the biological basis of food and livelihood security.

Inequitable tenure and control over resources

A significant cause of agricultural biodiversity erosion is local people's loss of access rights to, and control over, these resources, severely reducing their incentive to conserve resources and undermining local livelihood security. Western concepts of private property do not recognise the intellectual contributions and informal innovations of indigenous and rural peoples who have modified, conserved and managed so-called 'wild' species and landscapes. This is also the case for the genetic resources of domesticated plant and animals. Although most genetic resources originate from developing countries, transnational companies and northern institutions have captured a larger share of the benefits from using such resources in breeding programs and new natural product development. Legal means such as industrial patents and other intellectual property rights allow companies and northern institutions to maintain disproportionate control over the knowledge, genetic resources and benefits associated with agricultural biodiversity (GRAIN-GAIA, 1999). In contrast, the local communities and farmers who originally nurtured this genetic diversity have generally not been recognised or compensated for their innovations.

Market pressures and the undervaluation of agricultural biodiversity

Even though agricultural biodiversity has many values and performs many functions, it is undervalued or even ignored in conventional economic assessments, partly because these multiple functions are difficult to value in economic terms (IIED, 1995). This has biased conventional resource planning in favour of major food crops and species of commercial importance for urban centres.

The expansion of global markets and trade liberalisation tend to have a homogenizing effect on agricultural biodiversity by standardising food production and consumption. Global markets usually demand uniform foods that are increasingly processed and sold by transnational corporations, and are geared to meet the food desires of relatively wealthy, urban based consumers. In turn, these market pressures often force farmers worldwide to comply with those demands for uniformity.

Demographic factors

Whilst in some contexts population growth *per se* is clearly responsible for agricultural biodiversity loss, there are many situations in which inequitable land tenure, forest concession policies, colonisation programs, land use and fishing policies are the root causes behind the biodiversity loss induced by growth in human numbers or migrations. Conversely, more people can mean more care for the environment and enhanced agricultural biodiversity under certain conditions, as shown by research in Sierra Leone (Richards, 1993) and Kenya (Tiffen *et al.*, 1994).

Options for sustaining agricultural biodiversity and its multiple functions

Broadly speaking, there are two alternative scenarios for the management of agrobiodiversity (Table 1). Whilst the dominant blueprint approach to development has been identified as a major contributer to agricultural biodiversity loss, national governments, the private sector and civil society may choose to stay within this paradigm and reform some of its less acceptable elements in their quest for more sustainable agriculture and land use. In sharp contrast, the learning process approach focuses on major structural change, rather than systemic adjustments within well defined and often narrow boundary conditions. Discussions around these alternative scenarios are inevitably emotionally charged. The issues at stake go beyond purely technical matters and include the fundamental human right to food, the right to a healthy environment, as well as the political economy of who gains and who loses. These are difficult political questions that require debate within society and negotiated solutions involving all stakeholders. Answers are not the prerogative of experts and technical bodies alone. All the latter can do is to facilitate public debate by highlighting possible policy options and technical choices. Whilst some policy recommendations presented below may be relevant for both scenarios, many have been framed within the scenario that departs from dominant values and practices.

1. Expand knowledge on the dynamics of agricultural biodiversity

Rationale

Much is uncertain and unknown about the structure and multiple functions of agricultural biodiversity. The number of species living on Earth is still unknown: estimates vary between 5 and 30 million species; a mere 1.6 million species have been described to date. Knowledge about the functions of biodiversity, synergies and complementarities, interactions within agro-ecosystems, ecological processes within soils and interactions with the atmosphere and water, is rudimentary.

Major investments are therefore needed to improve and expand our knowledge. Historical analysis, combining methods from the social and natural sciences, and the knowledge of local resource users are all clearly needed to identify and properly explain the structure and functions of agricultural biodiversity at different scales. Participatory learning and action approaches can combine the strengths of modern science with local knowledge. There is indeed a strong rationale for democratising science in an age of uncertainty by directly involving *"extended peer communities"* (Funtowicz and Ravetz, 1993) that include farmers, herders, forest dwellers, fisherfolk and other rural people in the production and sharing of knowledge on agricultural biodiversity and its many functions.

Actions

• Provide adequate fiscal and administrative support for basic taxonomic work and inventories within and among plant, animal, microbial species and varieties.

• Support studies exploring the dynamic functions of agricultural biodiversity at different spatial and temporal scales, especially the roles of soil biodiversity, pollinators, pest predators and the processes of landscape transformation.

• Develop, use and promote methods and indicators to monitor the impacts of agricultural extensification and intensification on biological diversity and local livelihoods.

• Provide support and high rewards for studies on the functions of agricultural biodiversity that combine indigenous with scientific knowledge, and use innovative participatory and complementary methodologies.

• Diversify budget allocation committees of public sector planning and research institutes to include representatives of farmer, pastoralist, forest and fishing communities, organisations and federations, at both local and national levels.

• Establish procedures to ensure transparency, equity and accountability in the allocation of research funds and dissemination of new knowledge.

2. Increase effective use of agricultural biodiversity in food and fibre production

Rationale

Agricultural biodiversity performs vital functions in agriculture, land and water use. The diversity of plants, animals and microorganisms is essential for maintaining the productivity and sustainability of farm crops and animals, managed forests and rangelands, aquaculture and fisheries. Future global food security is dependent on harnessing and sustaining agricultural biodiversity and its many functions, from the farm plot to the landscape level. The current overemphasis on genetic engineering must be balanced by higher level approaches that build on agroecology, landscape ecology as well as social and biological diversity. National sovereignity and food security ultimately depend on a wide choice of agricultural technologies and development options.

Actions

• Establish national policy frameworks that ensure political commitment, incentives, educational and institutional capacities to support approaches that enhance agricultural biodiversity in food and fibre production, such as integrated pest, crop, nutrient and soil management, as well as land use planning.

• Provide fiscal and administrative support for studies into ways to maintain and enhance agricultural biodiversity in crop and animal production and in different kinds of agroecosystems, particularly high yielding and intensive commercial production systems.

• Promote development on the basis of locally adapted genetic material. Strengthen capacity to develop new crop varieties and animal breeds that are specifically adapted to local environments. Increase the range of genetic diversity available to farmers.

• Broaden the use of genetic diversity to protect crops and animal breeds against pest and weather problems by introducing multiple genetic systems for coping with stresses and also by deploying functional genetic mixtures and multilines where appropriate.

• Broaden the use of species diversity into functional designs for agroecosystems that sponsor more of their own soil fertility, crop protection, pollination and water management (agroforestry systems, multiple cropping, fish polycultures…).

• Plan and manage rural landscapes to sustain biodiversity and ecosystem services. Where appropriate, maintain hedgerows, windbreaks and mangrove strips, leave tracts of land in native habitat, plant a diversity of crops, encourage pastoral activities, mixed species forestry and aquaculture. Maximise the use of resources internal to the landscape whilst closing nutrient cycles by integrating production with local needs and local markets. Apply the same principles for urban landscapes where food and fibre are produced.

3. Promote local adaptive management of agricultural biodiversity

Rationale

Variation within and among agroecosystems is enormous. Daily, seasonal and longer term changes in the spatial structure of agricultural biodiversity are apparent at the broad landscape level right down to small plots of cultivated land. These spatio-temporal dynamics have major implications for the way agrobiodiversity is managed, how, by whom and for what purpose. They call for flexible responses, mobility and local level adaptive resource management in which local users of agricultural biodiversity are central actors. This suggests new practical avenues for technical support in which land users' own priorities, knowledge, perspectives, institutions, practices and indicators gain validity (Pimbert and Pretty, 1998; Posey, 1999).

Actions

• Ensure flexibility and diversity in institutional and organisational design to enable government administration and services to track the dynamic changes which occur in agroecosystems and the functions of agricultural biodiversity at different time and spatial scales.

• Carry out administrative tasks, land use planning, agricultural research and development as near to the level of actual users of resources or beneficiaries of administration as is compatible with efficiency and accountability

• Educate policy makers, professionals and the public (including the bearers of local knowledge) about the value of local and indigenous knowledge and management systems in sustaining agricultural biodiversity and its many functions

• Strengthen local groups and institutions by devolving resources and removing administrative or legal hurdles to local planning and action. Support the development of local institutions for common property resources and the equitable sharing of benefits from their use

• Identify and support a mediator for conflict resolution and an arbiter of last resort; guaranteeing a level legal playing field and equality of advocacy in disputes, both within and between local groups as well as between local groups and powerful external interests. Of particular importance are government policies and actions that explicitly prevent discrimination on the basis of differences in gender, ethnic origin and wealth.

4. Support local participation in planning, management and evaluation

Rationale

Decisions about *what* agricultural biodiversity is to be conserved, how it should be managed and *for whom* should be based on an understanding of local livelihoods and people's own definitions of well being. Most professionals have tended to project their own categories and priorities onto local people and landscape management. In particular, their views of the realities of the poor, and what should be done, have generally been constructed from a distance and mainly for professional convenience. This implies the adoption of a learning process approach in the management of agricultural biodiversity and its functions (Table 1). It also calls for a new professionalism with new concepts, values, participatory methodologies and behaviour (Pretty and Chambers, 1993).

Actions

• Ensure participation of women and men (particularly farmers, herders, fisherfolk and forest dwellers) in the development of land use and agricultural policies and technologies.

• Ensure inclusive equitable representation (gender, class, ethnic origin, age) in the participatory activities and process.

• Provide capacity building for technical and scientific personnel to foster the participatory skills, attitudes and behaviour needed to learn from farmers and rural people.

• Provide institutional space and incentives for professionals to understand social and cultural complexity as well as agroecological diversity.

• Support joint problem-solving, participatory research agendas and resource management agreements among local people, scientists and extension workers.

• Support the participatory monitoring and evaluation of national policies, land use plans, and production technologies to include the perspectives of all stakeholders. Encourage the use of local indicators and criteria in monitoring and evaluation as well as in guiding subsequent technical support, policy changes and allocation of resources for agricultural biodiversity management.

5. Transform bureaucracies and professional practice

Rationale

Local adaptive management of agricultural biodiversity and participation does not mean that state bureaucracies and other external organisations have no role. The challenge instead is for bureaucracies to assume different roles and responsibilities, such as a shift from project implementor to facilitator of local people's development processes. The whole process should strengthen local institutions, so enhancing the capacity of people to take action on their own. Appropriate partnerships and co-management agreements between states, the private sector and rural communities are also required through new legislation, policies, institutional linkages and processes.

However, training of agency personnel in participatory approaches must be part of a larger process of reorienting institutional policies. In both government departments and non-governmental organisations, the challenge for top and middle management is to design appropriate institutional mechanisms, organisational cultures, financial management practices, reporting systems, supervisory methods and reward systems and norms (IIED-IDS, 1999) to encourage the spread of participatory methods within the organisation. Without this support from the top, it is unlikely that participatory approaches will become core professional activities.

Actions

• Encourage shifts from hierarchical and rigidly bureaucratic structures to 'flat', flexible and responsive organisations.

• Ensure that senior and middle management positions are occupied by competent facilitators of organisational change.

• Promote and reward management that is consultative and participatory rather than hierarchical and efficiency-led. Establish incentive and accountability systems that are equitable for women and men.

• Provide incentives and rewards for staff to experiment, take initiatives and acknowledge errors as a way of learning by doing and engaging with the diverse local realities of farming, fishing and pastoral societies.

• Redesign practical arrangements within the workplace to meet the diverse needs of women, men and older staff as well as their new professional obligations to work more closely with farmers and other stakeholders (eg career paths, working hours, provision of paternity and maternity leave, childcare provisions, mini sabbaticals, promotion criteria…).

6. Strengthen local rights and security of tenure

Rationale

The legitimacy of rural peoples' claims to tenure and rights to agricultural biodiversity are made more apparent as landscapes are re-interpreted as the product of social and ecological histories. These findings support a rights based approach to the participatory management of biodiversity important for food, agriculture and livelihoods (Pimbert and Pretty, 1998; Posey, 1999). They also have major implications for national policies on the sharing of benefits derived from the use of landscapes, agricultural biodiversity and its end products. Guaranteeing the right of farmers to save and re-use seeds and livestock progeny is crucial in this connection. Failure to enshrine these rights in national legislation and policy practice may lead to inequitable benefit sharing schemes and conflicts that could undermine the sustainable management of agricultural biodiversity and food security.

Actions

• Reform policies and laws on rights of access, use and control over land, trees, water and genetic resources to ensure that farmers' and indigenous peoples' rights are protected as a basis for equitable benefit sharing arrangments.

• Ensure that intellectual property rights over genetic resources currently re-negotiated within the TRIPs agreement of the World Trade Organisation do not undermine the objectives of conservation and sustainable use mandated by the Convention on Biological Diversity and the FAO negotiations on the International Undertaking on Plant Genetic Resources.

7. Reform trade policies, markets and economic incentives

Rationale

Economic instruments are key to sustaining agricultural biodiversity and its multiple functions. Trade policies, markets, subsidies and economic incentives must reinforce the objectives of the International Convention on Biological Diversity rather than contradict or actively undermine them. A multilevel and systemic approach to economic transformation will often be needed to reform trade, taxation and public spending aimed at sustaining agricultural biodiversity and its multiple functions (Robertson, 1998; ATTAC, 1999).

Actions

• Reform international and national trade policies that contribute to the loss of agricultural biodiversity and develop trade rules that promote social and biological diversity by regenerating local economies and food systems.

• Eliminate policies and economic incentives that erode agricultural biodiversity, particularly subsidies for High Yielding Varieties, pesticides and fertilisers; credit policies that

require the use of such inputs and monocultures; variety release and seed certification legislation that hinder the utilisation of diverse genetic material through their requirements for distinctiveness, uniformity and stability; pricing and tax policies that favour genetically and ecologically uniform production systems.

• Assess the economic benefits of agricultural biodiversity (domesticated and managed wild diversity) in a more comprehensive manner to improve the decision making basis for policy makers, land use planners and agricultural R&D. Economic benefits based on the use of 'wild' and domesticated agricultural biodiversity should be situated and evaluated in a total livelihood context.

• Establish flexibility in marketing standards to allow food distributors and retailers to diversify varieties of produce and reduce wasteful cosmetic standards for foods in markets.

• Implement anti-trust laws and other regulations that limit or prevent unfair market domination by corporations that sell seeds, animal embryos, agrochemicals, veterinary products and biotechnologies and/or process and distribute food and fibres.

• Restructure the tax system to encourage employment and enhance agricultural biodiversity in the entire food and fibre production-distribution chain. Ensure greater public sector spending and fairness within the food system by redistributing tax levies on speculative international financial flows. A small (eg. 0.1 to 0.25%) international transfer tax on foreign exchange transactions (currently amounting to US$1600 billion *per day*) would allow governments to curb the powers of TNCs and redirect international capital flows to meet environment and development goals.

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