Conservation and Sustainable Use of Agricultural Biodiversity

A SOURCEBOOK

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Introduction

The appreciation for agricultural biodiversity has grown and matured, resulting in an increasing awareness that its valuation and use might contribute to long-term conservation. This sourcebook encourages action aimed at managing agricultural biodiversity resources within existing landscapes and ecosystems, in support of the livelihoods of farmers, fishers and livestock keepers. This is designed for use by rural development practitioners and local administrators as well as trainors and educationalists.

Agricultural biodiversity is defined as the part of biodiversity linked to agricultural production in a broad sense, including food production (e.g., crops, aquatic species and livestock), livelihood sustenance (e.g., raw materials, medicinal plants, animals for transportation) and habitat conservation of agro-ecosystems (e.g., useful wild species). The diversity of genetic resources for food and agriculture encompasses all crop plants and their wild relatives that are cultivated, preserved, exchanged and utilized by farmers, and all livestock.

Agricultural biodiversity is the basis for global food security. It helps secure people's livelihoods and habitats by sustaining multifunctional agro-ecosystems. Plant and animal genetic resources are the primary source material for the further development of crop varieties and animal breeders by farmers and breeders. Equally, biological diversity in agriculture safeguards the potential for natural adaptation to changes in the environment and ecosystems, and to meet changing human nutritional requirements.

Farmers, livestock keepers and fishers, especially those living in areas where diverse systems are still practiced, are the main stewards of these valuable biological resources. However, only recently are they beginning to be recognized for the environmental services that they provide to the wider community. This recognition, especially for women and ethnic (minority) groups, has been central to participatory methods and community-centered research and development approaches. In these approaches, local communities play a central role in chronicling their own knowledge, maintaining biodiversity inventories, conserving and improving cultivars using community seed banks.

The valuable collection of resources in this compilation is the result of generous contribution made by people from around the world: policymakers, scientists, researchers, community workers, rural development activists and practitioners. They submitted articles electronically. A small production team of artists, editors and desktop publishers met in the Philippines to review, select, package and edit the materials. Some articles were merged, rewritten or divided into separate articles, each with a different focus and a new title. Illustrations and computer-generated graphics were added to the edited and (mostly) shortened versions. The revised articles were sent back (again via electronic means) to the individual authors for their final review and approval. An International Advisory Committee guided the process at different stages. Changes were made and another (pre-publication) version of the sourcebook was prepared for the three-day review workshop of the five institutional partners held in Rome in November 2002.

This sourcebook comprises a total of **75** articles packaged in the form of a set of three separate booklets:

Volume 1: Understanding Agricultural Biodiversity
- dimensions
- local knowledge
- system dynamics

Volume 2: Strengthening Local Management of Agricultural Biodiversity
- local seed systems
- participatory approaches to crop improvement
- livestock and aquatic resources

Volume 3: Ensuring an Enabling Environment for Agricultural Biodiversity
- policy and legal frameworks
- institutional arrangements and incentives

The collection of articles is intentionally diverse, addressing topics ranging from international treaties, legislation, policy, community processes, local knowledge, field-level interventions and methodological issues. There is, however, a predominance of article on crops. It is hoped that there will be additional contributions on livestock and aquatic resources in the future.

Each article in this compilation stands on its own and can be read or used independently. The names and coordinates of the contributing authors are included at the end of each article so that direct contact can be made. The views and opinions expressed in the various articles are primarily those of the contributing authors and not necessarily representative of the views of the participating institutions, the international advisory committee and the production staff. There is no copyright to this publication and free use is encouraged, provided the source and authors are duly acknowledged.

Local language translations are encouraged. Articles can be serialized in local newspapers preferably in local languages. These materials can serve as references in designing community-level educational support materials. They can also be used in environmental education campaigns in schools or in advocacy work by NGOs. It is expected that this sourcebook and the associated websites and CD ROMS might serve as prototypes for the production of country-specific versions.

UPWARD (Users' Perspectives With Agricultural Research and Development), an Asia-wide network for participatory research and development program sponsored by CIP (the International Potato Center) worked with SEARICE (Southeast Asia Regional Initiatives for Community Empowerment), an NGO involved in conservation of plant genetic resources, GTZ, IDRC and IPGRI to shape and define the scope of the project. Funding was provided by IDRC, GTZ and IPGRI.

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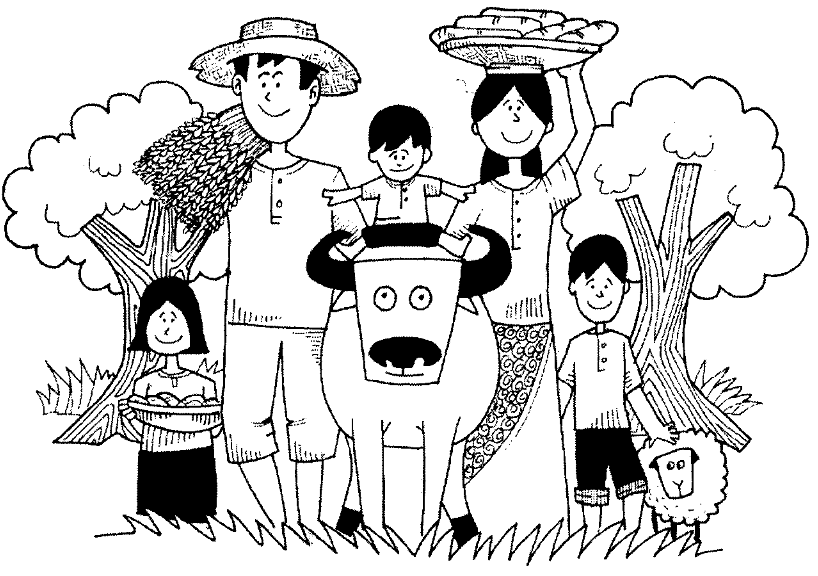
Dimensions



1

Defining Agricultural Biodiversity

Agricultural biodiversity includes all components of biological diversity of relevance to food and agriculture: the variety and variability of plants, animals and micro-organisms at genetic, species and ecosystem level which are necessary to sustain key functions in the agro-ecosystem, its structures and processes.

Agricultural biodiversity is essential to the world for the following functions:

- sustainable production of food and other agricultural products, including providing the building blocks for the evolution or deliberate breeding of useful new crop varieties;
- biological support to production via, for example, soil biota, pollinators and predators;
- wider ecological services provided by agro-ecosystems, such as landscape protection, soil protection and health, water cycle and quality, and air quality.

Agricultural biodiversity includes the following:

- higher plants - crops, wild plants harvested and managed for food, trees on farms, pasture and rangeland species;
- higher animals - domestic animals, wild animals hunted for food, etc., wild and farmed fish;
- arthropods - mostly insects including pollinators (e.g., bees, butterflies), pests (e.g., wasps, beetles), and insects involved in the soil cycle (notably termites);
- other macro-organisms (e.g., earthworms);
- micro-organisms (e.g., rhizobia, fungi, disease-producing pathogens).

Local knowledge and culture can be considered as integral parts of agricultural biodiversity, because it is the human activity of agriculture which conserves this biodiversity. Indeed, most crop plants have lost their original seed dispersal mechanisms as a result of domestication and so can no longer thrive without human input.

Domestication started 10,000 years ago and has been followed by natural selection through exposure to different climates, pests, pathogens and weeds, by human selection for specific traits and market needs, as well as for socio-economic reasons, and by wide dispersal. Crops and domestic animals are now found well beyond the limits of ecological tolerance of their immediate wild relatives, there is remarkable variability among and within crop landraces and animal breeds, and extraordinary ranges of adaptation. In the last 100 years, there has also been controlled plant and animal breeding by scientists which has allowed the recombination of diversity from widely different backgrounds, and the application of intense selection pressure.

There are several distinctive features of agricultural biodiversity compared to other components of biodiversity.

- Agricultural biodiversity is actively managed by farmers.

- Many components of agricultural biodiversity would not survive without this human interference;

indigenous knowledge and culture are integral parts of agricultural biodiversity management.

- Many economically-important farming systems are based on 'alien' crop species introduced from elsewhere (maize and cassava, two most important food crops in Africa were introduced from America); this creates a high degree of inter-dependence between countries for the genetic resources on which our food systems are based.

- As regards to crop and livestock diversity, diversity within species is at least as important as diversity between species.

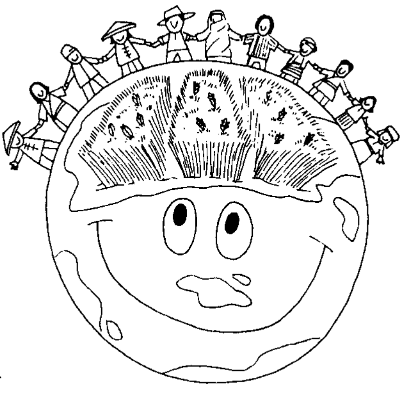
- Because of the degree of human management, conservation of agricultural biodiversity in production systems is inherently linked to sustainable use - preservation through protected areas is less relevant.

- Nonetheless, in industrial-type agricultural systems, much crop diversity is now held *ex situ* in gene banks or breeders' materials rather than on-farm.

Components of Agricultural Biodiversity

Crop Diversity

Of the 27,000 species of higher plants, about 7,000 species are used in agriculture, but only three (wheat, rice and maize) provide half of the world's plant-derived calorie intake. A substantial share of energy intake is also provided by meat, which is ultimately derived from forage and rangeland plants.



Although world food production in the aggregate relies on few crop species, many more are important if production is disaggregated to regional, national or local levels. For example, in Central Africa, cassava supplies over half of the plant-derived energy intake, although at the global level, the figure is only 1.6%. Outside the communities concerned, however, there is a lack of knowledge about the diversity and distribution of less utilized food and agriculture species.

Genetic diversity (variation within species) is vital for the evolution of agricultural species and their adaptation to particular environments through a mixture of natural and human selection. In crop agriculture, for some species, this selection has led to the development of many thousands of landraces or farmers' varieties.

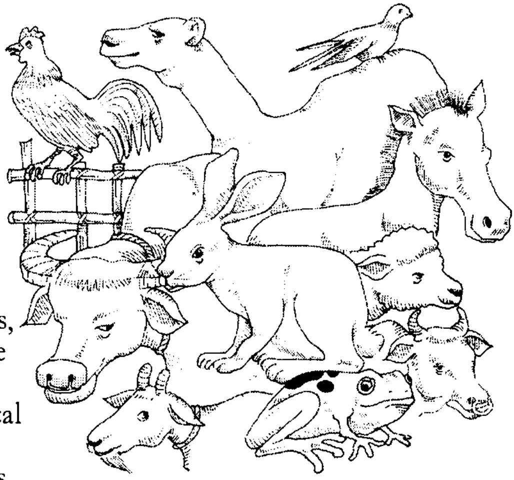
Wild Plant Biodiversity

In addition to domesticated plants, wild species are important nutritionally and culturally to many people. Foods from wild species form an integral part of the daily diets of many poor rural households. They are an important source of vitamins, minerals and other nutrients, and also represent ready sources of income for cash-poor households.

There are also wild relatives of crop plants which may supply useful genes through natural or artificial introgression. Neighboring wild companion plants can harbor biocontrol agents useful in agriculture. Weed plants may be left to grow in order to be harvested later for food.

Many wild plant populations are carefully nurtured by people although less intensively than those cultivated in their fields. Thus, there is no obvious or strict division between 'domesticated' and 'wild' food species.

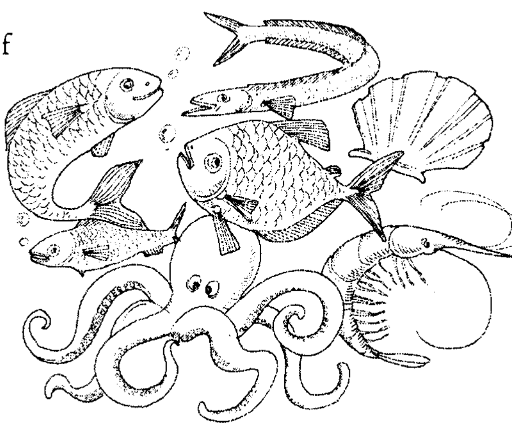
Livestock Diversity



Of about 50,000 known mammal and bird species, only about 40 have been domesticated. These species provide people not only with food but also clothing, fertilizer and fuel (from manure) and draught power. From these species, farmers and breeders have developed about 5,000 identified breeds to fit local environmental conditions and to meet specific needs. Such diversity has enabled people to inhabit a wide range of production environments from hot humid tropics to arid deserts and cold mountainous regions.

Genetic diversity also allows livestock to adapt to diseases, parasites and wide variations in the type and availability of food and water. Yet, almost a third of these breeds are estimated to be at risk of extinction.

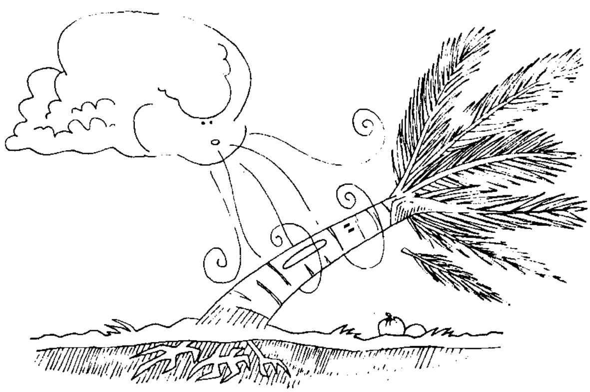
Aquatic Diversity



Fish and other aquatic species are integral parts of several important farming systems. For example, in the tropical rice-fish systems of Asia, fish from rice paddies may provide as much as 70% of dietary protein. More generally, aquaculture is becoming increasingly important and now supplies about 20% of total fish production.

Below-ground Biodiversity

Roots are responsible for nutrient and water uptake by crops. They physically stabilize soil structure against erosion and soil movement on steep slopes and, in tropical systems, the contribution of roots to soil organic matter is proportionately larger than from above-ground inputs. The effects of roots on soil biophysical properties are particularly critical in impoverished farming systems where crop residues are at a premium for fuel and fodder. But there has been little attention to the selection of rooting traits in cultivars by crop breeders, and much less research into the production, turnover and structure of rooting systems in tropical crops than into the above-ground components they support.

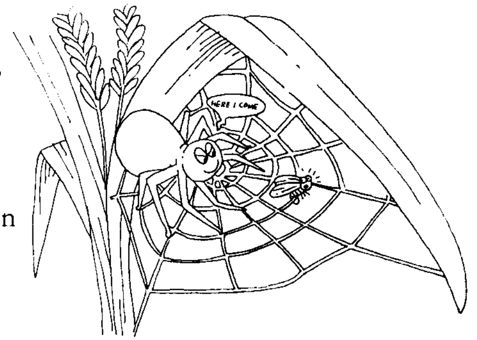


Microbial Biodiversity

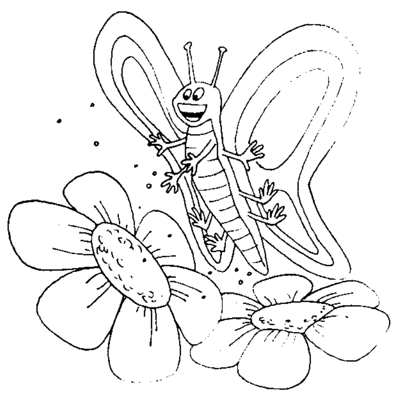
Microbes contribute a wealth of gene pools that could be a source of material for transfer to plants to achieve traits such as stress tolerance and pest resistance, and large-scale production of plant metabolites.

Microbes play varied roles in plant communities and agriculture. Microbial interactions with plant communities range from disease-producing pathogens to associations with plant rhizosphere, phyllosphere, and spermosphere as free-living entities or in well associated symbiotic associations for nitrogen-fixation or as mycorrhiza. Seed-borne microflora are instrumental in seed transmission of disease and thereby important in plant quarantine. Microorganisms, as food sources of 'neutral insects', support these alternative food sources of natural enemies of plant pests.

Arthropod Biodiversity



It is well known that insects, spiders and other arthropods often act as natural enemies of crop pests. But other components of arthropod diversity are also important in this respect. For example, research on Javanese rice fields has shown that arthropod communities are structured in such a way that the dynamics of seasonal succession consistently lead to high levels of pest suppression by natural enemies, with little chance of major pest outbreaks.



Control of plant pests by natural enemies is often considered inadequate due to seasonal oscillations in populations: the pest population peaks before that of the natural enemies. However, in the Javanese rice fields, "neutral' arthropods, mostly detritivores and plankton-feeders, such as midges and mosquitoes, provide an alternative source of food for the natural enemies of rice plant pests, thus stabilizing the populations of the natural enemies. In turn, the detrivores are dependent on high levels of organic matter in the paddies which provides the food source for an array of micro-organisms (bacteria and phytoplankton) and zooplankton.

Insects and arthropods are also important pollinators of many crops. Bees and other pollinating insects are essential agents for the production of many crops. Insect pollination is also required for seed production.

Agricultural Biodiversity and Ecosystem Functions

Historically, the focus in agricultural biodiversity work has been on characterizing and conserving species and genetic diversity. Now, however, there is increasing realization of the importance of agricultural biodiversity at the ecosystems level.

An ecosystem consists of a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit. Thus, agro-ecosystems need to be considered at several levels or scales. For instance, a leaf, a plant, a field/crop/herd/pond, a farming system, a land use system or watershed. These can be aggregated to form a hierarchy of agro-ecosystems. At a higher level still, the full assemblage of ecosystems constitutes the global biosphere.

Ecological processes can also be identified at different levels and scales. Maintenance of agricultural biodiversity within the agro-ecosystem is necessary to ensure the continued supply of goods and services such as:

- evolution and crop improvement through plant breeding;
- biological support to production; and
- wider ecological functions.

This is sometimes referred to as 'functional agricultural biodiversity', i.e., that which is necessary to sustain the ecological function of the agro-ecosystem, its structures and processes in support of food production and food security. Focusing attention on functional agricultural biodiversity can be a useful way of prioritizing effort.

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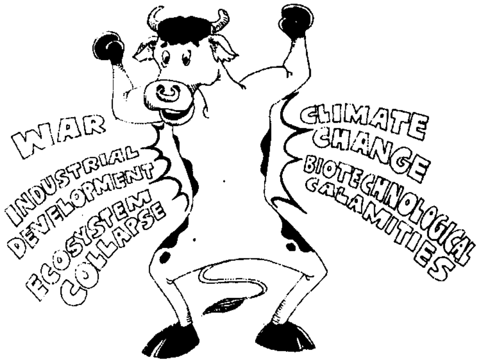
2

Agricultural Biodiversity:
Farmers Sustaining the Web of Life

Agricultural biodiversity is a product of human intervention in ecosystems as well as the principal input into agricultural production. It embraces the living matter that produces food and other farm products, supports production, and shapes agricultural landscapes. The variety of tastes, textures, and colors in food is a product of agricultural biodiversity. This represents the result of the interaction of indigenous peoples and women and men smallholder farmers, herders and artisanal fisherfolk with other species. The selection and management of these for local nutritional, social and economic needs has produced the agricultural biodiversity on which humanity depends. Food production systems need to be rooted in sustaining agricultural biodiversity so that farmers can continue to provide food and livelihoods and maintain life on Earth.

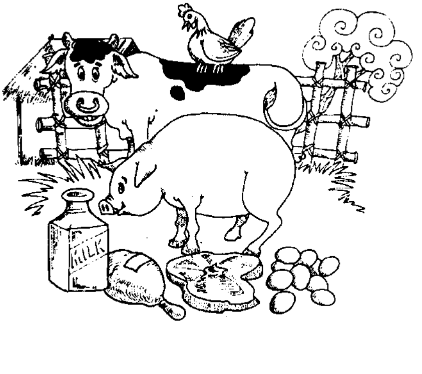
Strength in Diversity

Unprecedented changes in society, agricultural biodiversity population, and the environment also provide some security against future adversity (e.g., climate change, war, industrial developments, biotechnological calamities or ecosystem collapse). There is greater strength in diversity than in susceptible uniformity.



Furthermore, diversity in varieties, breeds and species ensure continuous agricultural production. Whatever the threats, hidden in the genetic code of today's crop plants and livestock are many invisible traits that may become useful in confronting future challenges.

Farmers' Agricultural Biodiversity Threatened



Agricultural biodiversity has been developed through the application of the knowledge and skills of farmers, herders and fisherfolk in a wide range of agroecosystems. The knowledge and agricultural biodiversity it has produced is key to global food security. While it originates in specific farming communities, it has been shared widely and is considered by many to be part of the much-threatened global commons.

The issue of reduced access and use of biodiversity by farmers and local communities is the focus of the debate between resource users, governments and inter-governmental bodies such as the World Intellectual Property Organizations (WIPO), Convention on Biological Diversity (CBD), World Trade Organization (WTO), Food and Agriculture Organization (FAO) and the Consultative Group on International Agricultural Research (CGIAR).

> The loss of forest cover, coastal wetlands and other 'wild' uncultivated areas also lead to losses of agricultural biodiversity: the 'wild' relatives of crop plants and livestock breeds; the 'wild' foods that are essential for food provision; and the species that support production (i.e., predators, pollinators and soil biota.)

Agricultural biodiversity is also threatened by changes in production systems. More than 90 per cent of crop varieties have been lost from farmers' fields in the past century. Animal breeds are disappearing at the rate of 5 per cent per year. In place of the diversity of farmers' varieties, consumers are being provided with more homogeneous and uniform food commodities produced from a limited range of varieties developed and owned by plant breeding companies and biotechnology corporations. One potential risk is the spread of genetically modified crops that may contaminate large areas of farmland currently planted to local varieties that are genetically diverse. These farmlands have plants of questionable genetic integrity, containing genes that are owned by global corporations.

Maintaining and Developing Agricultural Biodiversity

Civil Society and farmers' groups around the world implement campaigns to keep agricultural biodiversity, its vital genetic resources and their associated knowledge in the public domain. This means keeping these resources free of patents and plant breeders' rights, and away from the control of genetic engineers, so that

farmers and other food producers can continue to have access to these resources. In this way, these resources can play an important role in providing food security and environmental integrity.

> Agricultural biodiversity is the basis of the world's food supply, farm livelihoods and landscapes; and is humanity's insurance against future threats to food and farming.

Up until the 1980s, the official response to agricultural biodiversity conservation was through the collection of seed samples from farmers' fields and their storage in national and international 'gene banks.' More than half a million samples are stored in the gene banks of the International Agricultural Research Centres The National collection in the Vavilov Institute in St Petersburg, Russian Federation maintains over 330,000 accessions of cultivated plants and their wild relatives. This response is now recognized to be a limited but important security back-up strategy so long as these seed samples can be isolated from genetic contamination such as genetically modified organisms (GMOs).

The on-farm conservation of agricultural biodiversity and on-going development of varieties and breeds by farmers and resource users are being prioritized and supported by UN resolutions and programs. In particular, the FAO International Seed Treaty -- the Intenational Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA) -- provides a governance framework for crop biodiversity. This strategy is also promoted by Civil Society Organizations (CSOs), which support many initiatives rooted in local communities. Likewise, CSOs popularize and protect diversity in more affluent countries whose citizens wish to safeguard the diversity of local animal breeds and vegetable varieties.

Seed Fairs in Kenya

Communities organize many local Seed Fairs each harvest time. In Tharaka, Kenya, 46 farmers came together and displayed 206 different varieties of local crops including cowpeas, millet, sorghum, and squash. These events foster the exchange of seeds and related information among farmers and maintain local agricultural biodiversity. These show the richness and availability of local crop varieties. (Ref: ITDG East Africa)

Community Seed Banks in Paraíba, Brazil

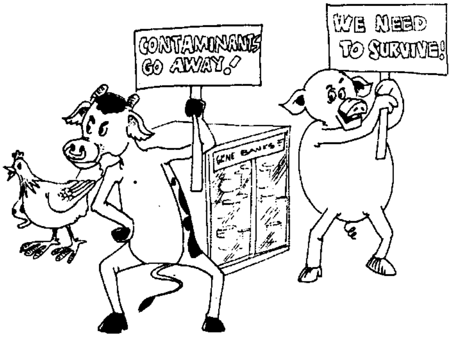
In Paraíba, a state in the northeastern region of Brazil, diversity is synonymous with food security. However, diversity suffers from long periods of drought reducing farmers' access to seeds. In order to address problems of poor rains and the replacement of traditional varieties by modern commercial varieties, community seed banks have been built. These have increased farmers' autonomy through the provision of seeds and conservation of agricultural biodiversity. (Ref: AS/PTA, Brazil)

Domestic Animal Diversity - The Re-Introduction of Polish Red Cattle

Animals with supposedly higher genetic potential have replaced local breeds in Poland. However, these turned out to be unsuitable for local conditions. To remedy this trend, a local non-government organization (NGO) working with the community of Zegocina has revitalized and increased the population of Polish Red Cattle. This is a traditional local

cattle breed that is valued because of its high productivity and resistance to various diseases. Likewise, this breed is very productive in hilly and mountainous regions where, using controlled grazing, slopes are protected against erosion. As a result, Zegocina has retained its beautiful landscape that attracts many visitors, supporting agro-tourism development. (Ref: Heifer International, Poland)

Preserving our Future Food Supplies



In order to survive, humankind needs to ensure that the genes of crops, livestock, other food species, and the agricultural biodiversity, of which they are a part, should be continuously under development in farmers' fields. Backup storage (frozen in time in international gene and semen banks and free of the threat of patenting), can store a limited slice of the diversity but this must be kept in the public domain so that it is accessible to all farmers and growers. However, vigilance is required to safeguard these resources from contamination by GMOs, especially in the centers of origin and diversity of the world's crops and livestock.

The following provide opportunities and incentives for a more secure food future:

- farmers' actions on conserving and using diversity;
- publicly-funded genebanks;
- the FAO International Treaty on Plant Genetic Resources for Food and Agriculture; and
- consumer choice for diversity in their food and farm production.

With farmers' actions and Civil Society and official support, through a virtuous circle of consumers supporting farmers to produce the diversity of foods, nutrients, textures and tastes that consumers want and need, agricultural biodiversity will thrive.

References:

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ITDG, ETC Group and GRAIN. 2002. Sustaining Agricultural Biodiversity and the Integrity and Free Flow of Genetic Resources for Food and Agriculture.

Mulvany, P. 1996. Dynamic Diversity. Paper presented during the 5th Global Biodiversity Forum, Buenos Aires.

For further information on agricultural biodiversity issues, see:

- The UK agricultural biodiversity coalition (UKabc) <www.ukabc.org>
- CGIAR agricultural biodiversity research centre <www.cgior.org/ipgri>

Key links to organizations and papers on agricultural biodiversity: <http://dmoz.org/Science/Environment/Biodiversity/Agricultural/>

ITDG (Intermediate Technology Development Group) <www.itdg.org> and Farmers' World Network <www.fwn.org.uk> collaborated on the original work for this paper.

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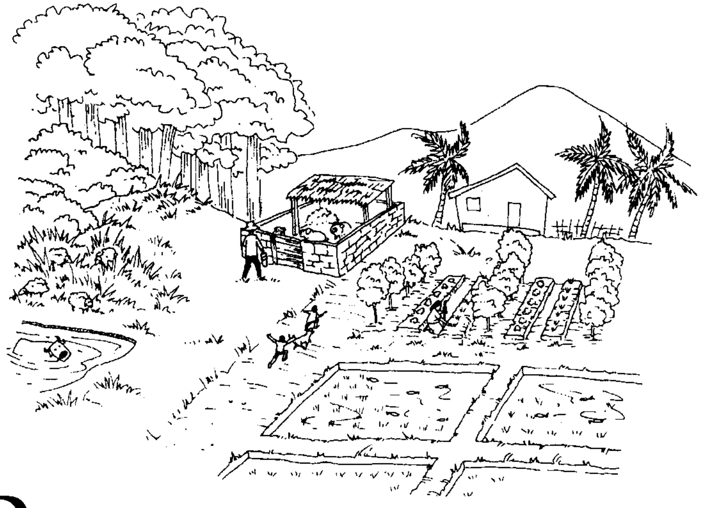
3

The Central Role of Agricultural Biodiversity: Trends and Challenges



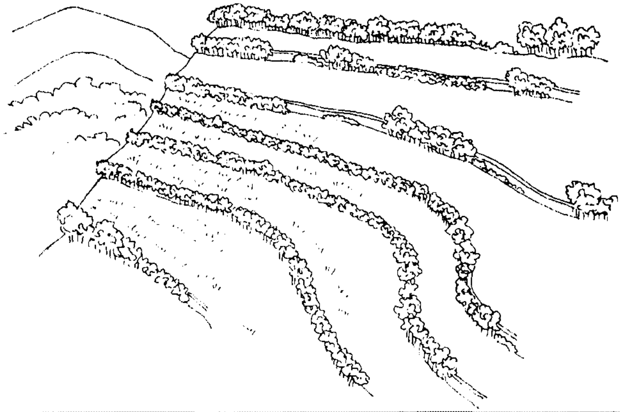
Predominant patterns of agricultural growth have eroded biodiversity in agroecosystems including plant genetic resources, livestock, insects, and soil organisms. This erosion has caused economic losses, jeopardizing productivity and food security, and leading to broader social costs. Equally alarming 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.

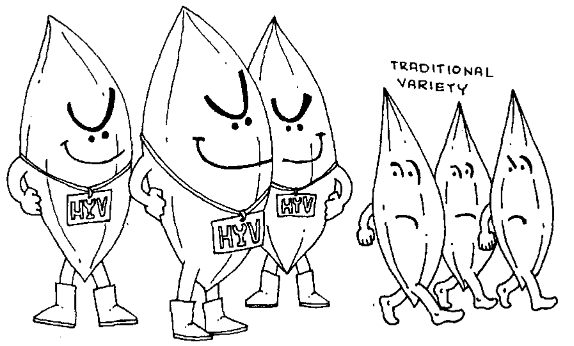
Changing Trends in Agricultural Development and Biodiversity Links

Agricultural Biodiversity Loss: Conflicts and Effects

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.

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 1960s. 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.

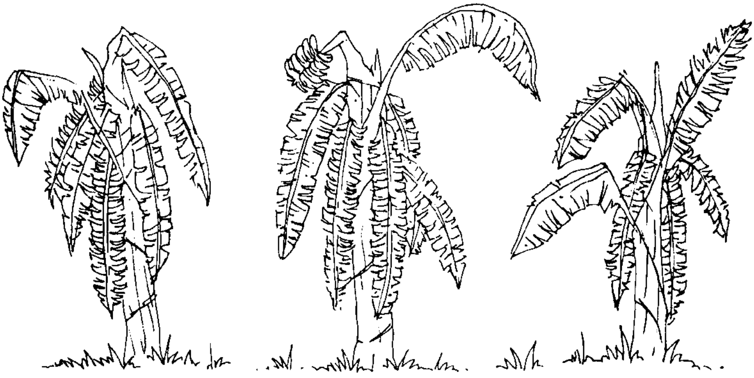
As forms of biodiversity are eroded, food security can also be reduced and economic risks increased. Evidence indicates that such changes can decrease sustainability and productivity in farming systems. Loss of diversity also reduces the resources available for future adaptation.

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.

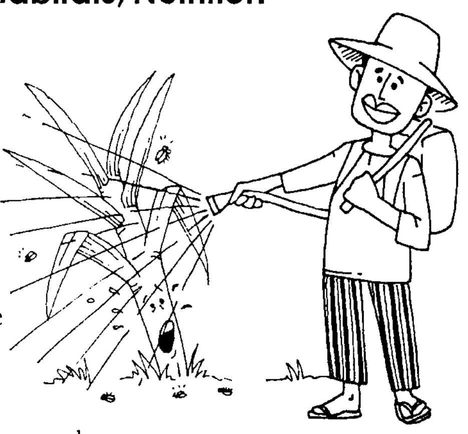
There has also been a serious decline in soil organisms and soil nutrients. Beneficial insects and fungi also suffer from heavy pesticide inputs and uniform stock -- making crops more susceptible to pest problems. These losses, along with fewer types of agroecosystems, also increase risks and can reduce 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 fulfill 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.

> 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.

Confronting the Causes

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.

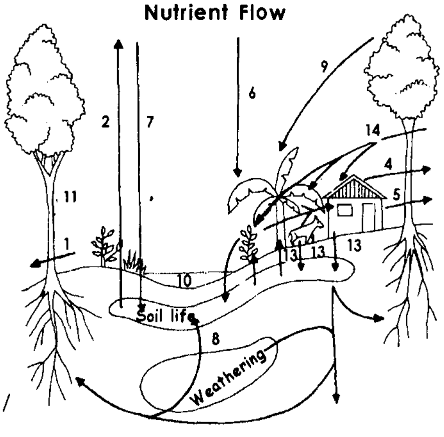
Practices for soil fertility/health and nutrient cycling also make use of agricultural biodiversity. Good examples include:

- 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.

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 agro-chemical 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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Adapted from: Thrupp, L. 1998. Cultivating Diversity: Agrobiodiversity and Food Security. World Resources Institute, Washington, DC., USA.

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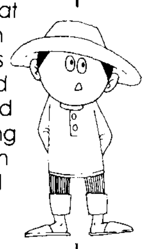
4

Supporting Agricultural Biodiversity Conservation: Key Questions

Sustainable use of biological resources is a global concern. Distinct types and varieties of plants, animals and micro-organisms are vital for food and health security. Diverse biological ecosystems provide essential – but often poorly appreciated — environmental services that make life possible. Variety among species is crucial for agricultural, pharmaceutical, and technological development.

In particular, Chapter 14 of Agenda 21 — the program that emerged from the 1992 United Nations Conference on Environment and Development (UNCED, also known as Earth Summit) — deals with "the conservation and sustainable utilization of plant genetic resources for food and sustainable agriculture." To understand the meaning of conservation and sustainable use (and to put both in practice), we need to look at the interplay of biological and agro-ecological forces, and socio-economic, policy, and legal forces.

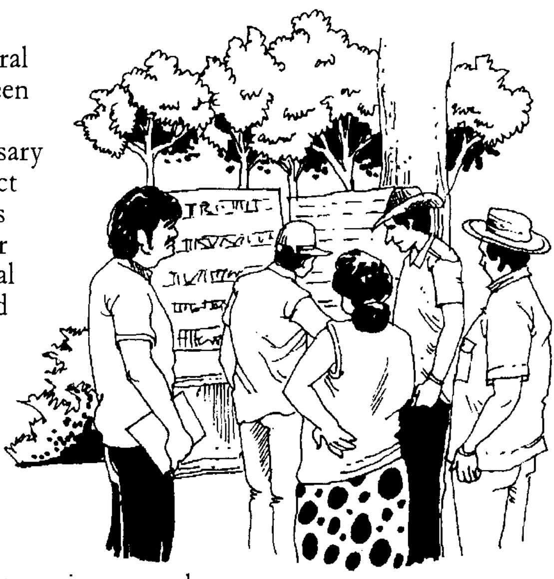


This paper identifies questions dealing with crop conservation and improvement, with participation, and with access, ownership and compensation. Examples of research projects supported by the International Development Research Centre (IDRC) illustrate how these questions are dealt with in practice.

Why Diversity Matters

Biological and Ecological Resilience and Durability

From an ecological perspective, agricultural biodiversity can be seen as a function of an agroecosystem necessary to support and protect human lives as well as provide the inputs for evolution. Agricultural biodiversity is a broad concept that includes various biodiversity components from agroecosystems to crop varieties to genes in plant and animal species. Stakeholders in agricultural biodiversity assign several values to the concept including ecological, economic, socio-cultural, and political ones. It is important to note that these values are not set in stone, time nor space. Loss of agricultural biodiversity leads to a reduced capacity of ecosystems to continue producing ecological services and renewable natural resources. It also lessens the capacity of the system to deal with change (i.e., decreased resilience), which directly affect farmers' management of the system.



Cultural Diversity, Local Knowledge and Flexible Social Organizations

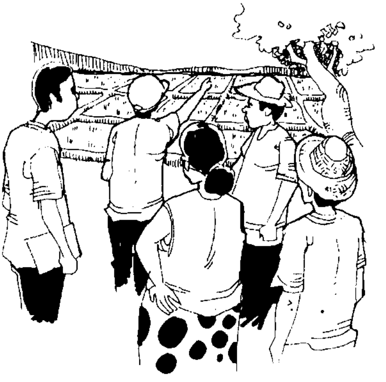
The loss of agricultural biodiversity often, if not always, results in reduced spaces to create and recreate farmer knowledge and experimentation — constituting elements of cultural and social diversity — essential to agricultural biodiversity conservation, evolution and improvement. Hence, the key role of farmers, farmers' knowledge and social organization in managing and sustaining biodiversity must be recognized including their critical role in providing food and livelihood security.

Adaptive, Decentralized, Dynamic Research

Understanding and supporting biological/ecological diversity and its cultural/social expressions, requires a research approach capable of "reflecting" or "absorbing" the key features of its subject. Thus, research concepts, their methodologies and organizations should be adaptive (flexible), locally grounded (decentralized, open to explore, assess and respect expressions of local knowledge) and dynamic (participatory).

Key Questions to Understand Use and Conservation of Agricultural Biodiversity

Questions Dealing with *(in situ)* Crop Conservation, and with Crop Improvement



- What is women and men farmers' knowledge about the properties and uses of agricultural genetic resources, and how can ways be developed to guarantee that this knowledge be respected and used appropriately and fairly for the benefit of local communities and the wider society?

- What are viable practices, mechanisms or incentives to strengthen *in situ* conservation under conditions of agro-ecological and socio-economic change?
- How to encourage new participatory paradigms in genetic improvement, which balance diversity with productivity; develop approaches for *in-situ* conservation and improve linkages between formal sector breeding and farmer breeding?

Questions Dealing with Participation

- How could we stimulate a more meaningful participation of agricultural biodiversity users in research, development and policy-making, particularly by men and women farmers in marginalized agro-ecosystem?
- What are the enabling political and legal conditions or changes necessary to make this happen?

Questions Dealing with Access, Ownership and Compensation

- What kind of policy changes (regulations, incentives, laws) are required to achieve more equitable access by (marginalized) women and men farmers to information and resources pertaining to the conservation and improvement of agricultural genetic resources?
- How do Intellectual Property Rights (IPRs) on living organisms impact on farmers' experimentation and innovation, and on the fair access to and distribution of the benefits derived from these processes?
- How can, prior to actual interventions, fair access and compensation arrangements be worked out between stakeholders in order to conserve or improve agricultural genetic resources?

The following are some examples of the agricultural biodiversity research projects that address one or more of the key questions:

Understanding farmers' knowledge and practices: maintaining sorghum landrace diversity in Ethiopia

This study, first done in 1992-1993 and further expanded in 2000-2001, documented the vast taxonomical knowledge of Ethiopian farmers. It confirmed their roles in the maintenance of sorghum landrace diversity in the north Shewa and south Welo regions, as a means to reduce the risk of homogenization. In addition, the study documented farmers' knowledge about storage conditions and duration of sorghum landraces and the action to be taken to reduce losses due to pests. The research focused on:

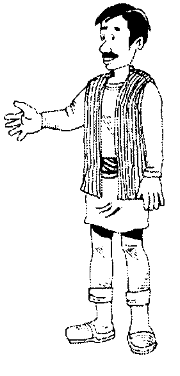
- the dynamics and trends over time and in space of crop diversity;
- farmers' selection criteria at field, community and agroecosystem level (*from a gender perspective*); and
- the biotic, abiotic and societal variables that influence diversity use and management.

Stimulating more meaningful participation: participatory barley improvement in North Africa and the Middle East

ICARDA pioneered a research effort in Morocco, Syria and Tunisia, experimenting with a novel breeding approach for barley improvement in the low potential, marginal rainfall environments of these three countries. The project brought together breeders, women and men farmers to work side by side, to learn from each other, and to join efforts aimed at fulfilling the needs of poor farmers living and working under harsh conditions.

Major Findings and Results

- Selections on stations, even when made by farmers, are very different from those made in farmers' fields as a consequence of large Genotype x Environment interactions.
- Farmers use selection criteria not previously acknowledged nor used by national breeding programs.
- It is important to identify women's selection criteria (and see when and why they differ from men's criteria)
- Farmers warmly welcome the possibility to select among a large number of lines; some farmers have started to increase selected seed varieties.
- Farmer participation can be introduced successfully in reluctant research environments.
- Breeders working together with farmers have adopted new ideas and attitudes; they became supporters of a participatory approach that has been integrated in the national breeding program.



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5

Cultural Factors and Crop Genetic Diversity

Over time, humankind has used more than 7,000 edible plant species. However, only 150 crops are now commercialized at a significant global scale. Only three crops (maize, wheat, and rice) currently meet 50% of global protein and calorie requirements. As a result, the base of global security has been narrowed. This limits livelihood options for the rural poor, particularly in marginal areas. To address both the needs and the problems associated with global environmental change (growing climatic instability, soil depletion and scarcity of water resources), the focus of research and development must broaden to include a wider range of crop species and varieties.

> Crop science and biotechnology have dramatically increased our ability to use plant genetic resources to increase productivity and value of crops. They do not, however, account for vast amounts of genetic diversity in crops upon which global food security and future crop development depends.

Cultural factors are important in maintaining rich genetic resources and associated knowledge of crops that have been neglected by formal crop improvement efforts and by commerce. Food preferences customs on plant use are deeply embedded in culture. For example, glutinous and starchy varieties of grains, roots and tubers, and vegetables arise out of differences in tastes. Migrating people often take crop germplasm (the genetic material for plant reproduction, including seeds, tubers and other plant organs) into new ecosystems or niches. Similarly, they introduce genetic resources into new cultures where the plants are used in different ways.

Management practices of local farmers enable them to develop and maintain the variation (phenotypes) required to meet their needs. Genetic diversity may be maintained in order to obtain crucial but diverse traits like frost or drought tolerance, or disease resistance in highly stressed agricultural environments. The set of ethnobotanical indicators described below can help us to better understand the mechanisms by which farmers manage genetic resources in order to obtain both the crop traits they need and the qualities they prefer.

Food Culture, Folk Taxonomy and Associated Folklore

Food culture, folk taxonomy and associated folklore are important indicators of diversity relating to how crop populations or ecotypes within a species may be treated differently. For example, a certain variety may have ritual value and uses that cause it to be maintained, despite changes in market forces, and perhaps assigned a special place within the cropping system. By developing many names for crop types farmers are

effectively segregating populations and often treating then differently. Over time, this segregation can engender botanically significant distinctions between varieties. Cultural knowledge about a crop variety helps to transmit plant knowledge both widely in a community and specialized knowledge within sub-sectors of the community. Common examples of this cultural knowledge are recipes and knowledge of associated pests and pathogens.

Multiple Use of a Crop Species

Multiple use of a crop species is a characteristic of cultures with a long history of co-evolution with a given crop species, resulting in a rich and complex body of associated knowledge about that crop. Identifying multiple use species does not mean merely noting those of

economic importance. In Southeast Asia, local communities have developed uses of rice to fit almost all known categories of ingested food, drink, processed snack or medicine; even rice stalks and husks have many important uses. It is in these latter cases of diverse and multiple uses of a crop, where we can expect to find a rich body of ethnobotanical knowledge on plant genetic diversity.

Planting a Crop in Diverse Niches and Environments

Planting a crop in diverse niches and environments is another ethnobotanical indicator of diversity. By working with genotype-environment interactions (developing and matching varieties to the niches where they are best adapted), human communities are maximizing both the use of ecological niches in their farming systems and the varietal diversity

existing within a crop species. The continuing evolution and adaptation of crop varieties to new and diverse environments is a process that contributes to plant genetic diversity and is often managed by farmers growing crops under traditional cultural practices commonly in marginal areas such as mountains, desert margins, tidal areas or those subject to periodic flooding.

Practices and Traditions for Managing Germplasm

Practices and traditions for managing germplasm (seeds and planting material) can also be ethnobotanical indicators. Such practices concern the selection of seed and planting materials and the ways to store and exchange seed. They also include the traditions and rules that decide who selects and maintains germplasm. Women farmers often have the most developed criteria for selection of crop varieties; criteria that are not limited to yield, but related to competition with weeds, storability, cooking quality, taste and other desired qualities.

We have presented the indicators in a checklist (see box on next page) that can be used to compile ethnobotanical information on diversity within crops as they are managed by local peoples. The indicators can also be used to identify ways to support, and offer incentives to, farmers continuing to manage crops and trees in ways that both meet food security needs and maintain cultural and biological diversity.

Ethnobotanical indicators of diversity within crops

Species with an important role in the local food culture

- several names for varieties of the same species
- folkore associated with species
- ceremonial and ritual uses of species
- knowledge about a species is well distributed across different sectors of the community and transmitted across generations

Multiple uses of the same species

- for example, it is used as a staple, vegetable, condiment, medicine, beverage, non-food uses
- different cultivars of the species preferred for distinct uses
- different parts of the plant used for distinctive foods and non-food uses

Planting of the same species in diverse environments and micro-environments

- within an ecozone, farmers plant it under different conditions, microenvironments (e.g., field, paddy, swidden, terrace, field margin, along watercourses, home garden, inter-cropped fields, orchards)
- the species is found across a wide range of ecozones and in marginal areas, even in places where one would not expect it
- the species can occupy both major and secondary roles within local farming systems

Existence of local germplasm systems and germplasm exchange within and between communities

- diverse cultural communities maintain the species within their local taxonomic and germplasm systems
- germplasm exchange across cultural communities and across growing environments
- farmers have distinct criteria for selecting planting material from their own harvest or from outside their farm or community.

The better understanding of the distribution and use of genetic diversity in crops is a major innovation in plant genetic resources conservation. By focusing on the ways that local cultures classify, manage and use plants, genetic resources programs are locating new and more valuable uses of these resources. A growing number of countries is taking steps to meet the obligations of the Convention on Biological Diversity to recognize and promote the role of local people in the maintenance of agricultural biodiversity.

Effective use of ethnobotanical approaches is dependent upon participatory approaches and protocols that:

- establish equal partnerships;
- protect the rights of local communities to use plant genetic resources; and
- maintain the distinctive cultural practices that help shape the genetic diversity of their crops.

Likewise, ethnobotanical methods allow better understanding of the maintenance of diversity-rich pockets, and microenvironments created and managed by people. These microenvironments can serve as points of introduction for new diversity for crop varieties or wild species that are under threat from commercialization or land use change.

> Oases in North Africa are examples of microenvironments that depend upon the traditional management practices of local communities. In agriculturally marginal areas such as mountains and desert margins, the role of traditional human communities has been shown to be beneficial to the diversity and stability of ecosystems.

Increasingly, genetic resources scientists use advanced techniques, including molecular genetics, to measure genetic diversity as it is managed and used by farmers. The growing partnerships between farming communities, ethnobotanists, and genetic resources scientists may help ensure that the next advances in agriculture will help maintain the diversity of plant genetic resources under farmer management. Thus, essential biological assets of communities living traditional lifestyles, often in marginal environments or centers of biodiversity, are enriched.

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6

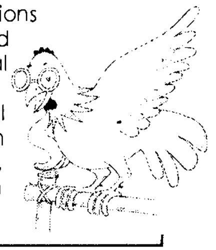
Reconciling Agriculture and Wild Biodiversity Conservation:
Policy and Research Challenges of 'Ecoagriculture'

Conventional wisdom holds that farming is largely incompatible with wildlife conservation. Thus, policies to protect wildlife typically rely on land use segregation, establishing protected areas from which agriculture is officially excluded. Farmers are perceived as problems by those promoting this view of wildlife conservation.

This paper argues, however, that enhancing the contribution of farming systems is an essential part of any biodiversity conservation strategy. And this strategy requires new technical research, support for local farmer innovation and adoption of new agricultural and environmental policies at local, national and international levels.

Key Challenges in Ecoagriculture

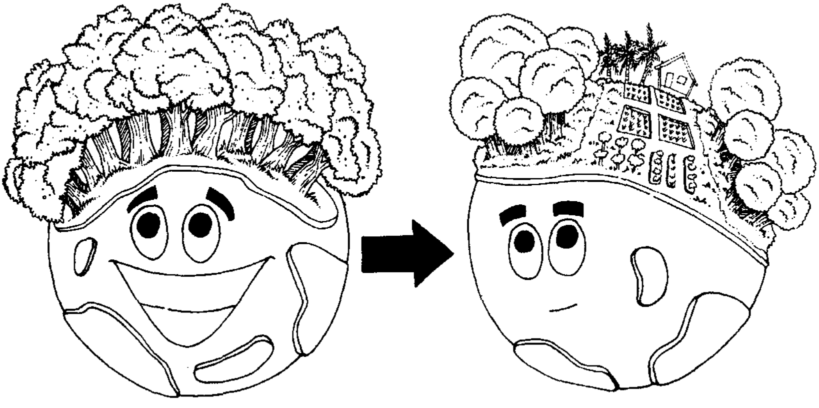
- Develop and fund a Global Program for Ecoagriculture Research and Development, in selected biodiversity hotspots. Undertake international and national policy research and innovation to develop cost-effective market, legislative and institutional interventions to promote ecoagriculture on a large scale.
- Develop networks of farmer innovators with technical specialists in agriculture and environment, who work in similar habitat types. The networking may be done through websites, e-workshops, and field tours in biodiversity hotspots of mutual interest.
- Fund basic research in biodiversity hotspots on interactions between agricultural systems and wildlife habitat and species, particularly in landscape ecology, agricultural ecology and wildlife behavior.
- Develop programs to educate farmers, agricultural researchers and policymakers in ecosystem management, and to educate wildlife biologists, ecologists and conservation policymakers in agricultural resource management.



Conflicts Between Agriculture and Wild Biodiversity

The scale of agricultural impact is much greater than had previously been recognized. In many countries, as much as 70 per cent of land area is in agricultural use. Over a third of the global agricultural land area is in high-intensity continuous cropping systems that use high levels of agrochemicals and reshape land and waterways. The rest of the agricultural area is under extensive farming systems that use far fewer inputs, but require relatively large expanses of land to produce relatively low crop and livestock yields. Both types of agriculture have had negative impacts on wild biodiversity, among which are:

- Nearly half of all temperate broadleaf forest and tropical and subtropical dry forest, and a third of temperate grass and shrubland, have been converted to agricultural use. Conversion has been greatest in Asia and Europe, with consequent loss of wildlife habitat.



- Irrigation is practiced on over 250 million hectares, and uses over 70 per cent of all freshwater - 89 per cent in low-income countries, often diverting water resources needed by terrestrial and aquatic wildlife.
- Globally, over half of wetlands -- among the planet's most valuable wildlife habitats--have been converted to agriculture.
- Farming has led to significant soil degradation on 16 per cent of all crop, pasture and forestland worldwide, and half of all agricultural land, thereby affecting the diversity of soil microorganisms.
- Excessive use and poor management of fertilizers, pesticides and livestock wastes are a major cause of habitat pollution that can kill wildlife directly or impair reproduction.

The distinction between agricultural land and protected areas maybe less useful than previously thought. Of over 17,000 major sites already devoted to conserving wild biodiversity, 45 per cent have at least 30 per cent of their land used for agriculture. Most of the rest are within predominantly agricultural landscapes. Currently, protected areas do not provide secure habitat for wildlife.

Can Ways be Found to Reduce, or Even Reverse, the Negative Impacts of Agriculture on Wild Biodiversity?

Initiatives to promote more ecologically sensitive farming systems (called 'sustainable', 'regenerative', or 'organic' agriculture) are expanding. Often, the impacts on wild biodiversity are positive, but they focus mainly on preserving 'useful' wild species, such as pollinators or beneficial soil microfauna.

> While protected areas are still required, and need to be expanded, they ultimately will be successful only if surrounded by production systems of high environmental value that are also economically viable.

In Europe and North America, wealthy urban populations are able to transfer large financial payments to their small farming populations to take land out of production to preserve as wildlife habitat or to provide financial incentives for conservation farming. But in poor countries with large rural populations, this approach is less viable. Environmental planners must rely upon local support for agricultural conservation that meets food security and livelihood needs of the rural poor.

An essential strategy for conserving wild biodiversity, especially that found in highly populated, poor rural areas around the world, is to convert agriculture that is destructive of biodiversity into ecoagriculture. Ecoagriculture builds on the concept of 'ecosystem management' and refers to land-use systems that are managed both to produce food and to protect wildlife and other critical ecosystem services. For ecoagriculture, enhancing rural livelihoods through more productive and profitable farming systems becomes a core strategy for both agricultural development and conservation of biodiversity.

Ecoagriculture encompasses strategies for land and resource management. It increases wildlife habitat in non-farmed patches in agricultural landscapes, creating mosaics of wild and cultivated land uses by:

1) Creating new protected areas that also directly benefit local farming communities (by increasing the flow of wild or cultivated products, enhancing locally valued environmental services or increasing agricultural sustainability);
2) Establishing habitat networks and corridors in non-farmed areas (such as hedgerows or wind breaks that are compatible with farming);

3) Raising the productivity of existing farmland to prevent or reverse conversion of wild lands (where that is possible, given tenure, labor and price conditions; and efforts to protect or restore the biodiversity value of uncultivated lands are also undertaken);
4) Reducing agricultural pollution through new methods of nutrient and pest management, and farm and waterway filters;
5) Modifying the management of soil, water and natural vegetation to enhance habitat quality; and
6) Modifying the mix and configuration of agricultural species (especially perennials) to mimic the structure and function of natural vegetation.

In a joint study by IUCN and Future Harvest, at least 36 examples of ecoagriculture, from diverse regions of the world and types of farming systems, have been identified and documented to have significant positive impacts on wildlife populations, farm yields and farmer income. A quarter of these are already being practiced on millions of hectares (including wildlands re-established as a result of crop intensification on a smaller area; integrated pest management and organic production to reduce pesticide pollution; minimum tillage in mechanized cropping; trees grown in pastures; and species-rich agroforests). The rest are being used on a smaller or pilot scale.

Agricultural and environmental policies need to be modified to encourage these new approaches. In some cases, ecoagriculture systems can be developed by using available components and information from scientific and local knowledge, and by improving these through trial and error to design landscapes that address both local livelihood and conservation objectives. But in most cases major scientific initiatives will also be required, using sophisticated methods and tools from various disciplines. Indeed, ecoagriculture is feasible now in large part because of our greater capacity to find synergies through scientific management. Advances in conservation biology, agricultural ecology, plant breeding, ecosystem monitoring systems and modelling are revolutionizing our ability to understand and manipulate wildlife-habitat-agriculture interactions at farm and landscape scales.

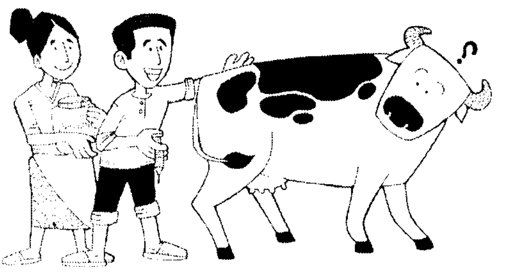
New Technologies for Ecoagriculture

- New methods to monitor wildlife and analyze the spatial and temporal movement patterns and territorial requirements for wildlife allow for the design and placement of corridors and habitat patches in farmlands. Local farmers can organize themselves effectively to play a lead role in designing

landscape and farm interventions. Promising examples include LandCare groups in Australia, farmer federations in the Philippines, and forest user groups in Nepal.

- Scientists working in West Africa developed a natural biocide, from a strain of an environmentally friendly fungus (*Metarhizium anisopliae*). This was successful in controlling grasshopper and desert locust pests that were devastating grain crops in West Africa, and greatly reduced the need for insecticides that had been threatening stork and songbird populations.

- Veterinary research to develop a livestock vaccine against rinderpest, a viral disease, has not only greatly protected domestic cattle in East Africa, but also protected millions of wild buffalo, eland, kudu, wildebeest, giraffe and warthog that share rangelands and reserves, and that are also susceptible to the disease.



- Crop breeders in the U.S. are developing native perennial grains (such as bundleflower, leymus, eastern gamagrass, Maximilian sunflower) that can be grown more sustainably with much less environmental damage in dryland farming regions.

- In the humid tropics, research has demonstrated the benefits of farming systems that 'mimic' the structure of the natural forest ecosystems. Millions of hectares of multi-strata 'agroforests' in Indonesia produce commercial rubber, fruits, spices and timber, often in a mosaic with rice fields and rice fallows. The number of wild plant and animal species in these agroforests are often nearly as high as in natural forests.

- In Central America, modified systems of shaded coffee with domesticated native shade tree species, maintain coffee yields while also diversifying income sources and conserving wild biodiversity.

An ambitious policy and research agenda is needed to develop and promote the adoption of farming systems that increase production, protect wildlife and raise farm incomes in areas of high biodiversity value. Such research will require a full partnership of ecologists, wildlife biologists and agricultural researchers, working in association with operational-scale conservation and agricultural development programs. Priority areas for such efforts include biodiversity-rich regions threatened by agricultural development; regions where agricultural productivity growth depends on restoring environmental services critical for agriculture; and regions where biodiversity conservation will benefit the poor directly through ecosystem restoration and income opportunities.

How Can Resources for Such an Agenda be Mobilized on a Globally Significant Scale?

First, private research and development (R&D) by large-scale commercial food producers and agro-processors could play an important role. Private food processing companies that obtain a large share of their raw material from smallholder farmers located near protected areas may be motivated to encourage ecoagriculture (e.g., current trends to reduce agrochemical use in cocoa production). Private agricultural service companies might, for example, sell pest control services to farmers based on ecoagriculture principles rather than simply selling them products. Private tourism industry that benefits from wild biodiversity may be willing to help support ecoagriculture. Public and civic conservation groups can encourage this work, and monitor wildlife impacts of farming systems.

Public sector institutions and civic organizations can play a leading role in ecoagriculture development, because so much of the necessary research and investment is to provide 'public goods'. Wildlife conservation organizations will need to take the lead in developing ecoagriculture strategies and contracting for targeted research to support those strategies.

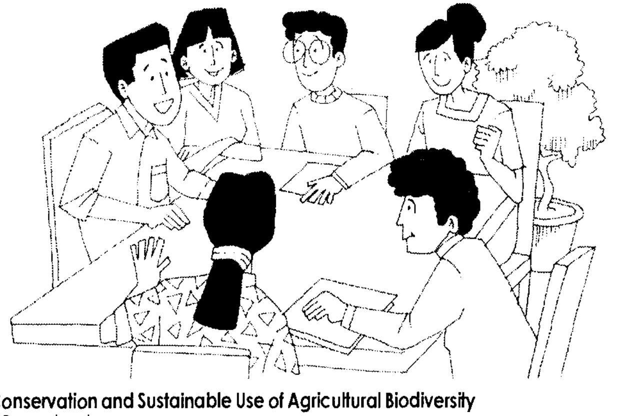
Ecoagriculture and Wildlife Conservation

Ecoagriculture and wildlife is a new research agenda that would require collaboration across sectors and disciplines. Some of the priorities are the need to:

1) undertake international and national policy research to determine cost-effective market, legislative and institutional interventions to promote ecoagriculture on a large scale;

2) develop networks that link farmer organizations with technical specialists in agriculture and environment who work in particular habitat types, through websites, e-workshops, and field tours in biodiversity hotspots of mutual interest; and

3) support national scientific institutions in 'mega-diversity' countries that have strong agricultural research capacity, to carry out research in biodiversity hotspots, on interactions between agricultural systems and wildlife habitat and species in landscape ecology, agricultural ecology, and wildlife behavior, etc.



In a world where human population may reach 9 billion by mid-century, it is not enough to 'leave wildlife alone'; 'wild lands' must be actively managed as we already do to our agricultural lands. This point can be taken a step further: agriculture itself needs to be reconceptualized as a producer of both food and key ecosystem services, such as biodiversity conservation. With such compelling evidence on the vulnerability of wildlife to agricultural expansion and intensification, and the dependence of much of the world's poor on agricultural development, ecoagriculture has become a pressing policy and research priority.

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For further information and example of ecoagriculture, see:
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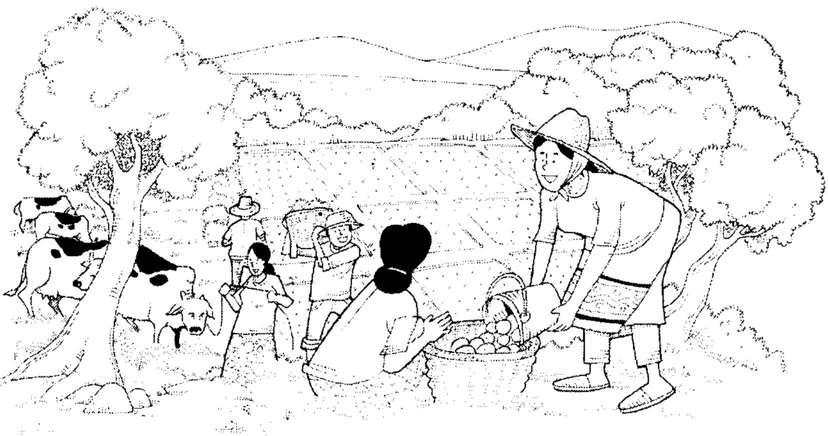
7

The Ecosystem Approach and Agricultural Biodiversity



The focus of agricultural biodiversity has led to the realization of the importance of the components of agricultural biodiversity at the ecosystem level. These are important in supporting agricultural production, and in providing a wider range of "ecosystem services."

> As defined in Article 2 of the Convention on Biological Diversity, an ecosystem consists of a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Preliminary categorization of the multiple goods and services provided by agricultural biodiversity in ecosystems.

Goods and Services	Examples	Nature of Value	Contibutions to Livelihoods and Benefits to other Stakeholders	Major Challenge for Sustainability of Use
Goods				
1. Products derived directly from biological resources hunted or gathered from managed systems through agriculture	Crop and livestock production, timber from plantation forestry, and fish from aquaculture	Direct use values (consumptive, some not traded in markets)	Basis of food industry and sustainable food production and livelihood systems, especially for traditional farmers	To ensure sustainability of the managed ecosystem itself; to avoid negative externalities on other ecosystems
2. Products derived directly from biological resources hunted or gathered from natural or seminatural systems	Most fish, wildlife, gathered wild foods and medicinal plants, etc. Pharmaceutical derivatives and new plant varieties	Direct use values (consumptive, much not traded in markets)	Significant contribution of nutrition and other livelihood needs of rural and peri-urban vulnerable groups, and of traditional healers	To avoid over-exploitation of resources and damage to ecosystem integrity
3. Products derived indirectly from the information content of collected genetic resources	Nutrient cycling, pest and disease control, pollination	Direct use value (current use) Option value (known material, not used currently) Exploration value (undiscovered sources)	Raw materials for plant breeding and pharmaceutical production. Values largely appropriated by breeding and pharmaceutical companies, and by farmers in 'industrial' areas that use improved varieties	To ensure continued provision of genetic resources by incentives and fair and equitable sharing of benefits derived

Goods and Services	Examples	Nature of Value	Contibutions to Livelihoods and Benefits to other Stakeholders	Major Challenge for Sustainability of Use
Services				
4. Essential processes to ensure continued functioning, resilience and productivity of ecosystems which provide the goods 1,2 and 3	Watershed protection, carbon sequestration, habitat protection, climate stabilization	Indirect use values	Essential support to sustainable food production and livelihood systems for all types of farmers. Benefits largely appropriated at the local level	To maintain ecosystem integrity; and to prevent pollution
5. Wider ecosystem functions	Varieties valued for culinary properties; scenic and culturally important landscapes; sacred sites, etc.	Indirect use values	Benefits of services appropriated at various levels, from local to global	To maintain ecosystem integrity; to prevent pollution and habitat conversion; and to internalize externalities
6. Spiritual, cultural, and aesthetic functions	Use of multiple species, breeds and varieties	Direct use value (recreation), Indirect use value Existence (non-use) value	Benefits of services appropriated at various levels, from local to global	To prevent damage from excessive and/or inappropriate tourism; and prevention of habitat
7. Insurance against risk and uncertainty		Porfolio value Option and exploration values	Portfolio value appropriated at various levels from local to global	

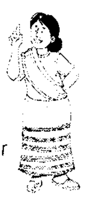
One feature of the ecosystem approach being developed under the Convention on Biological Diversity is the attention it gives to the full range of goods and services provided by biological diversity (see table on previous page). The application of the ecosystem approach implies:

- intersectoral cooperation;
- decentralization of management to the lowest level appropriate;
- equitable distribution of benefits; and
- use of adaptive management policies that can deal with uncertainties and are modified in the light of experience and changing conditions.

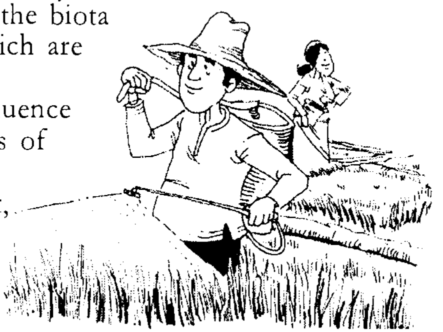
Farmers as Ecosystem Managers

There is an opportunity for farmers to be engaged in the management of agricultural ecosystems. They can help reduce negative externalities and increase productivity. This management is usually practiced by: individual fishers, farmers, or forest harvesters (through communities, non-governmental organizations, district governments, nations, private corporations, large eco-regions, and global organizations).

Farmer field schools facilitate application of an ecological approach to agricultural intensification. It uses an adaptive management that requires the main responsibility of ecosystem management be returned to the farmer and the community.



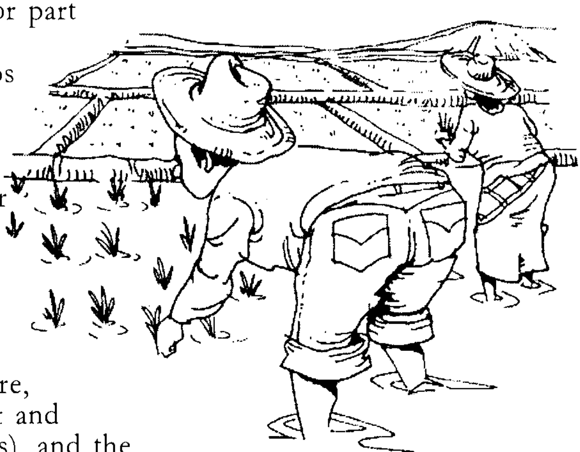
Likewise, farmers in agricultural systems choose and maintain a major part of the biota (i.e., crops and livestock), which are often from exotic species. Furthermore, the farmers influence the composition and activities of the associated biota (i.e., herbivore, predator, symbiont, and decomposer groups), and the structure and function of the landscape within which agricultural production systems are situated.



Ecosystems Approach and Ecosystem Services

Agricultural ecosystems are designed to produce certain goods (e.g., food, feed and fiber). Increasingly, it is being recognized that agricultural ecosystems also provide other services, such as recreational areas and clean water.

In agricultural ecosystems, a major part of the biota (i.e., usually exotic crops and livestock) is chosen and maintained by the farmer. The farmer also influences the composition and activities of the associated biota (including herbivore, predator, symbiont and decomposer groups), and the structure and functioning of the landscape within which agricultural production systems are situated.



Agriculture often represents a simplification of the ecosystem as compared to the one that it displaces. Nonetheless, there are usually substantial levels of biological diversity in agricultural ecosystems. In addition to the "planned components" (i.e., crops and livestock), many "associated components" of biological diversity in agro-ecosystems are essential for agricultural production itself. These components include:

- soil-nutrient cycling;
- pest and disease modulation; and
- pollination of many crops.

Agricultural ecosystems constitute major parts of watersheds. These are often the main landscapes for recreation and tourism, and they harbor important biodiversity in their own right. In fact, in some regions, it is only now that some elements of biodiversity exist in areas dominated by agriculture. Management of biodiversity in such areas, is therefore, an essential component of an overall approach to its conservation. There is a wide range of agricultural ecosystems, and in some of them, biodiversity is comparable to levels in natural ecosystems.

The ecosystem approach to the management of agricultural biodiversity combines food production and the provision of other goods and services derived from biodiversity in agriculture.

Principles of the Ecosystem Approach

The following 12 principles are complementary and interlinked:

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice.

Rationale:

Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the ecosystem approach, and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.

Principle 2: Management should be decentralized to the lowest appropriate level.

Rationale:
Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

Rationale:
Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make, if necessary, appropriate compromises.

Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context.

Any such ecosystem-management programme should:

a. Reduce those market distortions that adversely affect biological diversity;
b. Align incentives to promote biodiversity conservation and sustainable use; and
c. Internalize costs and benefits in the given ecosystem to the extent feasible.

Rationale:
The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations and provide perverse incentives and subsidies to favor the conversion of land to less diverse systems.

Often, those who benefit from conservation do not pay costs associated with conservation and, similarly, those who generate environmental costs (e.g., pollution) escape responsibility. Alignment of incentives allows those who control the resource to benefit and ensures that those who generate environmental costs will pay.

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

Rationale:
Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processess are of greater significance for the long-term maintenance of biological diversity than simply protection of species.

Principle 6: Ecosystems must be managed within the limits of their functioning.

Rationale:
In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity. The limits of ecosystem functioning may be affected to different degrees

by temporary, unpredictable or artificially maintained conditions and, accordingly, management should be appropriately cautious.

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

Rationale:

The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.

Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processess, objectives for ecosystem management should be set for the long term.

Rationale:

Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency of humans to favor short-term gains and immediate benefits over future ones.

Principle 9: Management must recognize that change is inevitable.

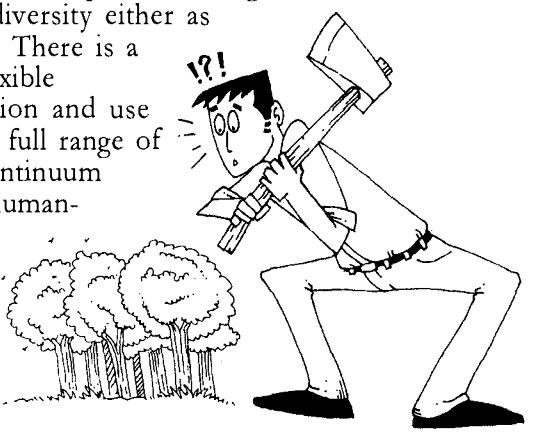
Rationale:

Ecosystem change, including species composition and population abundance, hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential "surprises" in the human, biological and environmental realms. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must utilize adaptive management in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change.

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

Rationale:

Biological diversity is critical both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a shift to more flexible situations, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.



Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

Rationale:

Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functions and the impact of human use is desirable. All relevant information from any concerned area should be shared with all stakeholders and actors, taking into account, inter alia, any decision to be taken under Article 8 (j) of the Convention on Biological Diversity. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Rationale:

Most problems of biological diversity management are complex, with many interactions, side-effects and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional and international level, as appropriate.

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For more information, see:

UNEP/CBD/COP/5/Inf.11. Information paper prepared for the fifth meeting of the Conference of the Parties of the Convention on Biological Diversity, Nairobi. 2000.

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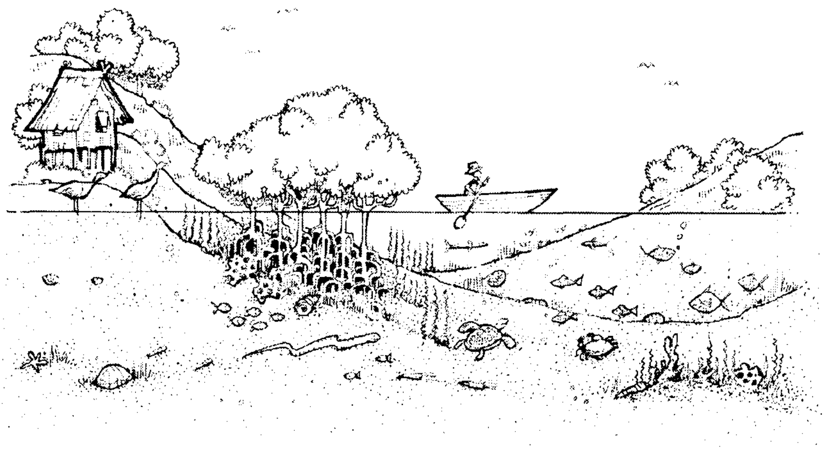
8

Aquatic Biodiversity Issues

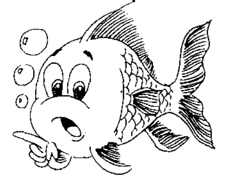


There are around 25,000 marine and freshwater fish species and more are still being discovered. In fact, more than half of all vertebrates are fishes. Coral reefs are usually singled out as examples of high marine biodiversity, with 93,000 species so far identified.

Unfortunately, because fish species are quite inaccessible, we know much less about their conservation status than we do for any other vertebrate group. Aquatic life is seldom seen, hard to study and extremely difficult to keep tabs on. This is one reason there are so few aquatic biodiversity "hotspots."

Comparing Agricultural and Aquatic Biodiversity

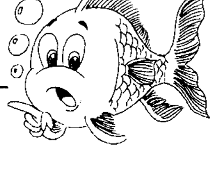
Differences	Similarity
• aquatic organisms are still mostly hunted and gathered • fishing communities carry no seeds of survival with them • biodiversity effects of fishing are more far-reaching than agriculture • the tools needed to manage aquatic biodiversity and agriculture differ	• both need genetic diversity for selective breeding



Marine and Freshwater Biodiversity

Geography is the main reason why marine and freshwater organisms look and act different. Marine environments are "open," with few barriers, while freshwater systems are "captive," so animals cannot escape habitat disturbances. Thus, freshwater populations are smaller and more vulnerable than marine ones.

Marine Biodiversity	Freshwater Diversity
• marine animals are either pelagic (open water) or bottom leaving • harvested along coastal zones and the continental shelf • mangroves and coral reefs are some of the best known and most productive marine habitats • biggest human impact is fishing	• found in lakes, rivers and wetlands • essentially coastal and vulnerable to man-made disturbances • fisheries are mostly small-scale and play a much bigger role insupporting communities • biggest human impact is habitat destruction

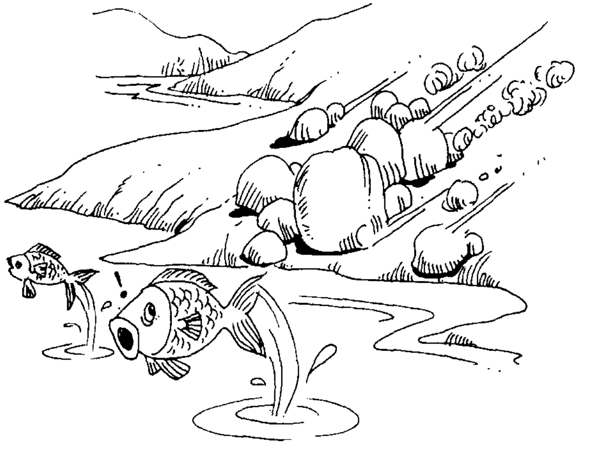


The best indicator of the status of global marine biodiversity is fisheries landings. More than half of the main world fisheries are at their peak or declining, and need urgent changes in management. Even more disturbing is the act of "fishing down the food web." Larger fish at the top of the food chain are being fished out and replaced by smaller species at a lower trophic level.

Aquatic biodiversity is inseparable from the waters themselves. Fresh water provides transport, irrigation, waste disposal, and hydroelectric energy as well as recreational and cultural benefits. And one can drink it too! In terms of goods and services, inland waters contribute more to global economies than all terrestrial ecosystems combined, and that includes forests, grasslands and rangelands. Freshwater aquaculture produces more than twice the tonnage of fish harvested from the wild.

The Big Issue: Genetic Erosion in Freshwater Species

Genetic diversity is the cornerstone for livelihoods that exploit aquatic resources. Genetic erosion, or loss of that diversity, is a big concern for freshwater species, which are at greater risk of extinction than marine ones. Eighty-four per cent of fish species in the IUCN Red List are freshwater. Globally, at least 20% of freshwater species are threatened, endangered or extinct.



Key Issues in Aquatic Biodiversity

Dams

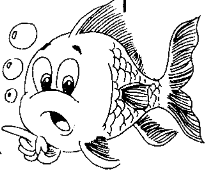
Dams, whether for water storage or for hydroelectric power, can have devastating effects on both inland and marine species and the communities that depend on them. Dams are still widely perceived by governments in the developing world as symbols of 'progress.' Unfortunately, many of their benefits are unsustainable.

Dams convert sections of rivers to lakes. However, the species that evolved in the river are rarely adapted to standing water, so lake species are stocked. The dams keep migratory fishes from their spawning beds, and they prevent nutrients from being washed down the river to deltas. Thus, coastal fishes suffer, and erosion along the coasts increases. Furthermore, mangroves find less soil to root in. In effect, communities that live along the coasts have fewer fish to subsist on.

Aquaculture

Aquaculture relies on biodiversity, affects biodiversity and causes considerable controversy by its environmental effects. Freshwater aquaculture exceeds marine and offers an alternative livelihood to inland communities. But the culture of aquatic species raises fundamental questions about the sustainable use of aquatic biodiversity, including its collection, ownership, dissemination and preservation. Unfortunately, there are huge hidden environmental costs, including habitat loss, spread of disease, and introduction of exotic species.

Not all kinds of aquaculture have negative effects. Small-scale aquaculture in the developing world poses few problems. Small-scale aquaculture projects can acknowledge and identify promising new species or help quantify the value of native biodiversity.



Protected Areas

Aquatic protected areas seem to be working on several levels. Even in small areas, local people are shown the richness of aquatic life and are sent a strong message on human effects on ecosystems.

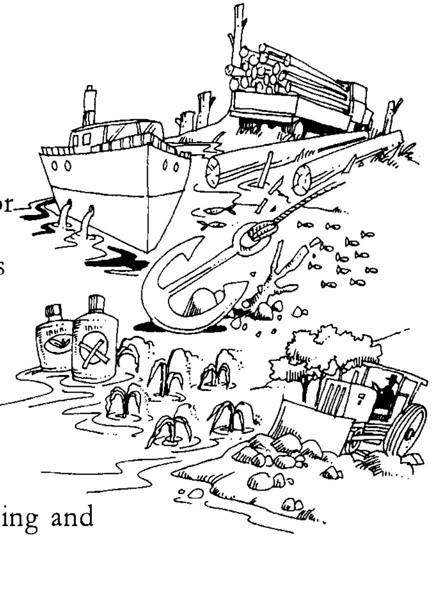
Climate Change

Global weather patterns will be disrupted, droughts will be longer and storms more violent and frequent. Aquatic animals that cannot tolerate changes in water temperature will be affected first. Likewise, migratory fishes that depend on transient floodplains for reproduction and rearing may lose habitat. These species are critical providers for local communities, who are in for some painful surprises over the coming decades.

> By the year 2100, climate change is expected to be the major threat to biodiversity in inland waters.

Other Sectors

Aquatic diversity is vulnerable to much more than just fishing. Various practices that affect aquatic biodiversity include:



- water taken from rivers for farming is returned to the rivers by pulp mills, and is dirtied by logging;
- coral reefs are damaged by the anchors and flush toilets of yachts;
- agricultural chemicals pollute water;
- soil eroded from poorly tilled fields silts up spawning and nursery beds;

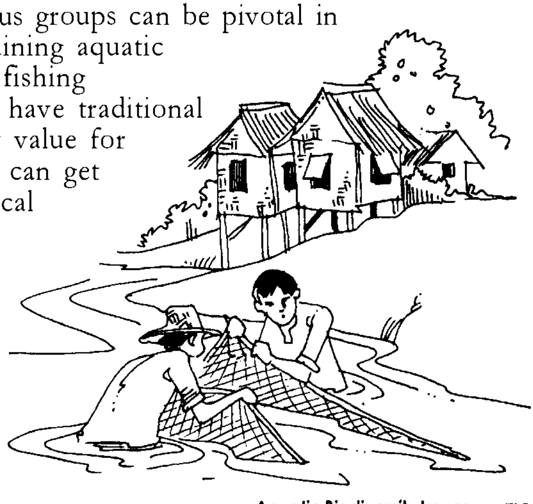
- farmers plowing to the riverbanks
  destroy native vegetation that shades the water and provides food for fish and crustaceans; and
- forestry harms aquatic biodiversity largely by destroying habitats, through siltation and erosion.

Involving Communities in Research and Management

The collapse of marine fisheries and the explosion of freshwater aquaculture paved the way for better awareness of aquatic biodiversity. Much of the urgency has come from fishing communities whose way of life is changing, as aquatic biodiversity is lost.

Ecosystem-based management requires basic knowledge of the aquatic ecosystems in question. For example, one cannot establish and manage protected areas without some understanding of the population dynamics and predator-prey interactions within them. Likewise, local communities cannot manage their aquatic resources without access to information on stock compositions, migrations, harvest impacts, and policies of other sectors that affect the resource. Unfortunately, most of this knowledge, which is not even an issue in agriculture, is lacking.

Local and indigenous groups can be pivotal in valuing and maintaining aquatic biodiversity. Local fishing communities often have traditional knowledge of great value for management. They can get involved in biological studies needed to improve management, including studies of life history and other biological characteristics.



Similarly, participation in sampling programs encourages linkages between communities, scientists and managers.

Although inland fishery mechanisms are poorly documented, these small-scale operations can be considered as a powerful inducement for conservation and sustainable use of aquatic biodiversity.

Success Stories

An example of successful community-based management o inland waters comes from the Amazon River basin, one of th most species-rich. The Inland Aquatic Resources and Aquaculture (IARA) Project has produced a management model that involves all stakeholders, and, with modification: appears to be transferable to other basins in the country. And in British Columbia, indigenous people who have harvested salmon for millennia have seen traditional concepts of sustainability gradually built into fisheries management schemes that involve government, local and indigenous communities.

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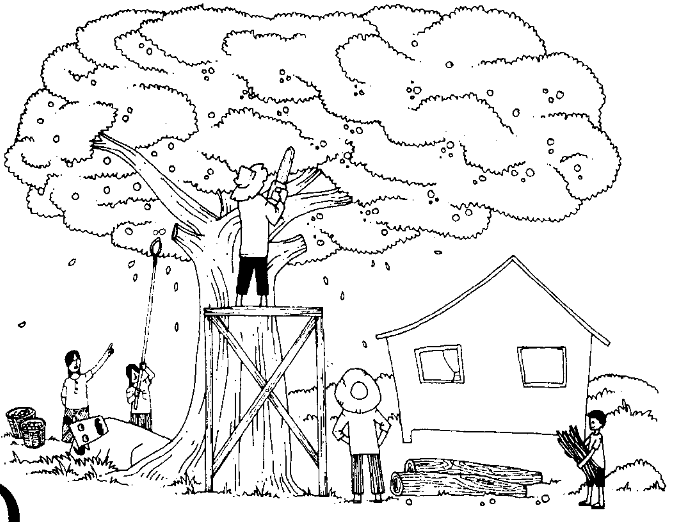
9

Gender in Agricultural Biodiversity Conservation



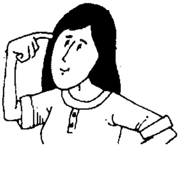
Development responses will be more equal, efficient and sustainable when gender is mainstreamed in agricultural biodiversity conservation strategies.

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

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.



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.

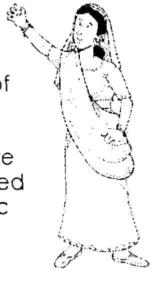
Efficiency. Societies that discriminate on the basis of gender pay a significant prize - in terms of increased poverty, slower economic growth, weaker governance and lower quality of life. For example, a World Bank review found that 74% of 54 completed agricultural projects with gender-related action 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 sysytems are referred to as community "living genebanks" 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.

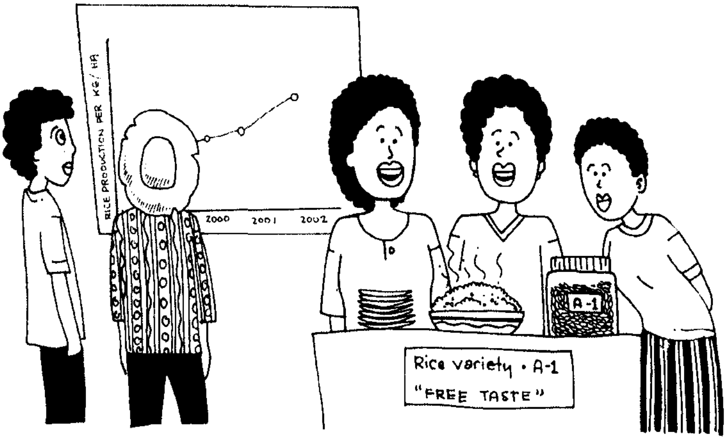
Method

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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Local Knowledge

10

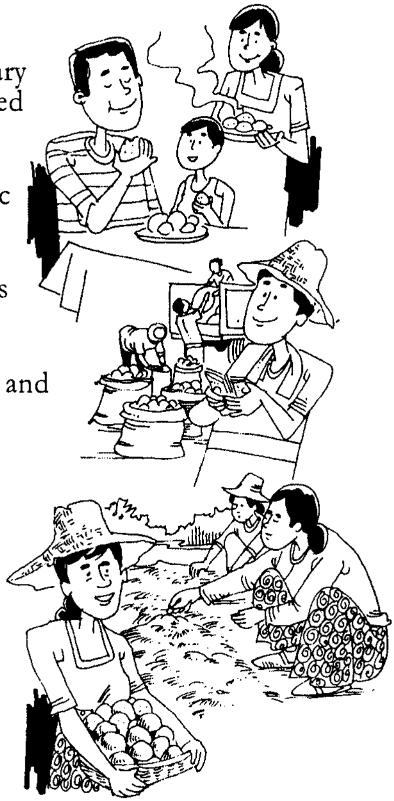
Using Local Knowledge to Conserve the Diversity of Sweetpotato in the Philippines

Rootcrops and other non-cereal crops are often lumped under the category of "secondary crops." These are considered by some to be of low importance and consequently receive far less public and private sector investments in human, financial, and other resources.

What Is Local Knowledge?
Local knowledge represents the body of knowledge that develops, becomes shared and is used by a particular social collectivity (e.g., a farming community, social network, ethnic group) in the pursuit of certain goals and interests. It generally emerges from the direct experiences of people as they learn about their biophysical and social environments. Local knowledge is not necessarily entirely indigenous as local people gain knowledge through their contacts with other communities and scientific institutions. It is diverse in nature as the knowledge gained by individuals and groups is shaped by particular social, cultural, physical and temporal contexts.

Contrary to their label as secondary crops, rootcrops have been utilized in many parts of the world for multiple purposes in different agroecological and socioeconomic conditions. Particularly for sweetpotato, research has shown that it performs primary functions such as:

- consumption/nutrition;
- income and employment; and
- sustainability and social equity, within and among farming house holds in Asia.



In spite of the primary importance of secondary crops like sweetpotato, it has received extremely low level of attention from mainstream scientific research even with its large distribution and livelihood importance throughout Asia.

On the other hand, local knowledge on sweetpotato has evolved out of farmers' need to learn about the crop and its management, given the limited availability and access to relevant scientific knowledge. Among resource-poor farming households in marginal agricultural environments, local knowledge is one of their few vital resources for sustaining agricultural livelihood. Empirical studies undertaken by the Users' Perspectives With Agricultural Research and Development (UPWARD) Network and other research projects of the International Potato Center (CIP) revealed that local knowledge plays a critical role in farming households' conservation and cultivation of a crop often neglected by formal agricultural research institutions.

Sweetpotato in the Philippines: Cultivar Diversity and Local Knowledge

In the Philippines, cultivar diversity is a key element of local sweetpotato production systems. The following serve as major impetus for local farming households to conserve sweetpotato diversity:

- local food consumption patterns and preferences;
- adaptability to local growing conditions; and
- traditional beliefs and practices.

In the Philippines, sweetpotato is grown in three main production systems - commercial lowlands, upland swidden and homegardens. In highland northern Philippines, where sweetpotato is a staple food, at least 200 cultivars have been recorded. In an upland municipality in southern Philippines, 55 cultivars were identified to have grown over several decades. However, farmers no longer cultivate nearly half of these cultivars due to changes in market demands. Similarly, increased commercialization of sweetpotato production in the lowlands of northern Philippines has resulted in a reduction of numbers of cultivars, from 25 to less than 5, over the last 50 years.

Local knowledge on diversity of sweetpotato cultivars helps ensure that specific cultivars are available when and where farmers need them. Local knowledge is an essential resource for identifying, cultivating, utilizing and maintaining different cultivars for different livelihood purposes.

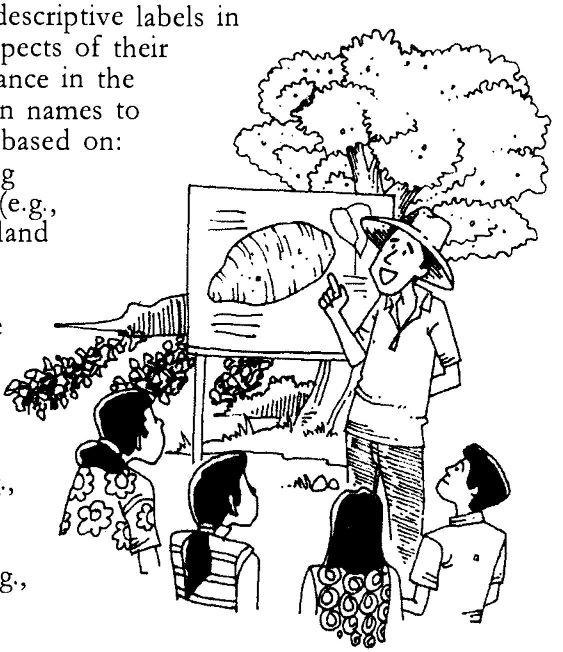
Local Knowledge as a Starting Point for Conservation of Sweetpotato Diversity

For research and development efforts to support agricultural biodiversity conservation, exploring local knowledge is a useful starting point in conservation efforts. Through the assessment of potential value and use of local knowledge, especially of neglected crops such as sweetpotato, research and development workers can build on a key resource in identifying and introducing appropriate conservation strategies.

Terminologies

Local people choose descriptive labels in referring to various aspects of their environment. For instance in the Philippines, they assign names to sweetpotato cultivars based on:

- a distinguishing characteristic (e.g., Amsitan for bland taste);
- person who introduced the cultivar (e.g., Bentong);
- place from which it originated (e.g., Kapangan); or
- popular personality (e.g., Imelda).



However, cross-checking with standard scientific nomenclature is necessary because the use of local names is highly arbitrary and variable.

Concepts

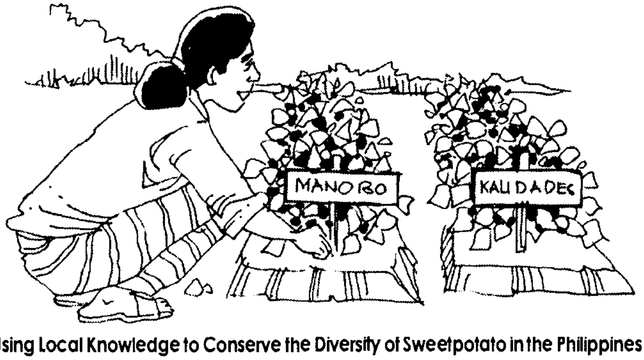
Local people develop constructs to represent particular agricultural activities, outputs or preferences. One example is *nabukag*, a multi-dimensional trait associated with mealy taste that is popular among subsistence farming households in the Philippines. Generally, farmers articulate a wide range of sweetpotato attributes (i.e., morphological, gastronomic, physiological/ ecological, familiarity, and function/use) that no single cultivar can fully satisfy. As a consequence, farmers cultivate a mix of cultivars with complementary traits.

Beliefs and Values

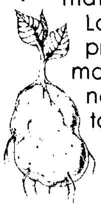
Traditional beliefs and values influence agricultural decisions and actions. In southern Philippines, farming communities do not view incentives for conservation only in terms of material benefits. Other valued incentives include the symbolic importance of the crop, opportunities for strengthening social networks, and the power and authority that is associated with leading conservation efforts.

Crop Management Practices

Intimate knowledge of crops and varieties is part and parcel of local agricultural knowledge systems. Local people learn and adopt different practices of maintaining a variety of cultivars for various uses. Subsistence farmers in the Philippines deliberately cultivate a mix of short-maturing cultivars (e.g., Manobo, harvestable after three months) and late-maturing cultivars (e.g., Kaledades, harvestable after seven months). This ensures a steady supply of sweetpotato roots to meet household food needs for a longer period.



Efforts to help local people conserve the diversity of their biological materials need to be accompanied by efforts to conserve the associated local knowledge. It may be argued that knowledge becomes lost even more quickly than the materials themselves. Loss of knowledge precedes loss of materials, as people no longer know how to use these materials.



Uses

Local people develop ingenious strategies in the utilization of sweetpotato, which influence decisions on cultivar choices. The market makes a similar influence as it creates demands for cultivars with specific uses. In the uplands of northern Luzon, the choice of creeping-type cultivars serves the purpose of cover cropping as part of soil conservation efforts. In central Luzon, high-starch *Bureau* and *Superbureau* became dominant cultivars at a time when farmers sought to exploit market opportunities created by the establishment of sweetpotato starch factories.

Exchange of Planting Materials

In the Philippines, informal social networks of women are key channels for the diffusion of cultivars through the exchange of planting materials. Kinship ties and traditional leadership authorities are also key factors in sustaining collective efforts to conserve sweetpotato diversity, such as the establishment of community-managed genebanks.

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11

Taro Biodiversity Management and Conservation in Yunnan, China

Taro *(Colocasia esculenta)* is a widely distributed food crop and is locally important in many parts of the humid tropics and subtropics. It fits well into multiple tree cropping and agroforestry systems. Some taro types adapt well to multiple habitats such as marginal lands and swamps while others are grown under intensive cultivation as starch crops.

Origin of Taro

The centers of diversity for taro are in northeast India, southeast Asia and Melanesia. Debate and research continue on the centers of origin of this global crop. Northeast India and Melanesia are the possible separate centers of origin and domestication.

Taro in China

Yunnan Province in southwest China is an important region for ethnobotanical and genetic studies of taro diversity. It is at the margins of the centers of diversity in Assam, and southeast Asia. Yunnan is also a major producer of taro under different farming systems from tropical swidden to intensive irrigated agriculture.

Taro is also known as dasheen, eddoes, malanga and cocoyam, in the Caribbean and West Africa. While the roots -- corms and cormels -- are the most important and widely used part of the plant, the leaves, stalks, and flowers are also eaten depending on the cultivar and culture.

In China, the average annual taro production is over 1.2 million tons. Taro's commercial importance is largely local, hence, the extent of its production and distribution is often under-estimated. Despite being a widely consumed tropical root crop, taro has been relatively neglected by research and conservation efforts. Taro genetic resources maintained in *ex situ* collections are limited and there is a dearth of information to assess how much genetic diversity exists and how much has been conserved. The various systems for growing and using taro are also poorly documented.

Taro Habitats in Ecological and Cultural Landscapes

The taro growing areas surveyed cover three agroecological zones in Yunnan: (a) the subtropical zone; (b) south subtropical zone; and (c) tropical zone. The conduct of the survey is according to mean annual temperature and rainfall, elevation and soil type.

The habitats of taro, including the range of different farming systems, are as follows:

- lowland rice agriculture areas, a market oriented farming system (central Yunnan);
- composite swidden agriculture areas in transition from subsistence to market oriented-system (southern Yunnan);
- subsistence shifting cultivation areas (southeast Yunnan and west Yunnan); and
- hunting and gathering areas in forest-dwelling communities such as Kucong in southeast Yunnan and Drong in northwest Yunnan along the borders of Myanmar.

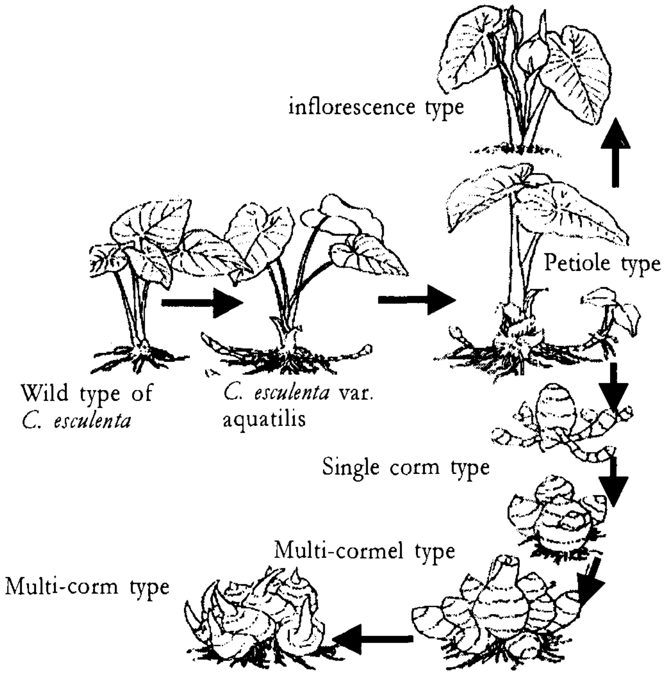
Taro is an important starch crop for traditional communities, such as Kucong (Lahu) people in southeast Yunnan and among the Drong people. The Yi ethnic people and Han Chinese in Central Yunnan practice intensive irrigated paddy production with good market access and exposure to Han Chinese culture for centuries.

Ethnic goups such as the Jinuo and Hani (Akha) in Jinghong and in southeast Yunnan along with the Jingpo people in west Yunnan, still practice subsistence swidden farming system. Taro can be found in their swidden fields and other microenvironments such as rainfed field, irrigated paddy field, homegarden, swamp and other natural habitats.

Ethnobotanical Surveys

The ethnobotanical survey across communities and ecosystems in Yunnan revealed a common set of characters that farmers use to group traditional taro cultivars into five types. The five traditional taro morphotypes are:

- inflorescence;
- single-corm;
- multi-cormel;
- multi-corm; and
- petiole morphotype.



Possible evolution tree of taro *(Colocasia esculenta)*

The methods applied for ethnobotanical survey include: a) free listing of local names; b) participatory sorting, scoring and ranking of traditional cultivars; and c) market surveys through key informants interview. Botanical survey includes measurement of plant characters in the field.

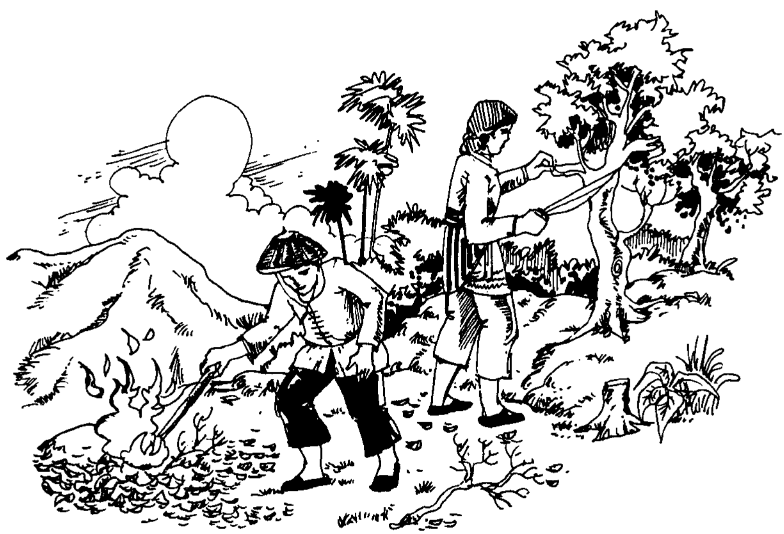
Throughout the surveys, samples were strictly organized according to the local communities' classification and maintenance. This is crucial in assessing how these varied management and use patterns using locally-identified types of taro have maintained genetic diversity through distinct selective pressure on taro germplasm. Results of the ethnobotanical study revealed specific socio-cultural and use factors underlying these distinct selection pressures. Both farmers and ethnobotanists identified distinct taro types. They

grouped the materials and its associated knowledge according to the indigenous or local farmers' varietal name. These samples were characterized using morphological and indigenous classification and grouped into morphotypes. The ethnobotanical surveys also documented and compared the traditional agronomic practices under which taro is grown as well as their location within particular micro-environments on the farm.

Conservation and Use of Taro Diversity

Land Preparation

In swidden agro- ecosystem, forest land is slashed and burned in the early dry season. In the lowlands where intensive cultivation of taro takes place, farmers usually plough the land before planting. Furrowing is commonly adopted in the lowland for easy irrigation and fertilizing during the growing seasons. In less intensive systems, a hoe is used to plant. Large single corm type and inflorescence type are the taro cultivars most commonly grown under irrigation or in single stand that facilitates more intensive land preparation.



The Yanuo village consisting of 82 households has currently planted a total of five different cultivars in their home gardens and swidden fields. They stated that neighboring villages use many other cultivars. It is a common practice among farmer households and communities to exchange varieties to get different cultivars varying biophysical and socioeconomic conditions. In most cases, a farmer maintains 3 - 5 cultivars in his own field while another farmer may use another different 3 - 5 varieties according to their field, labor and needs.

Germplasm Selection

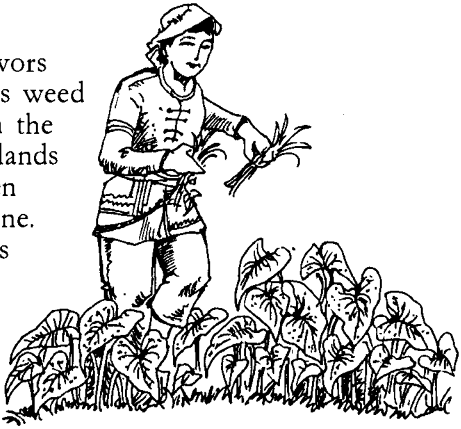
Swidden cultivators often select healthy taro for storage in the field hut for the following year's plantation. Mother taros are often sold at the local market by farmers who do not practice storage. Using corms for propagation and plastic film for land cover are commonly practiced in central Yunnan to harvest the inflorescence of flowering taro (*C. esculenta* cv. *inflorescence*) early and obtain a better price. Medium sized cormels with good top budding are usually selected for propagation. For single corm and flowering types, only the top part of the corm itself is used for planting. Some farmers cut the lower half of cormels for food. The new cutting is treated by burned residual ash for protection against diseases. For stolon types such as wangenyu, farmers select individuals with rounded leaves, which are considered as less acrid planting material.

Planting and Cropping Pattern

Taro is often planted in field margins, fertile spots, or as land markers between different plots in swidden fields. In the lowlands, taro monocropping is observed. The planting distance between taro plants is about 50x50cm or 20x80cm. Taro is often intercropped with corn, beans, sugarcane, fruit trees and vegetables in the rainfed and irrigated upland, rice in the paddy field, or rotated with winter crops such as garlic and broad-bean. The planting season starts in February until April.

Weeding

Warm humid environment favors weed growth. Although taro is weed tolerant, weeding 1-2 times in the uplands and 3-4 times in lowlands is widely practiced. In swidden farms, it is less commonly done. Taro is harvested when weeds become well-established and what remains in the ground reverts to its natural status. Roots and leaves are occasionally used for human or animal food.



Soil Fertility Management

Swidden cultivators often plant taro in low-lying areas to catch water and maintain soil fertility. Organic fertilizer is recommended before planting in the lowlands. Farmers who grow taro for marketing say that it needs lots of fertilizer. Fertilization can be done several times, particularly during root growth.

Moisture and Water Management

Taro prefers high soil moisture. Farmers often apply crop residuals or rice husks for land cover to increase soil moisture particularly during dry periods. Irrigation is suggested before monsoon in April - May for sprouting and during the late growing season in September - October for tuber formation.

For large corm taro, farmers use organic fertilizer to maintain good taste quality. For inflorescence type taro, farmers use both chemical and organic fertilizers to harvest more flowers.

Different taro cultivars have different water needs. One taro cultivar, "green taro", can tolerate drought conditions and is suitable for upland cultivation

Disease and Pest Control

Taro in the swidden fields have less pests and diseases due to small-scale cultivation and greater diversity of cultivars used. The main diseases of taro in the lowland are fungal diseases such as Erwinia *(Erwinia carotovora)* and phytophthora *(Phytophthora colocasiae)*, especially during high temperature and humidity. Cutworm is a common pest for taro. Aphids, in turn, expand rapidly during the dry season. The farmer's strategy is to:

- use a 2-3 year land rotation;
- select healthy taro for propagation;
- use different varieties, particularly disease-resistant cultivars; and
- use chemicals.

Only taro with edible inflorescence can be planted in the same field for many years because it is disease-resistant. Reasons for this resistance are not yet known. One possible reason is because its intensive cultivation is fairly recent, such that pests and diseases have not yet affected it. Alternatively, different management practices such as early planting and harvest could help evade the cycles of existing taro diseases. Finally, resistance could be genetically determined and be significant to areas such as the South Pacific islands where entire populations of taros -- the staple food -- are being wiped out by diseases. Further research on the evolution of taro diversity in China may provide answers to this question.

> Agricultural biodiversity is one of the most important resources which indigenous communities should have control over and have access to.

Harvesting and Post-Harvest Storage

C. esculenta cv. *inflorescence* can be harvested from late April to the end of September. Corm and cormel taro types can be harvested at the beginning of September for early-maturing cultivars to early December for

late-maturing cultivars. Taro corms and cormels are usually dried for several days and stored in a shady and open area. Some farmers, particularly swidden cultivators, bury the taro in the fields until the following year for replanting or selling. They cut the petiole and stalk of taro during harvesting and keep the tuber under the ground for the following year.

Recommendations for *In Situ* Conservation

Farmers in traditional farming communities use and maintain very diverse genetic resources, such as taro, which are often closely related to their culture. Culture and agricultural biodiversity in indigenous and other traditional societies are usually closely linked and consequently, there is also a need to address agricultural biodiversity from a cultural perspective.

Much can be done to support conservation of genetic resources by recognizing local culture and farming systems such as the following:

- Recognize the role of women in agricultural biodiversity management and conservation, this should be taken into account in community work and research due to more off-farm work for men in the rural area.

- Ensure equity in trade relations between the signatories of the World Trade Organization (WTO) (e.g., regarding the patents to genetic materials and farmers' access to genetic materials).
- Promote balance between marketed and subsistence crops as a means to preserve agricultural biodiversity in farming systems.
- Enhance farmers' access to information on national level policies that affect their culture and biodiversity.
- Promote the use of diverse genetic material based on local and exotic crops for intercropping, multi-cropping, rotation and green hedgerow in the agroecosystems.
- Recognize the rationale, relevance and values of traditional farming systems and their place in agricultural biodiversity management.
- Consider cultural aspects when introducing new crops with related crops (crop systems or the crop "family").
- Strengthen farmers' capacity and their institutions to manage agricultural biodiversity.
- Support *in-situ* conservation of agricultural biodiversity through state extension system and mechanism for financial and technical support.
- Gain better understanding of locally developed genetic resources and associated knowledge developed and maintained by farmers.
- Support diversification in agricultural biodiversity and its management.
- Promote under-utilized and rarely used agricultural biodiversity resources, such as taro.
- Support local process and small-scale enterprises development for value-adding of local products.
- Support local supply and management systems that help preserve and develop local agricultural biodiversity systems.

- Create awareness about the close relation of food culture and little used native crops, which are the usual reserve of agricultural biodiversity. Fast food habits will·increasingly be based on cash crops, that will narrow the food variety and decrease the use of marginal and little used grains and greens, tubers, roots and fruits, so causing harm to the health of people.
- Understand the diverse cultural interpretations of food security to develop site specific strategies to overcome hunger and food scarcity in ways that recognize cultural values.

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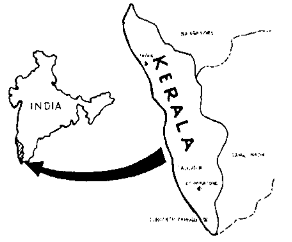
12

Uses of Wild Edibles Among the Paniya Tribe in Kerala, India



The Paniya is a socially marginalized group which constitutes the largest single Scheduled Tribe in Kerala, India and is mainly seen in the Wayanad District. Paniya women and men know about 265 distinct kinds of wild plants and animals with food and nutritional value, which they collect on diverse landscapes as *vayal* (paddy fields) and associated areas like *kolli* (marshy areas), *vazhiyariku* (waysides), *thottam* (plantations) and *kadu* (forest).

There are at least 3,000 edible plant species known to man, with merely 30 crops contributing to more than 90% of the world's calorie intake and only 120 crops are economically important on a national scale. Numerous publications have repeatedly discussed the need to study wild edibles to solve food scarcity worldwide. There are 1,532 edible wild food species in India, mostly from the Western Ghats and Himalayan regions. This study focused on about 265 wild edibles known to the Paniya tribe in the Wayanad district of Kerala, India. It shows the useful skills of both men and women in managing these foods.

The Paniya tribe uses many wild food species, especially leafy vegetables, for food, medicinal uses and for ritual purposes among others, examples of such are:

- young shoots of kayal *(Bambusa arundinacea)* are used to cure rheumatism;
- shells of aama *(tortoise)* can cure piles and burns;
- karimkoovalam (*Monochoria vaginalis*) leaves are used by diabetics;
- thazhuthama (*Boerhavia diffusa*) for chest pains; and
- pith of njettippana (*Arenga wightii*) to cure venereal diseases.

Both Paniya men and women are generally knowledgeable of the 30 documented multiple uses of wild food species.

The food species known to the Paniya tribe and the areas where such plants are gathered are listed in Table 1.

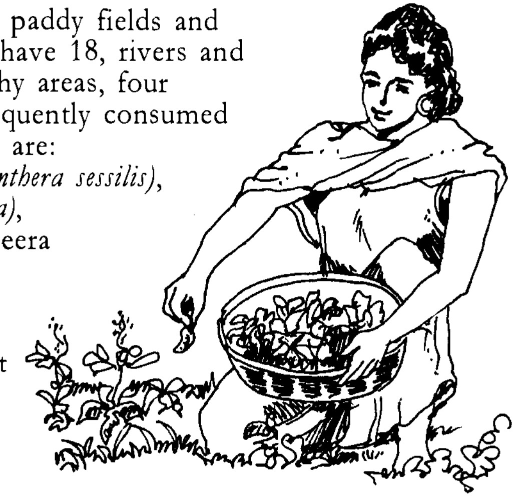
Table 1: Wild Food Collected by the Paniya Community from Different Landscapes

Wild food class	No. of species/ kinds	Landscape
Chappu (leafy vegetables)	72	Paddy fields, marshy areas, waysides, riversides, streams and rivers, plantations, forest
Kumman (mushrooms)	25	Plantations, paddy fields, forest
Kizhangu (roots & tubers)	19	Forest, thickets, riverside
Katttukai (fruits, nuts & seeds)	48	Forest, thickets, riverside
Meenu (fishes)	36	Rivers and streams, paddy fields
Njendu & *Noonji* (Crabs, snails, crustaceans)	8	Paddy fields, marshy areas, rivers, streams
Aama (tortoise)	2	Streams, marshy areas
Thenu (honey)	5	Forest, thickets, plantations
Pakshii (birds)	35	Forest, paddy fields, thickets
Kattumrugam (wild animals)	15	Forest
Total	**265**	

Collection and Use of Wild Edibles

Leafy Vegetables

In most Paniya households, daily meals still include wild leaves almost everyday. They use leaves of 72 wild plant species, mostly herbs (57) and a few trees (4) to supplement their diet. Wayside and open-area landscapes provide about 28 varieties, while thickets and forest landscapes provide 20, paddy fields and associated ecosystems have 18, rivers and riversides 13 and marshy areas, four varieties. The most frequently consumed leafy vegetable species are: ponnamkanni *(Alternanthera sessilis)*, thalu *(Colocasia esculenta)*, different species of cheera *(Amaranthus spp.)* and churuli *(Dryopteris sp.)*. Women and girl children usually collect the greens along with firewood and other minor forest products.



Mushrooms

The Paniya includes about 25 mushroom species in their diets. Women mainly collect the mushrooms though some men do so occasionally. Mushrooms are seasonal and very specific in their habitat. *Arikkumman* and *puttukkumman* are the most frequently gathered mushroom species during the two periods of the rainy season- the onset of monsoon –*Edavapathy* (June-July) and *Thulavarsham* (September to November). Women are more knowledgeable in locating

mushrooms, often based on the smell of spores and particular locations such as termite mounts, forest fringes, decayed wood and trees with dried trunks, where mushrooms usually thrive.

Wild Fruits and Nuts

About 48 species provide the community with edible fruits or seeds. Almost all these species are found in forests except for *Ficus, Artocarpus hirsuta, Artocarpus integrigfolia* and *Mangifera indica.* Among the fruit yielding species, trees contribute about 30, though some of them like *Syzygium hemisphericum*, *Syzygium densiflorum*, *Baccaurea courtallense* are getting extremely rare. Boys usually collect the fruits from forests and wayside thickets. During summer, Paniya women and girl children collect jackfruits from plantations as well as a number of other wild fruits (e.g., *Kottapazham*).

Roots and Tubers

The most commonly collected roots and tubers are: *Venni* (*Dioscorea hamiltonii)*, *Bolley* (*Dioscorea oppositifolia* var. 1), *Kurana* (*Dioscorea pentaphylla*), *Noora* (*Dioscorea pentaphylla* var.1), *Neynoora* (*Dioscorea pentaphylla* var.1 and *Dioscorea pentaphylla* var.2), *Kavala* (*Dioscorea oppositifolia*), *Naravayan* (*Dioscorea sp.*), *Kavalvayan* (*Dioscorea oppositifolia* var.2), *Muthanga* (*Cyperus rotundus*), *Nannari* (*Hemidesmus indicus*), *Sathaveri* (*Asparagus racemosus*) and *Nara.*(*Dioscorea wallichi*). Both men and women collect roots

and tubers, though women avoid going alone to the interior forests. However, when men and women are together, tubers are dug collectively. Most of the collected tubers are of *Dioscorea* species. Some tubers are often used as ingredients in certain traditional medicines while others are a major source of food, but dependence has reduced considerably due to the availability of alternative commercial food supplies.

Fish

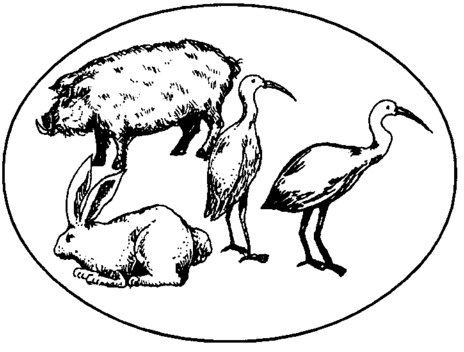
About 36 fish species provide additional food to the Paniya throughout the year. Collection during summer is easier due to low water in streams and canals. The most frequently consumed fish are *Kallupatti, Koyma, Konjai, Kannappae, Parel, Kadvae, Muzhu* and *Kommai. Malanjil,* a big sized fish, which used to be plentiful has become very rare and can now be seen only in big rivers. The same is the case with *Chethil, Aarel,* and *Kaichelu.* Women make independent decisions on choosing fish species, collection site and time. Catching fish from streams is always a collective effort.

Crabs and Snails

These are one of the most common foods consumed by the Paniyas. The usual species collected from paddy fields and areca plantations are *Vella njendu; Pal njendu; Kotti njendu* and *Karinjendu. Palnjendu* has white color, very slimy and when its outer shell is removed, a milky juice oozes out when its legs are broken. *Kundu njendu* is the smallest and tastiest crab being consumed. This *njendu* resides inside small holes near the *vayal* (paddy field) and *vayal varambu. Kotti njendu* is plentiful in areca plantations, especially during the month of *Karkidagam* (July-August). People can identify the presence of these crabs based on the nature of the mud outside the hole.

Small Animals and Birds

There are about 15 animals hunted in the forest by men irrespective of season. The most common are wild boar and rabbits, occasional animals like *Udumbu* and *Koye* are also hunted. At present, hunting activities are rare and limited only to rabbits and wild boars that trespass into plantations and agricultural fields. However, Paniya men and boys still trap many bird species for consumption. About 35 such birds contribute to the food needs of Paniya families in Wayanad. The most common birds being trapped are *Kokku* (cattle egret), *Pravu* (blue rock pigeon) and *Kattukozhi* (jungle fowl).



Honey

Honey contributes to income security of the Paniya who completely depend on the forest. *Kolthen, Pothuthen, Kombuthen, Cherutben* and *Kannithen* are the five kinds of honey collected from the forest. Usually, both men and women go together to the forest one month before the season starts and locate honey beehives. They visit the same place after a month and stay there for 1-2 days. Some types of honey are now becoming rare due to the absence of certain tree species.

Gender Differences in Wild Food Collection and Processing

There are obvious gender limitations and differences within the Paniya families. Women depend mostly on the *kolli and vazhiyariku* where they have free access to collect leafy vegetables like *churuli* (Dryopteris) and *thalu (Colocasia esculenta)*. They seldom go in the *kadu* (forest) area due to security risks. Gender differences are reflected in collecting, processing and managing (decision-making) wild food species as shown below.

Table 2: Gender Differences in the Collection and Processing of Some Wild Foods

Wild food	Collection by				Processing by				Decision making by			
	Men		Women		Men		Women		Men		Women	
	A	C	A	C	A	C	A	C	A	C	A	C
Leafy Vegetables	-	-	x	x	-	-	x	x	-	-	x	-
Mushrooms	-	-	x	x	-	-	x	x	-	-	x	-
Tubers & Roots	x	-	x	-	-	-	x	x	x	-	-	-
Honey	x	-	-	-	x	-	x	-	x	-	-	-
Fruits & Nuts	x	x	-	x	-	x	x	x	x	x	x	x
Fish	x	x	x	x	-	-	x	x	x	-	-	-
Crabs & Snails	-	x	x	x	-	-	x	x	-	-	x	-
Small Animals	x	x	x	-	x	-	x	-	x	x	-	-
Birds		x		-	-	x	-	-	-	x	x	- .

A= Adults; C= Children

Declining Knowledge of Paniya About Wild Food

Table 3 shows the results of a sample survey among 12 male and 12 female, representing three generations among the Paniya. An exercise was carried out to study the knowledge of certain aspects of wild food collection, processing and management and to determine how that knowledge declines across generations and gender.

Table 3: Erosion of Traditional Knowledge of Paniya on Wild Food

Attributes	Generations & number of people remembering					
	1 (40 above)		2 (15 to 40)		3 (Below 15)	
	M	F	M	F	M	F
Identifying edible mushrooms	3	4	2	4	0	2
Identifying edible yams	4	3	3	3	0	0
Identifying edible greens	2	4	1	3	0	3
Using legs to catch fish	3	4	2	2	0	0
Catching crabs	3	4	2	4	0	0

M-male; F-female

The sharpest decline is noted in identifying edible yams and the traditional way of catching fish and crabs. None among the sampled children are aware of such techniques. This decline has occurred suddenly in the third generation, though not much between grandparents and parents. In yam identification, men and women of parent and grandparent generations are equally knowledgeable; whereas in catching fish (by the "free legs" technique), knowledge has declined from the parental time. Women of the parental generation still know how to catch crabs but male children know none of the skills. Except for mushrooms and greens, the female children are also not familiar with wild food collection.

Knowledge has not been passed on from the second to third generation. The main reason is that children are not interested in learning such skills. The survey also indicates that children, especially those who attend school, are barely aware of most of the wild food species, except for fish and some birds like *crane*. Female children know about leafy vegetables and mushrooms, as they accompany their mothers or grandmothers for collection. Male and female members of the parental and grandparental generations are very

knowledgeable about wild foods. They still prefer these foods over the ones found in the market, and they collect them as needed.

As to the availability of wild foods, almost all of them agree that many are no longer freely available. They also know the reasons for the decline: landscape conversion, habitat destruction, invasion of alien species like *Parthenium* and *Ageratum*, restrictions from the forest department, forest fires, among others.

Maintenance of crop biodiversity has a direct link to traditional knowledge systems. Given this, efforts must be made to conserve knowledge systems starting with a "re-education" of children.

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13

Tribal Women's Contributions to Agricultural Biodiversity Conservation in India

Tribal and rural women in Tamil Nadu and Andhra Pradesh, southern India possess traditional ecological knowledge of plant species used for food and medicinal purposes. This traditional knowledge, passed on through generations, has played a significant role in the conservation and sustainable use of agricultural biodiversity.

> Tribal and rural women and men, over the millennia, have conserved genetic diversity of inestimable economic value. They are largely responsible for the *in situ* conservation of numerous plant species and landraces of cultivated species. Today, this genetic wealth serves both as feedstock for plant development and improvement programs, and as a safety net for resource-poor farmers in relation to risks in agriculture.

Tribal women belonging to several tribal groups in Javadi Hills, Chitteri Hills, and Anamalai Hills in Tamil Nadu, use a variety of plant species in their daily life, which they collect from forest areas or cultivated fields, including "weeds". These women are well versed with knowledge of edible greens, vegetables, fruits, seeds and other materials; their uses; and other specific information about the species (see table on pages 114-115).

They have clear knowledge of seasonal variations and availability of these edible and medicinal plants, such as tubers *(Asparagus racemosus)* and yams (*Dioscorea* sp.), and neem *(Azadirachta indica)*. In addition, they not only are knowledgeable about the plants, they also take care of collecting important wild plants and growing them in their homegardens.

Tribal groups in southern India

India is a center of rich biological and cultural diversity. It is home to about 67 million tribal people belonging to 573 distinct tribal groups living in different geographical locations with various subsistence patterns. These communities, which live in biodiversity-rich areas, possess a wealth of knowledge about the use and conservation of plant genetic diversity. This knowledge, collected and developed over years of observation by trial and error, inference, and inheritance, has largely remained with the tribes.

Women are responsible for processing and storing viable and healthy seed of cultivated crops of landraces for the next sowing season. They take care of drying and cleaning the grains before storing as seed as they simultaneously attend to household activities. With the men, they help in the *in situ* conservation of many traditional cultivars and landraces of cultivated species, thus, helping preserve the present day landraces.

Tribal women also play a critical role in maintaining as well as restoring the fertility of the soil. They apply biofertilizers, such as cattle dung or domestic refuse to the land when necessary.

In another part of southern India, the women of the *Konda Reddy* tribal group in Andhra Pradesh, are very knowledgeable about the value and sustainable harnessing methods of agricultural biodiversity. They procure food items from the wild according to the season or whenever they are required. They prepare a kind of porridge/gruel with pounded flour of maize *(Zea mays)* and finger millet *(Eleucine coracana).* The porridge, once prepared, lasts for up to two days, and is stored in gourds made from *Lagenaria ciseraria.* This porridge serves as a staple food from June onwards until the next crop season. It is a common sight during the season to see many old women picking the corn grains from the cobs for making the porridge. Other crops like common millet and foxtail millet are consumed after steaming and seasoning or cooked like rice, and eaten.

The Konda Reddys

The Konda Reddy tribal group is one of 27 tribal communities in Andhra Pradesh. *Konda Reddy* means rulers of hills. They are a dominant tribe with their own culture, religious rites, food habits, and a rich knowledge of agricultural biodiversity resources. The tribal group usually lives in isolated hilly tracts, valleys, adjacent plains, and cleared forest areas. Their houses are usually square or rectangular and built with woven mats or mud walls with thatched roofs. They practice an ancient method of agriculture called *podu*, or shifting (slash and burn) agriculture.

A curry is prepared using any of the pulses and vegetables available during the season. Mostly the Konda Reddy survive on the sauce prepared out of the tender or ripe tamarind and the locally cultivated chili. Young tamarind leaves are used to prepare a kind of chutney, which the tribal group relishes very much. During summer months the Konda Reddys depend on jackfruits and wild mango fruits. Konda Reddy women peel the ripe jackfruits, which are eaten, and also prepare flour out of mango seeds. A wild hardy legume (*Mucuna* sp.), locally called *dhamalu*, and cultivated by Konda Reddys, is consumed by locals after thorough processing by repeated washing in running water. Women preserve and process the seeds before cooking.

Storing seeds of crop species

- Ear heads are left on the plant to allow full growth, and only then are they harvested and stored. This practice prevents disintegration of seeds.
- Maize ears are suspended under the roof above the cooking stove. A mat made of reed and bamboo is kept below the ears to prevent the flame from reaching it. The smoke keeps the pests away.
- For common millet and Italian millet, a portion of the crop is left to attain maximum growth and to dry in the field itself.

Tribal communities conserve their own seed

The tribal communities, particularly *Irulas* and *Malayalis*, cultivate a few species of paddy and millets, which are drought resistant, and to some extent disease resistant and pest tolerant. These gene-rich crops have been conserved and enhanced genetically due to the conservation habit of these communities over the years. Sharing edible grains enables them to maintain seed material for sowing in the following season.

After harvesting their crops, the *Irula* and *Malayali* tribes set aside a considerable quantity as sowing material. This seed material cannot be used for consumption. Tribals could borrow food from other members of the community or they could substitute other edible resources from the forests. Their traditional way of storing in indigenous granaries has helped indirectly maintain the viability of the grains. These granaries keep off rodents and pests. The thatching material is from a grass plant *(Themeda cymbaria)* that is highly suitable for local weather conditions. Also, the use of leaves of some plants serves to repel storage pests.

The community cooperation and participation prevailing in the *Malayali* tribal community has helped conserve the seed material of minor millets for many years. Every family in the community contributes an amount of grain to the community granary, which is then maintained and managed by the chieftain of the hamlet. This practice enables the tribals to borrow grains during important occasions, such as marriages, social events, and festivals or for daily consumption. This system has also enabled the tribals to conserve seed material, even if some community members produce less in any one season or exhaust their own household stocks.

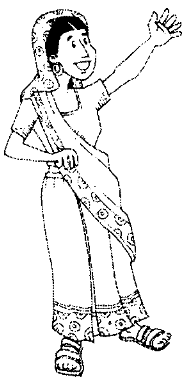
The Irula and Mayali people prefer traditional cultivars, which do well when given domestic refuse and botanical green manure. Also, traditional cultivars suit local dietary habits and can be easily cultivated without external inputs. Overall, the traditional cultivars are highly suitable and adapted to the local agroclimatic conditions.

Diversity Characterizes the Plant Species Used by Tribal Communities in Tamil Nadu

Use as food	Scientific Name	Local Name	Tribe Name
Greens	*Allmania nodiflora*	Thoyyan keerai	Malayalis
	Alternanthera sessilis	Ponnangenni	All Tribes
	Amaranthus spinosus	Mullu keerai	All Tribes
	Desmodium triflorum	Porikarappan	Paliyars
	Digera muricata	Panna keerai	All Tribes
	Lycianthus laevis	Earadi keerai	Paliyars
Vegetables	*Achyranthus aspera*	Naaviri	Malayalis
	Canavalia gladiata	Kaattu balavarankaayi	Kadars & Malasar
	Cansjeera rheedii	Vandu Theemili	Malayalis & Paliyars
	Cassia tora	Thogara	All Tribes
	Cocculus hirsutus	Kattu kodi	Malayalis
	Colacasia esculenta	Sema keerai	All Tribes
	Commelina benghalensis	Kayyen Kena keerai	Irulas & Malayalis
	Cycas circinalis	Eanjam	Kadars
Fruits	*Diospyors ferrea*	Irumuli	Irulas & Malayalis
	Gardenia gummifera	Kambi maram	Paliyars
	Glycosmis pentaphylla	Poomi palam	Kadars & Malasar
	Grewia teleafolia	Sadachi	Kadars & Malasar
	Memecylon edule	Kaayam & Alla	All Tribes
	Palaquim ellipticum	Paala	Kadaris & Malasar
	Phoenix sylvestris	Eacham	Irulas, Paliyars & Pulayars
	Phyllanthus emblica	Nelli	All Tribes
	Polyalthia cerasoidea	Nedunari	Malayalis
	Premna tomentosa	Podanga naari	Malayalis
	Schleichera oleosa	Pookkam	All Tribes
	Scutia myrtina	Thoradi	All Tribes
	Tarenna asiatica	Tharanna	Irulas & Malayalis
	Terminalia bellerica	Thaani	All Tribes
	Toddalia asiatica	Soori	Kadars
	Zizyphus mauritiana	Kotta	All Tribes
	Dolichos trilobus	Mala mochai	Paliyars
	Ficus racemosa	Athi	All Tribes

Diversity Characterizes the Plant Species Used by Tribal Communities in Tamil Nadu *(continued)*

Use as food	Scientific Name	Local Name	Tribe Name
	Mimosa intsia	Seengi	All Tribes
	Momordica charantia	Kurivithala pava	Kadars
	Moringa pterigosperma	Murungai	All Tribes
	Mukia maderaspatana	Mususukku	Paliyars
	Portulaca oleracea	Gonigai	Irulas
	Rhaphiphora pertusa	Mara sembu	Kadars
	Solanum trilobatum	Sukkuti	Kadars
	Talinum cuneifolium	Paruppu keerai	Malasar
	Trichosanthes nervifolia	Pey padal	Paliyars
	Alangium salvifolium	Avungi	All Tribes
	Argyrea sericea		Irulas
	Artocarpus heterophyllus	Palaa	All Tribes
	Canthium dicoccum	Kaara	Malayalis
	Carissa carandas	Kala kai	All Tribes
	Clausena heptaphylla	Potti palam	Paliyars & Pulayars
	Cordia obliqua	Narivili	All Tribes
	Zizyphus oenoplia	Soori	All Tribes
Seeds	*Xylia xylocarpa*	Irul	Kadars
Condiments	*Hibiscus furcatus*	Pulinjeera	Kadars
	Oxalis latifolia	Pulichari	Paliyars & Pulayars



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14

Farmer Management of a Hunger Emergency Crop in Northern Ethiopia

Genetic diversity is essential to both the level of current crop output and future crop improvements on which societies depend. Seed collections preserved in genebanks evolve differently from those that continue to grow in farmers' fields. Thus, conservation has emphasized the need to conserve materials *in situ.*

In the case of cultivated crop species, *in situ* means "on-farm." Although it is easy to emphasize the importance of dynamic, farmer-led conservation of crop genetic resources (from the perspective of plant genetics), related scientific and social questions are complex.

Agricultural biodiversity has received increased attention as a way for managing the environment and supporting food security in resource poor farming systems. Poorer farmers on marginal lands have more options to cope with variable environmental conditions in order to exploit niches and micro-environments.

Cactus as a Hunger Emergency Crop

Cactus *(Opuntia ficus indica)* is widely cultivated in Tigray, Northern Ethiopia for different purposes and farming systems. It is grown in mixed bush ecosystem, irregularly planted and placed on very steep slopes to deter erosion. It is also planted on backyards and homesteads. It is considered as breadfruit in Erob, famine breaker in Subha-saesie and largely as weed in Mekhoni weredas.

Cactus is grown under conditions of infertile soils, steep and rocky slopes. It is one of the oldest most important plants used by Erob and serves as the main diet during a considerable part of the year. The area provides the greatest diversity of cactus in the region, the kinds with the largest and most palatable fruits.

Beles (a variety that produces fruits and needs no special care) is normally cultivated under diverse conditions. Farmers select different types of cladodes based on their differential response to environmental stresses. More than 40 cultivars have been identified/developed in Erob wereda. Cultivars *"Ger'ao"* and *"Sulhuna"* (respectively means sweet and smooth) represent 80% of plantations. Six and four cultivars were identified in Mekhoni and Subha-saesie weredas, respectively. Farmers of the latter wereda prefer to grow spiny cultivars, as these provide a sure protection against browsing animals. Strictly, spineless cultivars are only found in areas of difficult access. A huge area of cactus is utilized from the foothills of the mountain chains, to the hilly areas and in backyards. When opuntia is ripe, the farmers remain in the area as long as nature provides them with food and feed on the tasty, juicy fruit which satisfies both hunger and thirst.

In order to gain a better understanding of the diversity of cactus varieties and to identify sources of variability and document the extent of diversity, a study was conducted on farmers' initiatives on cactus genetic resource management in Tigray, Northern Ethiopia.

The Indigenous Soil and Water Conservation (ISWC) II Program in Ethiopia took quite a different approach. Three districts from the eastern and southern zones of Tigray (Irob, Saesie and Mekhoni) were selected based on the level of cactus diversity and the representation of the social and physical environment of the crop.

The discovery and recognition of farmers' indigenous soil and water conservation techniques and innovations were the starting points. From then on, as many actors as possible from different sectors (i.e., staff of research, extension, teaching and policy-making institutions) were involved to raise their enthusiasm to support farmers' efforts in improving their land husbandry.

The "people orientation" of the approach to land husbandry, working on the attitudes and motivations of actors at all levels, is just as important as the technical content. The aim was to encourage scientists and development agents (DAs) to join farmers' ongoing experimentation and their search for new ideas to try out. The scientists and DAs thus become participants in farmer-led agricultural development.

Variability of Cactus

Fruits

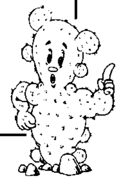
Farmers typically classify cactus varieties based on fruit characteristics such as shape, texture, size, color, palatability and taste. Of these traits, taste and color are the most important. Fruits vary from juicy to dry, and sweet to acidic.

Seeds

The number of seeds in fruits also differs across species as does the diversity of seeds with regards to number, color and size. Further research is needed to provide information in determining the degree of relationship and identifying the varieties.

Non-edible cactus species

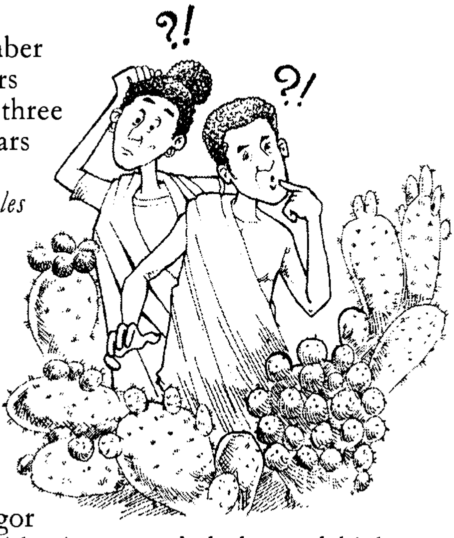
- Adobelasa/Dikir/Ferede - dry and not pleasant to the taste
- Abdale /Wodwada - upsets digestion
- Kelamile - intense red color stains the fingers, lips



Pads (Modified Stems)

Based on the spine on pads, two types of cactus varieties were observed. Most of the cultivars are spineless though some of them are observed to be spiny. The spineless cultivars are known as Sulhuna in Irob, and Lematse in Subha-saesie and Mekhoni.

Spine Clusters

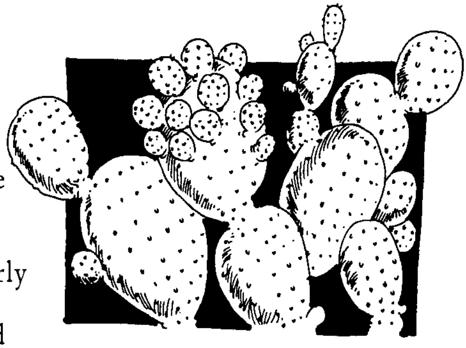


Cultivars vary in the number of spine clusters. Cultivars Sulhuna and Keyih have three spines, while most cultivars have four spine clusters. However, wild cactus *(beles berekha)* is small in both vegetative and reproductive structures and has many spine clusters. The availability of the ploidy level is commonly expressed by an increase in vegetative vigor (cladode or pod size) and reproductive vigor (fruit size). Phenotypes with vigorous cladodes and higher attractive fruits are selected and established vegetatively in their backyards.

Farmers' Description of Cactus *(Opunitia ficus indica)* Varieties at Erob Wereda

Cultivar	Fruiting time	Cladode	Fruit type			Preference ranking	More description
			size/shape	taste	color		
Gera'o	June-Oct	Thin, narrow	Medium/ big	Very sweet	Red & white	2	Few spine/ pad
Gargera	May-Sept	Narrow, short	Medium	Moderately sweet	Light, deep red	3	Very few spine/pad, early maturing variety, but low shelf life (spoiled easily)
Layele	June-Dec	Short	Big	Sweet	Red & white	5	Many spines/pad, 1.5-2m, long
Ado'beles	June-Jan	Thick, short, big width	Thin and long	Sweet	White	5	Moderately spiny, 1.5-2m long, not fleshy
Dilaledikh	June-Jan	Thick, long	Very big	Not sweet, watery	Rose	4	Long maturing variety, oval fruit
Sulhuna	June-Oct	Medium	Medium	Sweet	Red	1	Non-spiny, 3-4m, long
Moderate	June-Dec	Long and thin	Small	Very sweet	Red	5	1.5-2m long, long shelf life

Fruiting Time



Identified cultivars take different lengths of time to ripe. Most cultivars showed ripening from June to August. An interesting observation emerged that cultivars' names, particularly at Irob, indicate their vegetative, phenologic and reproductive characteristics. For example, *Gargera* in Irob language means "innocent," which is an indication of its early ripening character; and *Sulhuna* literally means "smooth" for its spineless character. The presence of spines and hard thick seeds is considered the most serious constraint affecting cactus pear consumption.

Farmers possess great skills and knowledge regarding plant resources available in their reserves. More varieties were identified in Irob than in Saesie and Mekhoni. This indicates that the farmers have learned to select and use everything from the plant. Farmers' selections emphasizing high yield and big fruits and natural hybridization played an important role in domestication. Most farmers select plants which represent the existing variation in the field. This selection process has contributed to great genetic variability and stability. It is this diversity of crop uses that provides incentives for farmers to retain and manage cactus diversity.

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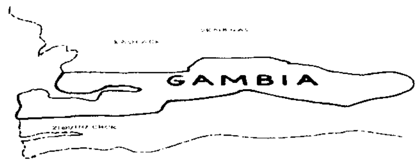
15

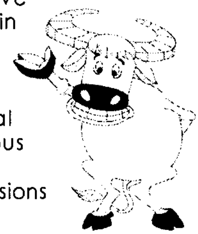
Participatory Methods to Assess Traditional Breeding Systems:
The Case of Cattle Breeding in The Gambia



Professionals concerned with animal genetic resources (AnGR) management, trying to promote breeding initiatives, will typically be faced with a situation where no formal breeding system exists. No written records are available, breeding structures are absent, breeders are rarely organized, and no enabling policy environment is in place. To assume that this indicates complete absence of traditional breeding activities would be a serious mistake. Traditional livestock breeding activities are simply unknown to outsiders. The traditional breeding systems are often rather difficult to identify, because they are related to existing low input production systems and are not formally institutionalized.

A range of issues is being addressed as vital elements in the formulation of novel AnGR management strategies, dealing with technical, operational and policy needs.

- Methodological considerations emphasize participatory approaches for a better understanding of traditional breeding strategies and to achieve active involvement of the livestock keeping communities in breed improvement initiatives.
- Community-based management of AnGR is suggested as an approach that incorporates involvement and empowerment of the local communities who own and manage the indigenous animal breeds.
- Consideration is given to the inherent social dimensions of animal breeding activities.



For better AnGR management and continued use of local animal breeds, appropriate methodologies that enable outsiders to better understand traditional breeding systems are required. A comprehensive investigation that seeks to understand traditional breeding strategies and emphasizes the existing local knowledge base is an approach that builds on cooperation with livestock owners and other stakeholders. This includes facilitation of communication between professionals in research and development (R&D) and the livestock-owning communities promoting the involvement of livestock owners. Simultaneously, the data requirements of formal breed improvement programs can find consideration.

Trypanotolerant Livestock of West Africa: The N'Dama Cattle

Despite severe ecological constraints, foremost is the presence of trypanosomosis, a parasite transmitted through livestock diseases endemic in the humid and sub-humid zones of West Africa, agro-pastoralists have succeeded in establishing sustainable production systems in which livestock is of vital importance. The exploitation of these production systems is possible due to the ability of some of their livestock species and breeds to survive, reproduce and remain productive under trypanosome risk. This unique characteristic called trypanotolerance, was recognized and

exploited by livestock farmers long before national and international institutions began scientific research on mechanisms of trypanotolerance.

Trypanotolerance in cattle is now well documented, particularly in the N'Dama, the most numerous trypanotolerant cattle breed in West Africa. In addition to the resistance to trypanosomes, trypanotolerant N'Dama cattle are also reported to be resistant to several other important diseases, such as a range of tick-borne infections. While initially perceived as less productive due to their small size, N'Dama cattle were found to be equally, if not superior, in their productivity, when compared to other local trypanosusceptible breeds maintained under similar, but trypanosome free production systems.

A Participatory Approach for Better Understanding of Traditional Breeding Systems

To assess the traditional cattle breeding systems in The Gambia, a sequence of survey steps was employed. This sequential procedure served primarily three reasons:

1. Many occasions for group discussions were created to facilitate informal exchange of breeding knowledge and experience between livestock owners and scientists.
2. Livestock owners could be informed about intermediate results obtained from consecutive survey rounds.
3. The feedback that scientists received during discussions with livestock owners was utilized in refining the following survey steps.

The study was conducted among herd owners and herders of 27 villages in three districts in The Gambia. Throughout the country, a traditional low-input mixed crop-livestock system prevails. Cattle are used as a multi-purpose breed providing milk, meat, manure and traction. About 95% of the Gambian cattle population consists of the N'Dama cattle breed.

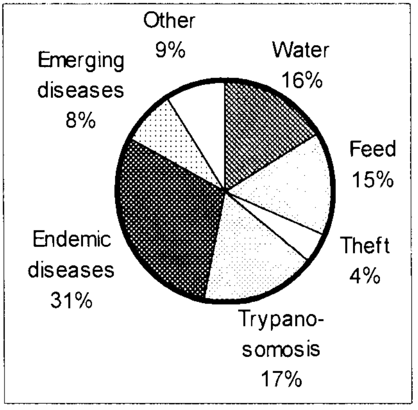
Information Obtained in Sequential Survey Steps

- Focus group discussions in seven villages served as an explorative tool to find out about agro-pastoralists' breeding strategies, including breed and trait preferences and breeding practices.
- A baseline survey among a large number of herders and herd owners provided quantitative information on aspects such as: production systems, herd management, cattle production constraints and possibilities, cattle breeds present and criteria used to characterize the N'Dama breed.
- Matrix rating of cattle types accompanied by a questionnaire to generate information on breeding practices, cattle production objectives and factors hypothesized to determine breed preferences was carried out among herd owners.
- The role of local institutions and organizations in cattle breeding was assessed, using a practical action-oriented approach for local institution analysis combined with an institution diagramming technique.

The Production System

To understand and evaluate livestock owners' breeding strategies, it is necessary to have sufficient information about the production system, livestock production constraints and production possibilities as well as production objectives.

In The Gambia, the majority of agro-pastoralists find livestock and crop-farming equally important undertakings of the farm-household. This underlines the high level of crop-livestock integration found among cattle owning households. Cattle have primarily a savings function. Milk production is important, but so are manure and traction power.



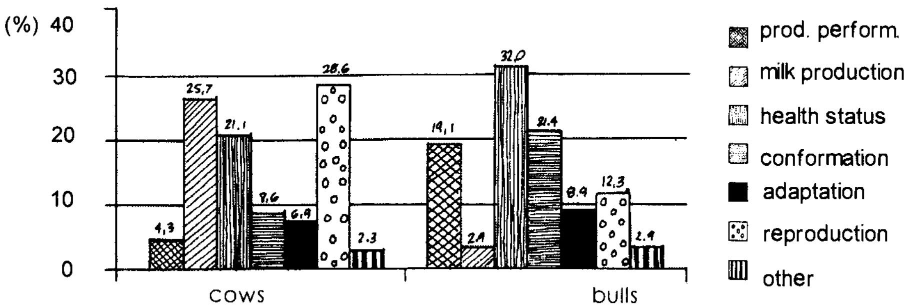
Production Constraints in Cattle Keeping

Cattle diseases are perceived as the most serious production constraint. More than half of all agro-pastoralists identify emerging or endemic disease and specifically trypanosomosis as important production constraints. Second to disease range insufficient availability of water and feed (grazing), particularly during the dry season.

Criteria Used to Characterize the N'Dama Breed

Agro-pastoralists were asked to describe all criteria that they use to evaluate the N'Dama cattle. Frequencies of the collected criteria indicate importance of traits in terms of their priority for agro-pastoralists (CIRDES/ILRI/ITC 2000). Most frequently mentioned evaluation criteria for N'Dama bulls were size, 'strength', libido and 'good offspring'. The term 'strength', as explained by agro-pastoralists, describes a combination of vigor and fitness. In N'Dama cows, milk production, yearly calving and 'strength' were priority criteria. All criteria were grouped into parameters to identify and quantify the importance of functional and production traits depicted below. Health status, reflecting disease resistance, was the most important parameter in bulls and very important in cows. Production traits of high priority were milk and reproduction for cows and conformation (size) and production performance for bulls.

Parameters Used to Characterize N'Dama Cows and N'Dama Bulls



Cattle Breeding Practices

Breeding goal and breeding practices are two key aspects of the traditional breeding systems that need to be well understood. Breeding practices, such as for example the mating system, the selection and availability of breeding males or keeping pedigree information determine whether the expressed breeding goals can be achieved. The minimum information to describe breeding practices includes herd size and herd structure, the number of breeding bulls available per herd, and how mating is organized/controlled.

In The Gambia, mating is predominately controlled by herding, unselected males are usually castrated or sold before maturity. Herd owners responsible for the herd management are usually able to detect cows in heat. In the majority of herds, one or two breeding bulls are present and the lack of a breeding bull is perceived a significant production constraint.

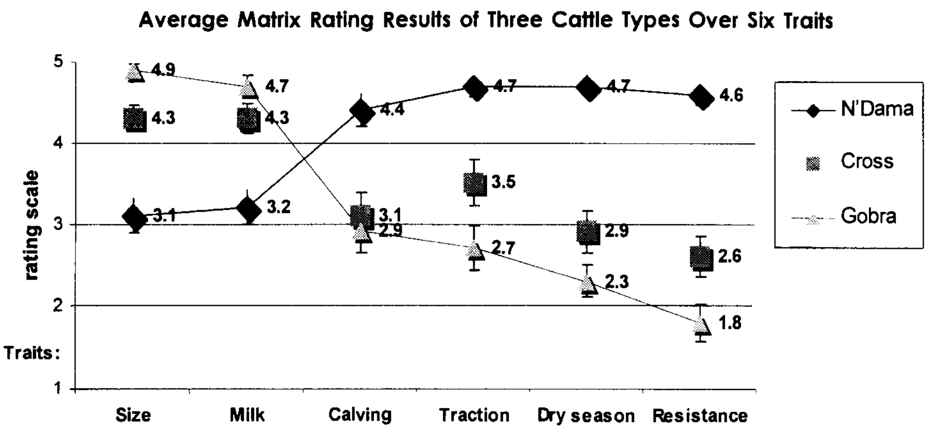
The Matrix Rating Technique

Matrix rating is a well-established analytical tool in R&D and lately used to investigate breed preferences. It produces quantifiable data for the evaluation of different breeds and/ or traits utilizing the local knowledge of the livestock keeping communities.

Cattle owners were asked to compare the local N'Dama breed, the Senegalese zebu-type Gobra breed and their cross-bred, commonly called Macha or Djokeré. Each breed was evaluated by ranking it for six predefined traits. These traits were animal size, milk yield, calving frequency, traction ability, ability to cope with hunger stress and disease resistance and were chosen based on previous study outcomes.

One to five shells could be placed in each cell of the matrix, where on the horizontal axis the cattle breeds were illustrated and on a vertical axis photographs symbolized the traits. Descriptive statistics was based on commonly-available software packages.

The diagram below depicts the matrix rating results. In comparison to the zebu-type Gobra, the N'Dama received far higher ratings for its adaptation to dry season stress, disease resistance and traction ability. The zebu-type Gobra, on the other hand, received lowest ratings for disease resistance and ability to cope with dry season stress, but was highly valued for its size and milk yield.



Cattle owners also expressed their general preference for the N'Dama breed and clearly established the important role of the N'Dama as a multi-purpose animal within the farm-household. Nevertheless, animal size and milk yield also mattered and were ranked as criteria of high priority in the selection of breeding stock. A preference conflict became apparent, which cattle owners had to solve. It was then not surprising that cross-breeding of N'Dama and Gobra cattle was found among the options in traditional breeding strategies.

Institution Analysis

Taking into consideration that animal breeding activities have an important social dimension and depend by their nature to a large extent on structural and human capacities to coordinate and interact, an assessment and evaluation of the role of local institutions and organizations in livestock breeding was carried out at the community level. A practical, action-oriented approach for the analysis of local institutions in combination with the participatory technique of institution diagramming was utilized.

Cattle owners described the relative importance of institutions, their functions and the degree of interaction among individuals, the community and the institutions and organizations relevant to their cattle enterprise. The analytical process was assisted through visualization by depicting the institutions, organizations and their linkages in diagrams.

The institution diagramming revealed that herd owners face difficulties to obtain good quality breeding stock. High risks were associated with the purchase from animal traders, because loss due to disease wss frequent. Competition among herd owners was identified as a problem. Information was usually not shared and breeding knowledge only passed on within the larger families. The organizational level of cattle owners was relatively weak and few traditional institutions were perceived to function well.

Conclusion

The use of participatory survey techniques, as part of an appropriate methodology to assess traditional breeding systems, was found to be very useful in gaining better insights into the prevailing production systems and the related breeding strategies. It was vital in promoting the involvement of the livestock-owning communities in AnGR management activities.

The consideration of the existing local knowledge base and traditional breeding practices for better AnGR management and continued use of local animal breeds could not be overemphasized. Where the aim is to support and strengthen local breeding endeavors, participatory techniques can be successfully combined with the collection of quantitative data necessary for more formal breeding approaches.

It was demonstrated that in traditional livestock systems, very rational breeding strategies are defined and implemented. Local breeders realize clearly-defined breeding objectives (the need for adaptation and disease resistance) reflected in preference for the local N'Dama and selection for such traits.

Two essential outcomes of the study have been the information that a considerable demand for certified quality male breeding stock exists in the project area and that additional resources will have to be invested in strengthening local institutions and breeders' associations.

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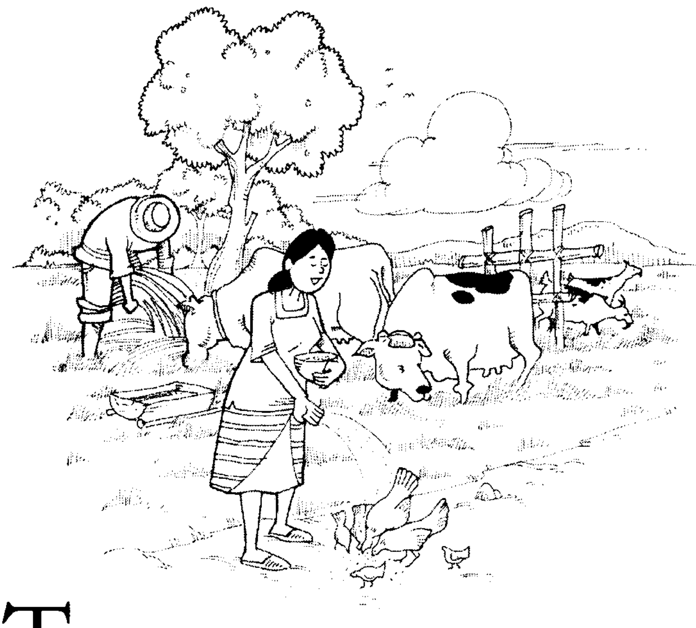
16

Livestock Breeds in Traditional Animal Genetic Resources Management



To appreciate the role that traditional communities play in the conservation and management of animal genetic resources (AnGR), it is important to understand the social institutions and cultural traditions that define the animal management choices available to farmers. Indeed, social and cultural forces are often the most important factors in diversifying livestock (and livestock production systems) and in developing distinctive breeds.

Social and cultural factors influencing the decisions of a farmer include:

- traditional livestock management practices;
- the role of livestock in culture and livelihoods; and
- the ethnic or community identity to which the farmer belongs.

The value of a breed in the lifestyle or identity of a particular social group is what encourages its maintenance. Breeds may have specific, unique traits valued by the community that are not obtained from other 'exotic' animal populations. Breeds may also be valued because of their place in local traditions because of:

- their use in religious or other cultural ceremonies;
- for production of products valued in traditional meals; or
- medicinal practices requiring specific qualities.

In its strictest sense, a breed designates a closed or partially closed population. Mating pairs are drawn only from within the population and relationships among individuals are documented. Members of a breed have developed under the same selection pressures and share common ancestry. To be successful, they must constantly change in response to changes in societal needs as reflected in market demand. The change is achieved through selective breeding as well as 'injection' of bloodlines from other breeds. However, for a population to retain its identity as a breed, there has to be less gene flow from outside relative to matings among members of the breed.

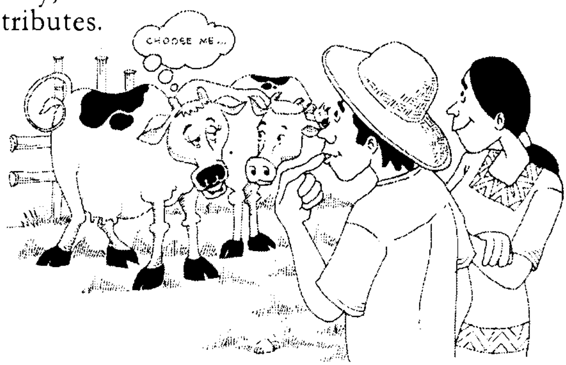
Social organization and institutions in a community can influence farmers' access to, and management of, household and community level resources, affecting their action regarding the farm AnGR. For example, land tenure and ownership systems vary between and within communities in terms of: private or communal ownership; equitability of distribution; size and number of parcels of household land; and intra-household access to land. A farmer's landholdings and how they are distributed, their sizes and quality may influence decisions about breed choices and allocation of land area among breeds.

Traditional Breeding Goals and Objectives

In comparing the evolution of western agriculture versus that of developing countries, one often encounters the statement that the present day animal (and crop) genotypes (breeds, strains, landraces) in developing regions are predominantly a result of natural selection. On the other hand, those in developed countries are a product of "many generations of artificial selection." This is a misconception.

For centuries, farmers in the traditional sector everywhere in the world have used, for selective breeding, phenotypic features, such as:

- physical characteristics;
- measures of yield;
- product quality; and
- adaptive attributes.

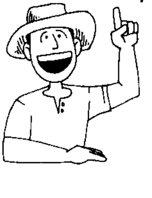


These phenotypic characteristics are used to identify or distinguish breeds. They are often the basis for the names farmers give to specific animal types or strains, usually within a range of animals of a particular type or breed owned by the broader community. Thus, the large diversity of coat color patterns in the Nguni cattle of southern Africa are classified by the Nguni herders into an elaborate system of names. Each refers to a set of color combinations. Phenotypic characteristics are also used in designating preferred or valued traits and as 'criteria' for making selection decisions to achieve selection goals.

Breed as a Unit of Genetic Diversity Measure

Recognizing the names farmers give to animal populations is important because the "farmer-named population" is the unit that farmers manage and use as basis for selection decisions. The name or description of a population as used by the farmer may not only be related to physical characteristic(s), but could also relate to the original source of the breeding material. Both names and traits, which define these names, may also be related to the biological performance (e.g., egg production, size, shape, color, milk yield or quality, aspects of adaptation, etc.). Farmers perceive these attributes at various stages of animals' growth and development.

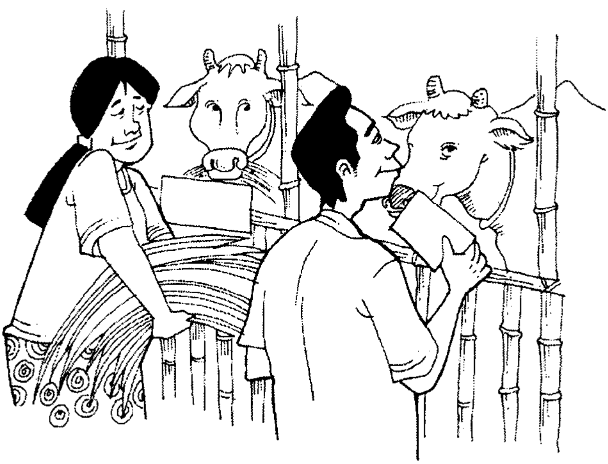
Livestock populations developed in different socio-cultural, ecological or geographical settings will become genetically distinct as a result of genetic drift and differential selection pressures, natural and artificial. This is true, provided they have been reproductively isolated from other populations developed under different conditions. Thus, the indigenous livestock from different regions of the world should probably be assumed a priori to represent different "breeds." It seems clear that populations with different adaptational characteristics or possessing unique physiological characteristics should be recognized as different breeds. Even if the populations are relatively closely related based upon measures of genetic distance, this distinction should be drawn.



Clearly, the traits, which farmers use to identify a 'breed' may be complex and are always deeply embedded in the culture and tradition of the community. Any attempt aimed at improving or conserving the breed has to understand these complexities and they must be taken into account when developing the intervention strategies.

Consistency in Names of Breeds/Strains

Farmers may or may not be consistent in naming and describing breeds or strains. It may happen that even within a village or community, different clans or families have different names for what is essentially the same breed or strain. This may be due to differences in valued traits, functions or other phenotypic characteristics or use of names linked to origin of the germplasm, separately or in combination with valued characteristics. To the extent that these are important not only in understanding the evolutionary history of the genetic diversity in the breed, but also as an input in formulating AnGR management strategies relevant to the communities, it is crucial that any discrepancy in names be discussed and reasons for differences understood.



It is very interesting that, in Africa, for example, present day breed names assigned by scientists, tend to have geographical connotations with names of tribes or ethnic communities. This 'naming system,' provides a useful analytical basis for broader environmental and cultural links to animal diversity. However, it over-simplifies the situation and ignores potentially important subtleties at local levels, which could provide insights into the historical breeding systems that have shaped existing genetic diversity. Thus, any study aiming to understand breeds, as they exist today, must include on-farm surveys designed in such a way that the indigenous knowledge by local communities can be captured, analyzed and subsequently used in designing AnGR management initiatives.

Nonetheless, the influence of local environments and, most importantly, the artificial breeding efforts of the diverse communities (which own the breeds) must be considered.

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17

Traditional Practices on Animal Genetic Resources Management

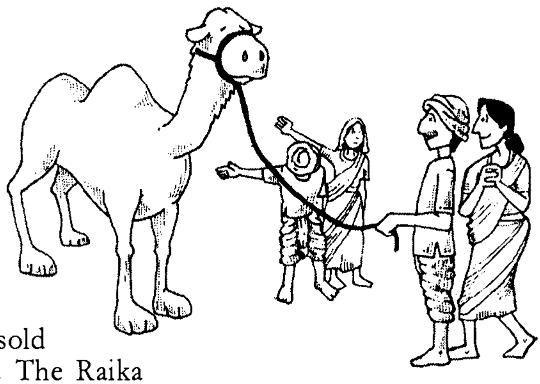
Most local livestock breeds in rural environments are products of a community of breeders. This community of breeders lives in the same area, keeps and breeds animals for a specific purpose and exchanges animals mostly among themselves. The manner by which people utilize and breed their livestock is determined by their cultural norms.

In some traditional groups, breeds are often associated with a specific ethnic group. In East Africa, the Somali, Rendille and Gabbra keep camels mostly for their milk, but do not use them for riding. In Arabia, camels are used for everything - meat, milk, transportation, racing.

In India, the Raika pastoralists breed camels to sell them as transport animals. They do not eat camel meat and even the sale of camel milk is traditionally taboo. Because these groups breed camels for different purposes, the breeds they have developed are also very different, in terms of production, and also in the way they look.

Some Traditional Practices

Livestock can be Considered Communal, or Private Property



In many livestock dependent societies, animals are regarded as assets of the community as a whole that must be maintained for future generations. As such, local custom dictates that female animals should not be sold outside the community. The Raika pastoralists follow this rule for camels and sheep. Camels traditionally change ownership only when they are given as marriage gifts of the bride's family to her in-laws. For sheep, this rule is no longer followed strictly. Elder Raikas sometimes attribute droughts and other natural calamities to the Gods being angry, because some community members have started selling female sheep.

Ritual and Social Aspects

Ritual and social aspects can be important reasons for continuing to keep certain breeds that have become economically unviable. An example is the Muturu cattle from west Africa which is not affected by trypanosomes and therefore a valuable genetic resource for tropical livestock

breeding. It is also resistant against ticks, environmental stress and has low feed requirement. The milk that it produces is used for medicinal purposes. Once widely distributed across the whole Sahel belt, it is being gradually replaced by the more productive Zebu cattle. The main reason why it still exists is the fact that it is regarded as sacred by many pastoral communities and is used in ceremonies.

Keeping a Mix of Breeds

To ensure survival in adverse conditions, many pastoralists keep a mix of breeds. For instance, the Raikas keep several sheep breeds. The Woodabe in Niger keep two breeds of cattle, the Awazak and Bororo which differ in their production potential and their ability to handle stress.

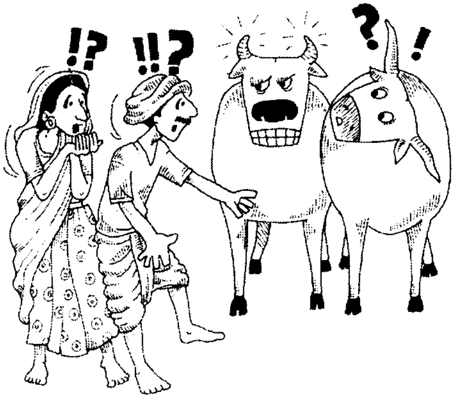
Breeding Strategies of Pastoralists

Pedigree Keeping

They often keep mental records of their animals' lineage and their specific qualities. The Maasai group their animals into different lineages consisting of all the animals descended from one particular cow. Similarly, the Raikas also give the same name to all the females of one particular line.

Selection Criteria

Breeders select their animals for their physical attributes, unique qualities, behavior and performance. Certain types of color or combinations maybe considered lucky. Certain horn forms may be regarded as pleasing to the eye.

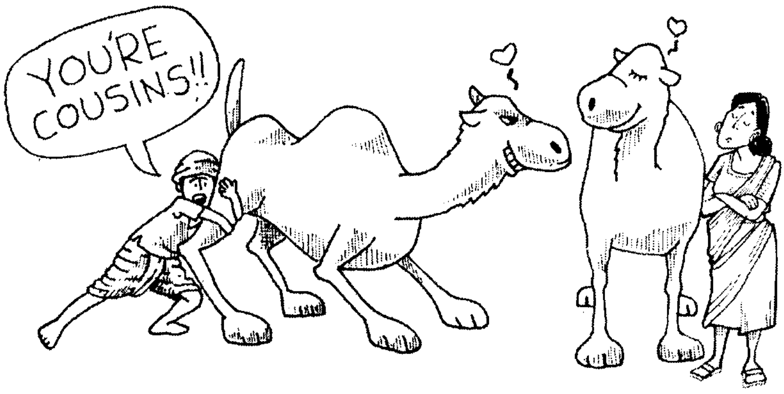


Offspring Testing

Some pastoralists, such as the Somali and the Raikas may restrict the use of male animals until they have known what the offspring is like.

Avoidance of Inbreeding

Breeding communities vary in their attitude towards in-breeding. The Raikas avoid in-breeding, as they consider it a sin to mate a male animal with his female relatives. They exchange their male breeding camels every four years. But some pastoralists do not see any harm in in-breeding.



Castration

Male animals not selected for breeding are often castrated to prevent them from producing offspring (and also to make them easier to handle and use for work).

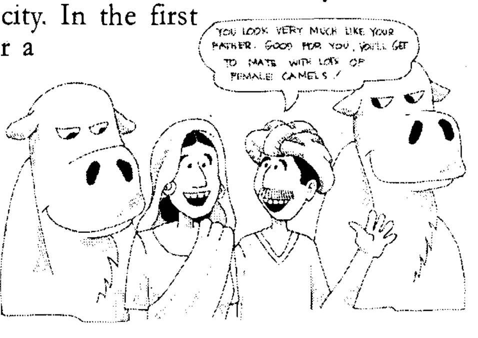
The Raika Experience

Camel Breeding

The Raikas are a Hindu caste in Rajasthan who are regarded as the largest pastoral group in western India. Camel breeding is their hereditary occupation. With the changing market demand, eventually, they have also taken up sheep, goat, cattle, buffalo, and even donkey. The Raikas provide an important service to farmers and rural poor by providing draught animals (camels and bullocks), as well as cows with good milk yields.

The Raikas keep oral records of genealogies, tracing the ancestry of their herds in female lines. Every animal has a name and a female camel is usually named after its mother. The sale of female camels to anybody outside the community is against traditional customs (although this is now starting to change). Female animals used to change ownership only at the occasion of marriages, being sent as dhamini when the bride joins her in-laws.

Selection of male camels is done with utmost care, although, due to economic constraints, not all breeders can afford to use the highest standards. Features such as the looks, size, color, temperament and milk yield of the mother and other female relatives are taken into account. Male animals who produce calves that look similar to their father are regarded as "strong" genetically, and therefore preferred as breeders. If one owns a good quality male camel, he/she is obliged to make it accessible for female camels to be mated. Some breeding bulls can attract hundreds of females, clearly exceeding their service capacity. In the first year, its services are only for a limited number of females, but if it produces quality offspring, then it is used more extensively. In order to prevent inbreeding, the bulls are changed every four years.



Sheep Breeding

Most of the sheep are kept in migratory herds. The Raikas distinguish a large number of different breeds and strains but their classification system shows little overlap with the scientific one.

Keeping a mix of geno-types enables the Raikas to optimize both good and bad years. Breeding rams are selected with great care and only those from excellent mothers are considered eligible. They are singled out as lambs and then given special care. The rams are prevented from breeding during certain times of the year to ensure that lambs are born only during favorable seasons. They are also exchanged with other herds in regular intervals to avoid inbreeding.

For decades, the Sheep and Wool Department of the Government of Rajasthan sought to upgrade the local breeds for prolificacy and wool yields by crossbreeding with exotic rams (Rambouillet and Merino). But due to high mortality, problems with feed supply and other factors, these measures failed to achieve a significant impact and the Sheep and Wool Department was finally dismantled.

> The Boti breed is drought and disease resistant and can survive in the most scorching temperatures. While the Bhagli breed is less resistant, but has higher production potential and gives better yields during good years.

The Raikas are astute breeders and adapt their breeding goals to market situations. In the current economic scenario, with the abundant supply of wool, especially of the coarse carpet type, it makes no sense to produce more wool. So, they purposely purchase rams with desired characteristics from far-flung areas, such as the long-legged animals of the Dumi breed from Gujarat, to improve meat yields. Because there is a chronic shortage of milk in the villages (most of it is transported to the cities), some Raikas have begun selecting for the purpose of increasing milk yields as well.

Goat Breeding

The Raikas raise two breeds of goat. One is the "black" or "Marwari" goat, which is highly adapted to drought but has a fairly low milk yield. The other one is the spotted/piebald Sirohi goat, which, in turn, is a good source of milk.

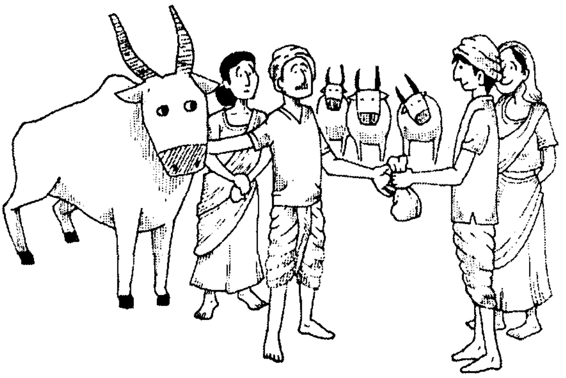
In the 1980s, the Government of Rajasthan and the Swiss Development Cooperation initiated the Indo-Swiss Goat Project, which sought to enhance the performance of local goats by artificial insemination, with semen from imported bucks. Field performance record revealed that the crossbred goats were not superior under the given conditions. The project was reformulated to concentrate on selective breeding within the Sirohi goat.

Cattle Breeding

The Rebaris have also developed the Nari cattle breed, which is locally famous but scientifically as yet unrecognized. This breed is highly resistant to diseases and drought, with reasonable milk yields and good draught qualities.
Nari cows produce 4-8 kg of milk per day, depending on the feed quality, in addition to nurturing their animals or oxen. Their milk has a high fat content and is used for the production of mava - the base of Indian sweets. The male calves are used as work animals by local farmers.

The large breeding herds are kept in migratory systems. Milking and late pregnant cows are left behind in the villages while the rest are taken on long treks to Gujarat or Haryana, returning only during the rainy season. Cows may be sold while on migration and many male calves are purchased by Bhats (a caste specialized in trading cattle and salt) who castrate them and then sell them in other areas, especially in the Mewar region of Rajasthan. This breeding system provides a valuable supply of good draft animals or milking cows.

Maybe because the Nari breed has so far escaped the attention of animal scientists, it has fared better than the officially recognized breeds. Most of these have been subjected to crossbreeding with exotic breeds and hardly exist in the pure form.



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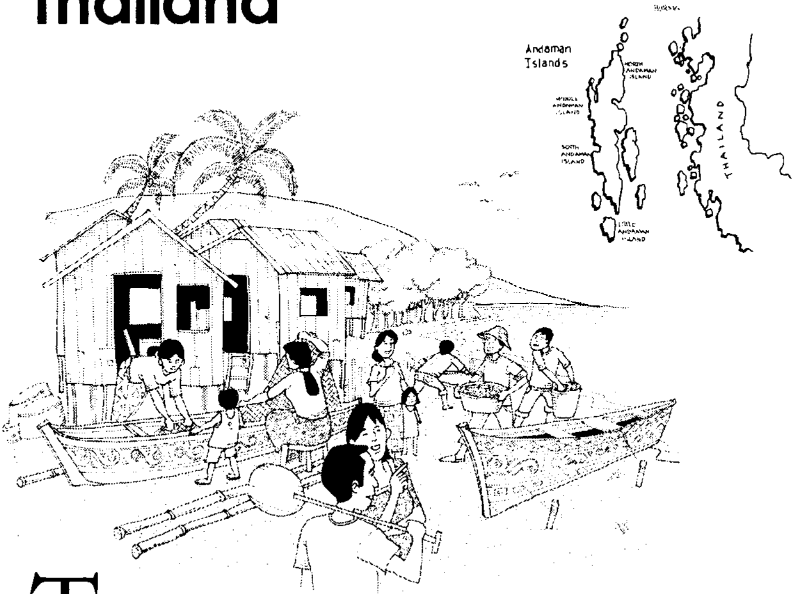
Andaman Fisherfolk Community and Biodiversity Management, Thailand



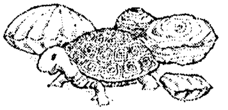
The western coastal line of Andaman Sea (from Ranong province to Satul province in Thailand) is 937 kilometers in length and is rich in biodiversity. It consists of diverse ecosystems such as: coastal line ecosystem, mangrove area, sea grass ecosystem, and coral reef ecosystem. Its mangrove area consists of diverse trees and plants, including parasitic animals. On the other hand, its coastal ecosystem is composed of highly diversified types of fishes.

> Some aquatic animals such as small fish (kao and tuna) live along seaweed coastal lines while young. On the other hand, other aquatic animals live there all year round.

Coral reef and seashore ecosystems have lesser diversity compared to the others. However, these are rich in natural resources with 183 types of coral reef found in Phuket Island. The coral reef area is the habitat of aquatic animals such as sea slug, sea porcupine, giant clam, top shell and big head prawn.

Different types of turtles that live along the seashore
- hawksbill turtle
- red eye turtle
- weed turtle
- carambola

Aside from turtles, various shell-type animals are also found, including,
- surf clam;
- oyster;
- bivalve mollusk;
- ark shell of the genus Arca; and
- asidula clam.



Importance of the Andaman Sea Ecosystem

The ecosystem of Andaman Sea, particularly its mangrove area, plays important roles, among which are the following:
- It serves as wind break and protects soil erosion along the sea line.
- It serves as sea trap preventing wastes and chemicals from flowing to the sea. The long and complex roots of the trees are good for trapping and the sediments trapped at the mangrove area become new land.
- The extracts from trees such as alcohol, citric acid, oil and tanning, are used in the coloring industry, and as drugs.

Local Knowledge and Practices that Promote Conservation

Before 1962, there were few houses along the seashore of Andaman. And even though the aquatic resources are rich, local people preferred upland rice farming. They planted coconut, mangoes and kapok.

Fishing was done solely for home consumption as there were still no market and trading opportunities in the community.

However, in 1955, the government promoted the fishing industry through various campaigns, including:

- the introduction and development of trawl;
- the establishment of "Sapanpla (fish bridge) Organization" which serves as central market for aquatic animals; and
- the promotion of fishery industry (i.e., canning seafood, ice making, ice room).

Its promotion boosted the country's export of aquatic animals to the world market, becoming one of the world-leading exporters. The market for expansion opened opportunities for fisherfolks living along the Andaman coastal line and islands to develop, adapt and invest in modern fishing gears.

At present, fishery in Andaman is still considered small-scale, although fisherfolks now use bigger boats and motors like long tail boats called "Hua Tong" (14-20 meters). In some cases, they use smaller boats with paddle or peat boats. Small and cheap fishing gears such as cast net, fishhook, and crab trap are used.

Nowadays, fisherfolks use more than 30 types of fishing gears. Each is designed to adapt to the nature or habitat of each animal. Although local fishing is strongly tied with commercial fishing, methods are different:

- Commercial fishing addresses the importance of developing fishing gears and new technology for the purpose of catching more aquatic animals.

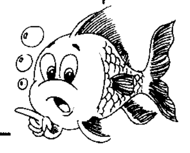
- Local fishing pays importance to the development of knowledge and experiences learned from the nature of aquatic animals and the sea. Knowledge learned is used and adapted to the complexity and diversity of natural resources rather than to compete with nature.

Threats to Biodiversity Conservation

Although traditional fishing complies with and is suitable to the ecosystem and biodiversity in the coastal area, marine resources are still in danger due to the following reasons:

Traditional Fishing
- traditional fishing gears catch only a small number of animals

Commercial Fishing
- can catch many animals (big and small) in just one fishing
- destroys coral reefs, rocks and seaweeds



The Intrusion of Commercial Fishing, Especially the Use of Push Net and Other Destructive Fishing Gears

This method has a capacity in catching all aquatic animals in the shortest time. However, it destroys breeding areas of marine animals (i.e., coral reef, seaweeds and rocks).

The Use of Light Bulb Boat to Catch Anchovy

This boat has a higher capacity to catch fish compared to the push net. It attracts and collects all types of fish within one kilometer and also destroys breeding areas of marine animals.

Use of Illegal Fishing Gears

Some small push net boats use poison or bombs, killing all aquatic animals within range.

Conservation Activities to Protect and Restore Biodiversity

The destruction of marine resources directly affects local fisherfolks seriously. Some had to quit fishing and work elsewhere. However, most of them sought alternatives to respond to the illegal activities.

- Fisherfolks grew trees at mangrove forests to make artificial coral reef, and to mark the seaweed line for protection.
- Communities implemented all activities in coordination with the local government and the public in order to support local communities in protecting marine resources.
- The fisherfolks' group/association patrolled the sea to catch illegal fishing boats entering the conservation line. They formed groups with representatives from the local community and government offices.

Need for Policy Support

- The government should honor community rights on coastal resources and sea management, especially mangrove forests. At the same time, it is necessary for the fisherfolk community to be involved in policy-making and related laws, such as Fishery Laws.
- The government should review the policy that addresses the export of aquatic products because it destroys marine resources and biodiversity along the coastal line and the sea. Likewise, the government should address the importance of local markets and the survival of the long-term domestic economy of the local fisherfolks including middle and small-scale fish business.

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System Dynamics

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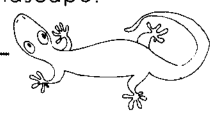
The Management of Forest Biodiversity

Forest biodiversity values can be obtained from many types of land and through different forms of management. Indeed, obtaining many of these values will often require multiple land and management types at the landscape level. Forest biodiversity is not just about setting aside protected national parks, it is about landscape management (and very often by the people who live in, and maintain, the landscape).

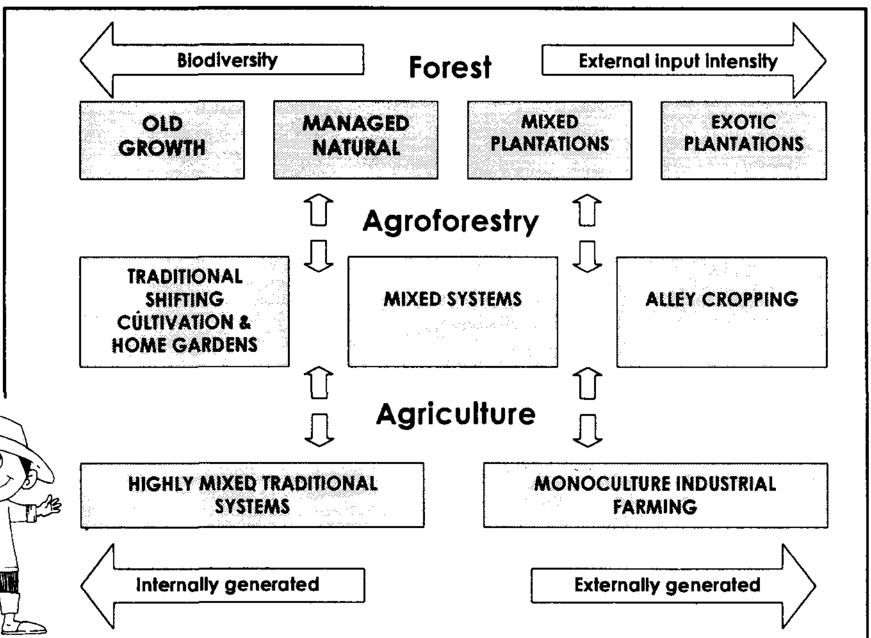
Forest biodiversity is not just about setting aside protected national parks, it is about land-scape management -- and very often -- by the people who live in, and maintain, the landscape.

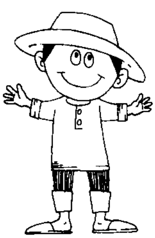


Many types of land provide **'forest biodiversity'**. Sustainable development involves maintaining at least a constant level of capital and passing it to future generations. But the mix can change, reflecting society's evolving demands for natural, physical, financial, social and human (individual) capital. Some capital elements may be considered critical and their conversion non-negotiable - national parks are a clear case.

Biodiversity values cannot be fully secured within protected areas because development will continue to entail a global-scale, but partial, forest conversion process resulting in a spectrum -- or continuum -- of land use from which forest biodiversity can be obtained (Figure 1).

Figure 1. Land Use Spectrum.





Different degrees of land management also provide 'forest biodiversity'. There are three main elements of forest management which contribute to biodiversity conservation:

- protecting forest;
- sustainable use of forests; and
- agroforestry.

The last assumes many guises - from partial conversion of forest to mixed tree-based systems, to the creation of tree-based systems from cleared land. In many of them, food production is key and food security goals will need to be integrated with biodiversity goals, therefore, both livelihood and bioquality perspectives are required. A fourth option -- total conversion -- cannot be said to contribute much to forest biodiversity. The land management options are outlined in Table 1.

Table 1 is obviously a simplification. The outcomes and success of any one component of land management are not independent. Successful management of biodiversity depends crucially on the landscape-scale matrix, degree of interconnectedness and overall balance among different components. For example, protected areas are subject to many influences from the surrounding agroecosystem or buffer zone. These may be mitigated by having larger reserves which minimize edge effects, by more sensitive management in the surrounding buffer zone (sustainable use or partial conversion) and by the creation of 'corridors' between reserves or forest fragments.

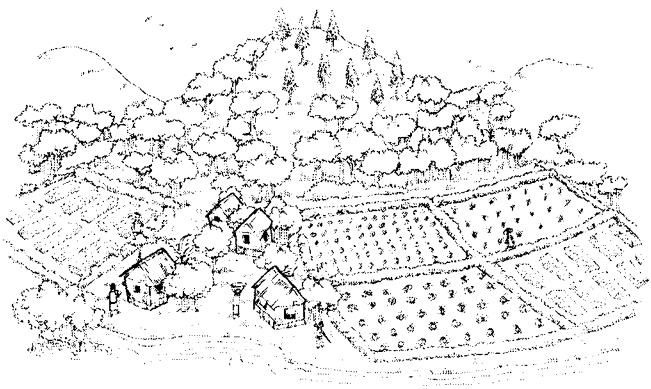


Table 1. Land Management Components and Forest Biodiversity

	Protection	Sustainable use	Partial conversion	'Total' conversion
Land management component	Protected areas (national parks and other biological reserves)	Natural forest management for timber and non-timber forest products (forest and extractive reserves)	Agroforestry, for example, bush fallow shifting cultivation, forest gardens, forest hyper-fragments in agroecosystem Fencelines, hedgerows and tress on farms	Commercial agriculture Monoculture plantation forestry Degraded lands
Bioquality maintained	High - very high But always subject to edge effects which increase as reserve size decreases	Moderate - high Not a substitute for protected areas Consumptive and/or productive use values dominant - timber and NTFPs	Low - moderate A variable and potentially significant but as yet largely unqualified subset of forest biodiversity	Very low Small, or very small subset of heavily used 'specialized' (domesticated) species at the expense and (threatened) extinction of remaining species except ruderal weeds
Realization of values	Characterized by non-realization of direct biodiversity values	Information-intensive approaches	Direct use values dominant (often subsistence), but may include culturally important indirect use values	Direct (income - generating) values dominant Indirect values often compromised Intensive use of (external) inputs

	Protection	Sustainable use	Partial conversion	'Total' conversion
Management inputs required	Protection - minimize outside interference, ecological restoration measures in disturbed areas and park surrounds	Maintenance of permanent forest area Extensive, fine-grained protection/ zoning; sustained yield management and/or local technical knowledge and rules	Integration with multiple livelihood systems is typical Diverse, usually small-scale; 'wild' undomesticated and incipiently domesticated Driven by farmer needs for security, risk reduction and seasonal considerations	Driven by forces of specialization, for example, economies of scale, product standardization Reliant on domestication Relatively high revenues feed the system

It is increasingly accepted that even large-scale intensive commercial agricultural and forest plantation systems may benefit from, and increasingly also depend on, an appropriate balance of converted and natural or semi-natural habitats in the local landscape for pest management and environmental amelioration. Swedish forestry companies, for example, practice **'ecological landscape planning'**, effectively zoning the production of various forest values according to landscape capabilities, resulting in mosaics of natural and planted/intensively managed forests. Similar approaches can be seen in the recent spread of plantations in Brazil, however, it tends to result in over-representation of riverine and steep-slope sites, as these areas are the least commercially viable to plant.

In this context, we need to consider a third level of approximation to our rules relating use to bioquality: that the scale has a strong compounding or diminishing influence on disturbance, i.e., even the removal of forest for farms is not irredeemable, providing there is time to recover and biodiverse remnant stands nearby. For instance, the amount

of time available and the proximity and density of remnants is related to the degree to which the temporary farm could be considered a **'sustainable use of the forest'** (in the way that cleared patches of rotational shifting cultivation are increasingly accepted as sustainable). In general, however, human time preferences and spatial frames are too limited to accept the whole-scale removal of more than a few tens of meters of forest canopy as sustainable use of 'hot-spot forests'. This is why forest parks in the past have been managed as pristine areas. There are a few exceptions, and some disproportional vocal supporters of these exceptions.

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Adapted from: IIED. 2001. Living Off Biodiversity. International Institute for Environment and Development, London.

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Assessing Crop Diversity in Rice-based Agroecosystems
An Example from Vietnam

Community-based assessment (CBA) consists of a set of tools to assess crop diversity and related socio-economic factors at **household** and **community** levels. It involves participation of a panel of core villagers and individual farmers. CBA encourages community initiatives by involving farmers and concerned stakeholders. Their participation in the planning, implementation, monitoring and evaluation of agricultural biodiversity conservation increases awareness and sustainability.

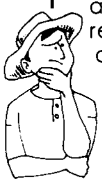
Objectives of CBA

- To sensitize and increase participation of farmers and concerned stakeholders in a community initiative for agricultural biodiversity conservation.
- To gather information on crop diversity and related aspects for assessing, planning, monitoring and evaluating on-farm conservation of crop diversity.
- To generate group understanding and collective decisions on crop production, management, and promotion of crop diversity.

In conducting a CBA, a set of detailed guidelines to assess a particular set of crop diversity subtopics, is formulated.

Steps in Conducting a CBA

The panel of core villagers, consisting of 12 - 15 members, are individuals who assume influential roles in community activities, community groups, sectors and organizations. They are village leaders, farm-crop experts, experienced farmers, agri-service farmers, representative from agricultural cooperative, Women Union and Farmer Union.



1. Preparation

- A trained facilitator and data encoder is made available.
- Guidelines and guide questions for crop diversity assessment at community level and a semi-structured interview questionnaire for households are formulated.
- Visual aids and data records containing lists of particular questions, subtopics, or a matrix for two ways of selection are made.

2. Discussion with community leaders or partners

The main concern at this point is to formulate objectives and design CBA and schedule activities.

3. Selection of target participants

A discussion with community leaders and various sectors of the community is held to determine target participants and criteria for selection of the core villagers. Community leaders are allowed to identify and involve community people who fit the criteria. However, biases in the selection process should be avoided.

4. Assessment

This can be done through a workshop. Workshop activities for each subtopic may include the following:

- Review current status by using various sources of information and data collection, such as available/ statistic records, by community leaders. The primary data are supplemented by key informants or participants.
- Define changes in particular factors by comparing quantitatively or qualitatively between the current measure and itself, at a defined point of time in the past. A *recall process* may be stimulated and facilitated using visual aids.
- Group consolidation, synthesis and decision-making.

Participatory Tools Used During a CBA Session

Brainstorming

Members of the panel take turn in sharing their ideas on the topic or question that is currently the subject of the assessment. The facilitator encourages participants to react to the topic or question, and to the responses of other participants as well.

A sample question and answer process during a CBA session to determine changes related to rice varieties at village level

Step 1. Show topic "Rice Varieties in Village"

Step 2. What rice varieties are being grown?
The group comes up with a listing of rice variety names.

Step 3. How many households grow each of these varieties?
The group reviews variety by variety for data.

Step 4. Which areas grow each of these varieties? Are there available records on the area?
Add variety data that were not recorded.

Step 5. Consolidate the data shown.
Group reviews data for its validity.

Step 6. Characterize each of the rice varieties in the past five years.
Group reviews variety by variety for data.

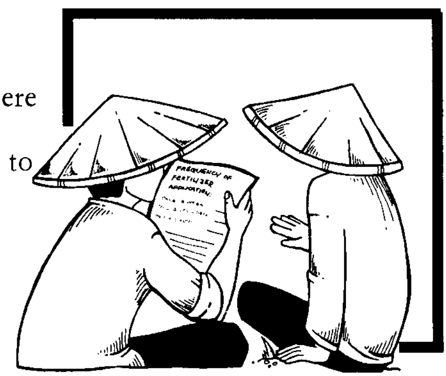
Step 7. Was there a significant difference?
Group rates any significant difference.

Step 8. What contributed to the change, if any?
Brainstorm for information.

Step 9. Group consolidates information.

Collective Rating

It is a group evaluation where a change or a factor was collectively rated or scaled to describe the extent of the variation.



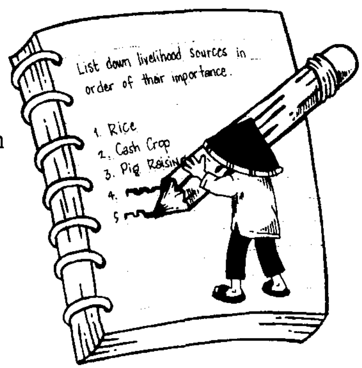
Sample outputs recorded in clip chart papers during a CBA session

Information	2001	1996
Rice production/hh	2 ton	=
Cash income/person/mo.	100vn$	-
Electricity supply	85% of households	NA
Importance of rice	1st	1st
Importance of cash crops	2nd	3rd
Importance of pig raising	3rd	2nd
Variety A: No. of households	50	--
Growing area	200 Sao	-
Variety B: No. of households	5	+
Growing area	50 Sao	++
Drought plots	10%	++
Irrigated plots	70%	-
Deep-water plots	20%	=

Note: =; +/-; ++/--; and NA refer to equal; higher/lower; much higher/much lower; and not applicable respectively. Sao is local area unit equivalent with 500 sq. meter.

Collective Ranking

This is used to identify and put into an order various problems, contributions or factors according to the given criteria. Ranking is different from rating as it focuses on the order of importance or priority of various factors.



Historical Transect

This tool makes use of a pictorial representation of socio-cultural conditions using variables such as land use, vegetation (varieties), aquatic resources and income among others. In specific cases, it is used to analyze the changes in coastal rice-based agroecosystems associated with the replacement of traditional varieties with the modern ones. Likewise, it is used to analyze relationship between taro expansion and pig raising.

Participatory Mapping

In most CBAs, participatory mapping is used as a visual aid and also as data recording sheet corresponding to the topic or question. By deciding what to include, what to delete and how to modify details, participatory mapping encourages villagers to draw a model of their village including where and how resources are located. In particular studies such as on-farm conservation, it helps identify available crop genetic resources, origin, location, flow and which household type conserve the diversity. Among the maps often used are seasonal calendar, daily activity diagram, social map, transect map and resource map.

Farmers' Characterization and Variety Classification

This is a participatory tool to identify farmers' knowledge of crop varieties. A farmers' workshop may be supplemented by a field activity. In the coastal rice-based areas of Vietnam, the farmers' perception vary among genders or groups. During the farmers' workshop, targeted groups (gender or group) have separate sessions. The participants are asked to list and characterize the varieties. They then consolidate the characteristics given and categorize them into, for example, morphology, use, productivity and quality. The characteristics of the different varieties are identified and determined through a process of brainstorming followed by group

discussion and collective consolidation. The variety descriptions may or may not be among the variety characteristics described during characterization.

Participatory Evaluation of Field Crop

This activity may be combined with the variety characterization, to evaluate performance of varieties, and a technical application using farmers' criteria. In particular, on-farm conservation studies have been applied to evaluate rice varieties which were redistributed according to farmers' preference, and to evaluate farmers' technical trials adding value to traditional rice varieties.

Community Diversity Competition

By giving a prize and recognition to selected farmers or groups, the community is able to promote crop diversity. The core villagers are facilitated to design a community competition among farmers or groups. They set up criteria for selection of the winner(s), prepare for the activity and organize the evaluation. Simple initial competition has two sessions: crop sample display and a question-answer test.

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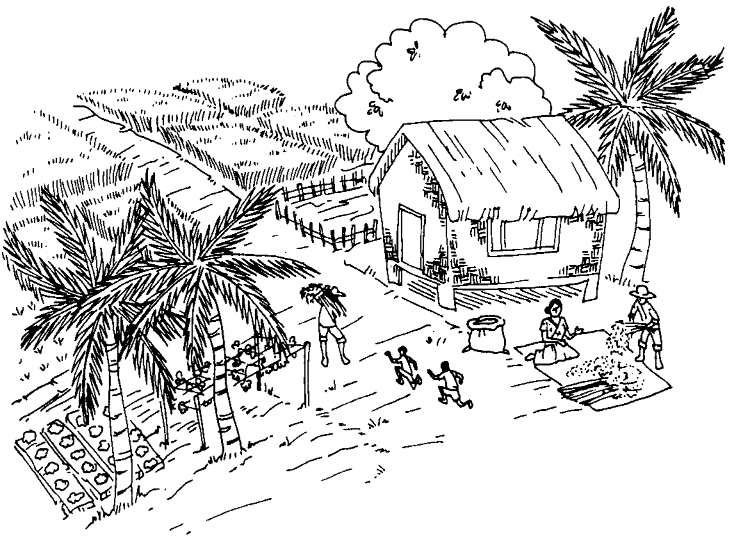
Local Rice Genetic Diversity in Northeastern Thailand



Rice is involved in the way of life of *I-sarn* people in northeastern Thailand and this has merged into their culture and beliefs. For these people, rice is sacred and valuable. Before *I-sarn* farmers can transplant rice, there is a proper ceremony to be conducted, including putting dust in the field, sacrificing to and venerating the goddess of rice. There is also a plowing ceremony and a first transplanting rice seedling ceremony. In harvesting, rice is cremated in a ceremony to show respect to the goddess of rice and earth. Before the farmers store rice in the storehouse, there is a proper ceremony to call back the rice spirit.

All of these related rice traditions, ceremonies, legends, beliefs and relation systems not only illustrate local community and people's way of life but also reflect the relationships between human and nature, as well as human and human. Consequently, this influences local rice genetic conservation and management.

Rice Genetic Diversity

Even though many rice species had already been extinct during the past 30 years, the study of local rice genetic diversity in northeastern Thailand during 2000-2001 revealed that farmers still remember more than a hundred rice species. However, nowadays, only about 50 rices are still grown in the area. A list of the most important ones is shown in the table below.

Thailand Rices with Special Uses

Rice	Characteristics	Uses
Glutinous (*Ee-tom-yai*)	Grain is fat. Variety is highly productive. Late-maturing.	Good for making shredded rice grains and tasty *Sa-tho* (local undistilled alcohol)
Glutinous (*Kaw-khum*)	Grain is rounded. Unpolished rice is dark purple with a fine scent. Medium-maturing.	Good for cooking Thai dessert served in ceremonies and festivals. High price.
Glutinous (*Kaw-khum-kab-bai-dum*)	Grain is rounded. Variety can grow in any soil. Medium-maturing.	Good for cooking Thai dessert served in ceremonies and festivals. Good price.
Glutinous (*Dau-kaw*)	Grain is rounded. Medium-maturing.	Good for cooking popped rice.
Jasmine rice (*Hom-mali-dang*)	Unpolished rice is brown. Medium-maturing.	Popularly grown in Surin Province.
Rice (*Nang-mon*)	Grain is small, slender and aromatic. Late-maturing.	A famous variety. Usually cooked with *Nang-mao*. Believed to strengthen body and cure bone disease.
Rice (*Nang-mao*)	Grain is small and rounded. Soft, tasty and aromatic. Late-maturing, high-yielding.	A famous variety. Usually cooked with *Nang-mon*. Believed to strengthen body and cure bone disease.

Thailand Rices with Special Uses

Rice	Characteristics	Uses
Rice (*Chao-dang*)	Grain small, long, slender, red, fine aroma. Medium-maturing.	A famous variety. Good for *kanom-pad* and *kanom jean* dessert. Believed to strengthen body and bone and build up resistance to illness.
Rice (*Chao-leungoon*)	Grain big and long. High-yielding.	Good for making desserts.
Rice (*Chao-nang-roy-yai*)	With fine aroma when cooked. Grows well in all soils.	Good for making desserts.

Factors that Contribute to Rice Genetic Diversity Conservation

The farmers in northeastern Thailand could conserve local rice species due to several factors and conditions such as the following.

The Suitable Ecosystem for Different Rice Varieties

This is the most important reason for the farmers to choose a rice variety that is proper to field locations. Field locations can be divided into five levels.

- **Slopes of the hill or high paddy land.** The appropriate rice species are medium-maturing varieties, for instance, glutinous rice.
- **Highland field.** The appropriate rice species are early-maturing varieties, harvesting in October, and medium-maturing varieties, for example, glutinous rice.
- **Mire-soil paddy field.** The proper rice species are late-maturing varieties, harvesting in December, for example, glutinous rice.

- **Lowland field.** Most proper rice varieties for lowland field are medium-maturing varieties.
- **Flooding area or deep water field.** The proper rice varieties should have a special characteristic to stretch its height up to the water level. These varieties are usually late-maturing.

The Rice-Eating Culture of *I-sarn* People

Although *I-sarn* people usually eat glutinous rice, different areas have different culture in eating rice. Those in central and upper northeastern, such as Khonkhan, Mahasarakham, Roi-et, and Yasothorn provinces, like to eat tender and fine scent of long-slender glutinous rice, for example, *Hleung-boon-ma*, and *Nang-nuan*. Most *I-sarn* people in lower northeastern, such as Surin, Bhurirum, Srisaket provinces, like to eat small and fluffy cooking rice. Phu-Thai people in Kalasintu province like to eat big grain glutinous rice.

Medical Beliefs

Some people believe that eating some rice varieties is good for health. For example, people in Surin province and lower *I-sarn* believe that *Bong-kasatriya* glutinous rice, and rices such as *Chao-nang-mao* and *Chao-nang-mon* could strengthen their body to work for longer period as well as cure bone disease. On the other hand, some people believe that some rice species such as *kor-khor* rice are so tender and not good for diabetes.

Role of Rice in Festivals or Traditional Ceremonies

Some rice varieties are used for festival or traditional ceremony periods.

Food Security and Labor Allocation

Many farmer families grow a variety of rice, which have different harvesting periods, i.e., early-maturing variety, medium-maturing variety and late-maturing variety to ensure that they have rice supply all year long.

Marketing Demand

Because of economic demands, some local rice varieties have high prices and farmers continue to grow these rice varieties with high demand. The market price condition is a significant factor that affects farmers' decision in planting rice.

Decreasing Cost

Most local rice varieties have high insect/disease resistance. They have high yield and require neither pesticide nor chemical fertilizer. As a result, cost is decreased.

The Farmers' Conservation Consciousness

Some farmers are conscious that all local rice varieties descended from their ancestors who used to grow them. These rice varieties are not supposed to be lost from their rice fields.

Local Rice Genetic Conservation and Development

Since the last decade, the northeastern farmers have collaborated and established the Northeastern Alternative Agriculture Network (NAAN) to seek alternative agriculture systems and improve quality of life. The farmers analyzed the situation and found that the commercial agricultural system, especially exportation, is dependent on outside conditions. Consequently, it became the most important cause of poverty, debt, and other problems.

Many *I-sarn* farmers are still growing different rice varieties to provide for the family and community needs. It is important to adjust the ways of rice genetic conservation and development to make it suitable in spite of social changes as well as local knowledge.

In 1997, the "Local Plant Varieties Improvement and Preservation Network" was established in association with several NGOs. The network's members were from Surin, Yasothorn, Khonkhan, Mahasarakham, and Kalasintu provinces. The purpose of this network is to conserve and improve rice varieties, especially, to provide for community needs.

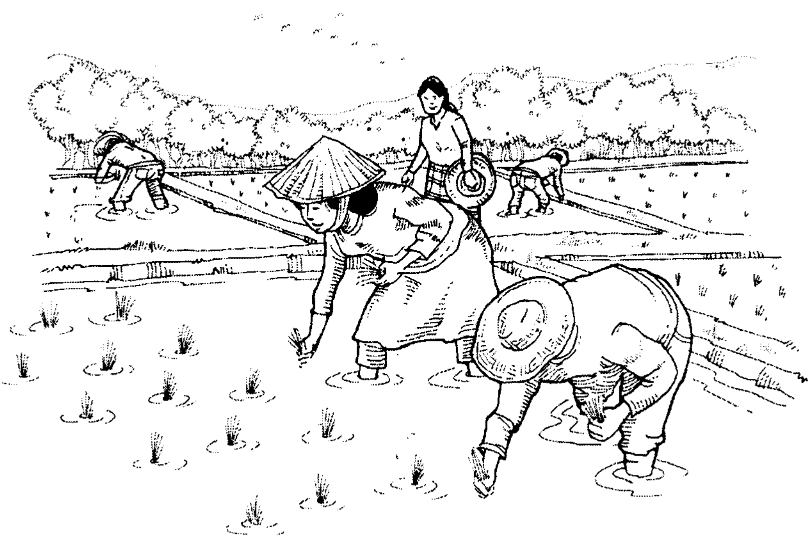
The members of the network developed several alternative systems, for instance, integrated agriculture, agro-forestry, organic farming, and non-chemical agriculture system. They also have recently been aware of and developed local wisdom such as medicinal plant and local food preservation. Therefore, the farmers of the Northeastern Alternative Agriculture Network are aware that local rice varieties are needed to be studied and improved.

The network farmers have recently initiated to survey and collect local rice strains. Based on field experimentation, these strains would be selected, and grown in different ecosystem locations. The network also plans to breed rice to cater to community needs. Both farmers' knowledge and experiences and outsiders' technology can be used to support the goals of rice genetic conservation and development.

Some of the options for local rice genetic diversity conservation and development at the field and community levels are the following:

- The local seed system of farmers should exchange and spread local rice strain among communities and networks as much as possible, so farmers get higher rice genetic diversity.
- The farmers should experiment on participatory crop improvement to conserve and improve local rice genetic-diversity based in-field. The experimentation would be a tangible example to demonstrate and extend to others.

- To proclaim ownership, the farmers should raise awareness and consciousness of local plant species and take action in the field.
- The farmers should record local rice and plant genetic-diversity information for the continuation of conservation and development.
- At all levels, such as field, regional, national and international levels, the farmers should annually meet and exchange local and traditional strains.
- The farmers should establish local rice genetic conservation and development networks, and extend to other local plant genetics as well.
- Indigenous culture and tradition related to local rice and plant strains conservation and development should be revealed.
- The farmers should collaborate to protest against genetically modified plants, and other policies that transgress every community's right to local plant conservation and development.



At the policy level:

- Besides implementing the government agency's expertise, the government should support farmers to implement local rice conservation and development at field levels. Significantly, the local rice conservation and development should be based on farmers' participation, conscious of local culture, beliefs, knowledge and farmer wisdom relevant to local ecosystem.
- The policy that relates to rice and plant genetic resource management should be aware of farmers' and communities' rights. It should neither bring about the overwhelming monopoly of rice and plant genetic nor destroy farmers' or communities' rights.

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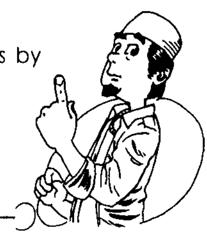
Rediscovering Local Rice for Improved Food Security in Indonesia

Consumption of local rice is a part of Indonesian culture. Rice is grown in each area based on the local geographical condition. For thousand of years, Indonesian ancestors had been successful in producing rice way above their demand.

Facts on Indonesia

Population	• 210 M
Total Width	• 1,919,440 km²
Rice Requirement	• 25 B tons/year and it grows by 3% each year, 95% of the population consumes rice
Rice Production	• 20,000,000 tons/year; production decreases by 6% (BPPS data)



But the change in the agricultural system, for the last 25 years, caused fatal effects such as soil infertility, influx of new pests, impoverishment of farmers, production of rice varieties which are unfavorable for human health (metabolism) and food insecurity among others. As a consequence, there was a negative effect on the economic resources in the villages and cultural changes were observed.

At the national level, such situation caused a scarcity in the rice supply, hence, the importation of rice. The condition can be worse as rice demand in other countries, similarly, increases over the years. Furthermore, data show that the rice sold in Indonesia is of inferior quality. In one case, some imported rice had to be disposed of because two harbor workers died after consuming the contaminated rice.

Effects of Modern Farming System to the Loss of Local Rice

The modern approach to farming, which makes use of chemicals, is considered as product-oriented and does not the answer the problem of food insufficiency. The system even carries with it significant effects on the social, economic, political and cultural aspects of the country.

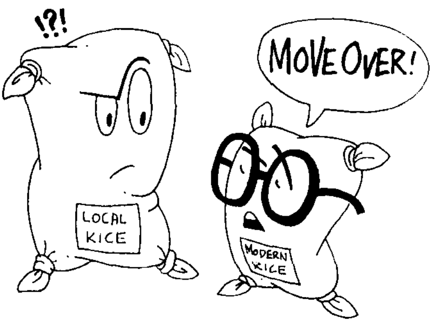
Initially, the result of modern farming was promising. However, after 20 planting periods, it proved destructive. Statistically, the productivity of the rice harvest tends to drop: for Pelita IV - 2.36% per year (1990), Pelita V - 1.94% (1995) and in 1998, the harvest dropped to 6.7% (BPPS, 1998). It was observed that in 1997-2000, the production of IR-64, which used chemical fertilizer, dropped sharply by 50-60% as compared to the production 10 years ago. Ironically, the use of fertilizer has risen sharply from 100 kg to approximately 700 kg, and sometimes even more than 1200 kg. With the drop in rice production, Indonesia was forced to import 75% of the world's rice stock during the economic crisis.

Loss of Local Rice as Threat to Genetic Diversity

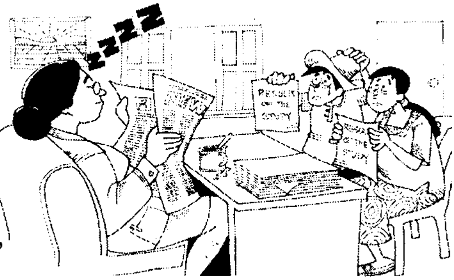
Rice is a major choice for conservation because in Indonesia, monoculture seedlings are being developed. Unfortunately, in 1967, the New Order disallowed farmers to plant local rice varieties (about 7,000 kinds).

However, local rice has more superior qualities than the ones developed through modern agriculture. As a matter of fact, the local rice has several favorable qualities such as:

- better flavor;
- higher production (up to 16 tons/ha);
- nutritional value;
- perennial;
- easy to plant;
- economical (organically);
- longer shelf life (three days) once cooked;
- grains expand substantially when cooked (a kilogram of grains can yield 15-18 plates of rice); and
- medical purposes (stomachache, cough, metabolism acceleration).

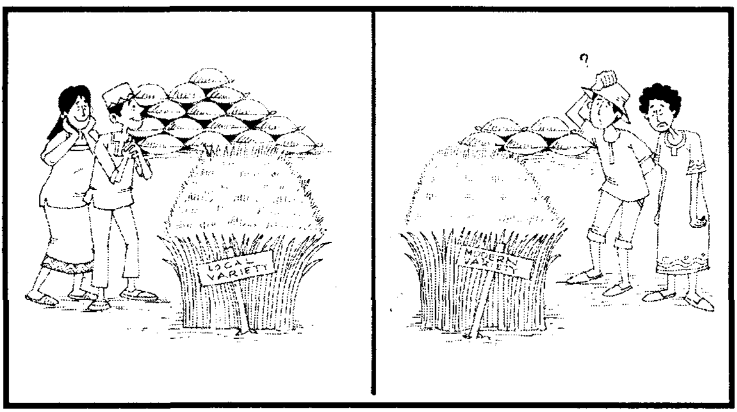


Factors that Hinder Farmers from Using the Local Rice Variety



Some of the reasons why farmers refuse to use the local rice variety are the following:

- The farmers have misconceptions about local rice. They assume that local rice is not a resistant variety, renders low yield and takes a long time to mature.
- Policymakers do not support the utilization of the local rice. Although results of studies show the viability and productivity of the variety, still, all the efforts are left unrecognized.
- Agriculture organizations, sponsors and the government are not open to providing funds.



Possible Solutions to Increase "Local Rice" Production

To encourage farmers to adapt the traditional farming system once again, some interventions have to be effected.

- Rectify the farmers' misconception about the traditional farming system (using local varieties) by conducting samplings, comparative studies and intensive information campaign.

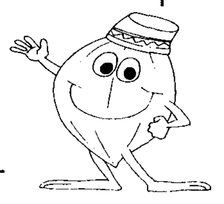
- Solicit support from scientists, non-government organizations (NGOs) and other concerned agencies in promoting the positive values of continuous farming using the local seedlings.
- Enhance the communication system as it significantly helps information campaigns. The use of various forms of media should be explored and utilized to the fullest.
- Continuously train farmers on rice farming.
- Establish new regulations in traditional farming.
- Maintain the quality and the quantity of the fields. The tradition of dividing the inherited fields is not efficient or effective, hence, not recommended.
- Villages should develop rice barn system to sustain the food security. The village government should be directly involved.
- Multiculture system should be developed in fields. Planting corns and beans on the bunds help in controlling agriculture pests.

At present, local rice varieties are being revived and developed by volunteer organizations, particularly PUSSPAINDO, and its network in and out of Java. New rice varieties are developed from the seedlings found in old rice barns, or in remote areas such as Dayak and Flores settlement.

Through this effort, nine different varieties of local rice are now being planted by farmers in the regions of Malang, Jember, Banyuwangi, Situbondo, the Municipality of Malang, Klaten, Magelang, Sleman, Wates, Purbalingga, etc.

From the experiment conducted by PUSSPAINDO, several important points, supporting the contention that local rice is better than the modern varieties, are presented.

- Harvest of local rice varieties can reach more than 10 tons/ha using traditional knowledge and agriculture system, affirming the viability of the traditional agriculture system in strengthening food security in the future.
- By using local seedlings, the production cost is lowered (50% lower then the cost of producing the modern varieties).
- By using the continuous farming approach, soil fertility is maintained as it conditions the soil biologically, physically, and chemically. Microorganisms will be enhanced, thus, contributing to making the soil fertile.
- Traditional wisdom should be applied: using local seedlings, local distribution mechanisms and building cooperation in marketing.



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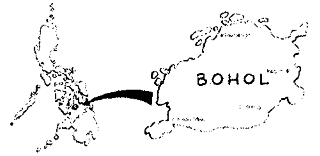
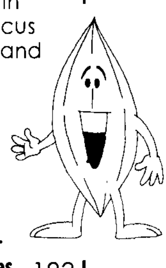
Farmer Management of Rices in Bohol, Philippines



Farmers' management of genetic resources diversity is not only about varieties and crops. It also includes the management processes of these varieties and the associated farmer knowledge required to maintain these varieties. In the island province of Bohol, Philippines, red rices are commonly eaten by the majority of the people. Boholano farmers continually plant different red rice varieties aside from the white rices. Despite the lack of red rice varieties from the formal system, the farmers continually develop planting materials by selecting from their own varieties.

A research study was conducted to better understand the continuous and dynamic process of maintenance, development and adaptation of rice varieties among farmers in Bohol, Philippines with focus on their role in selecting and enhancing red rice varieties. It also studied the influence of gender and socio-economic differences to the selection criteria and selection methods.



Farmers' Selection Criteria and Methods

Farmers' selection criteria were according to their preferences and needs. These were grouped into three: agronomic, morphological and gastronomic traits. Results showed that farmers generally prioritized agronomic characteristics related to high yield more than morphological and gastronomic traits. This may be attributed to the following reasons:

- Farmers are producing both for consumption and income generation. Given their limited land size, an average of 0.83 ha, farmers were in extreme pressure to produce enough food and surplus to defray other household expenses. Therefore, they would prioritize characteristics that would lead toward this goal.
- Farmers had multiple criteria in selecting what varieties to plant. Despite preference for high yield traits, other traits such as grain color were also be considered. Farmers' decision on what varieties to plant depended on several combined traits such as high yield, pest and disease resistance, grain color, eating quality, etc.

Farmers used two selection methods that were related to the purpose of the seeds and manner of harvesting. These were panicle selection and mass selection.

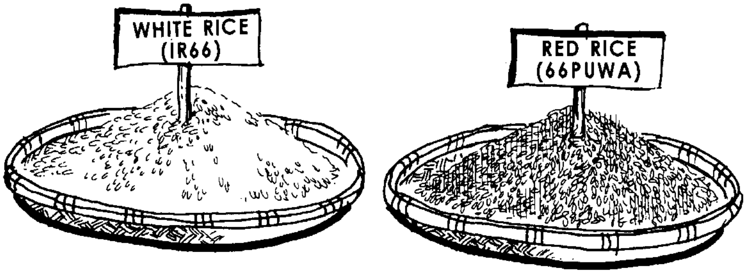
Mass selection is choosing good plants and bulking the seeds. Farmers select the seeds of good plants of the variety that will be planted for the next season from their field. Farmers commonly use this method to prepare seeds for the next season.

Panicle selection is choosing and selecting the best panicles from individual plants in the paddy. The farmers select one or two panicles of offtypes to create new varieties. Farmers pick out

the unique panicle or panicles of offtypes and grow them for evaluation. Seeds from better performing plants were harvested in bulk and until sufficient volume was obtained. Only few and experienced farmers in communities did panicle selection while most farmers employed mass selection to produce their own seeds. These selection methods were found very useful in management of farmers of the genetic diversity.

Red Rice Diversity Analysis

The presence of different types of rice varieties showed the existing genetic diversity that continued to evolve in the community. The availability of red rices and their diversity were indicative of farmers' management, enhancement and development of genetic diversity. Because of farmers' conscious effort to come up with red rices through their own selection methods, they continued to select and experiment on off-types from the rice field to develop as planting materials. The case of the three farmer selectors in different communities showed how special and experienced farmers continually evaluate their materials as source of new varieties.



The agro-morphological and genetic characterization studies proved the similarities and differences between the farmers' selections and original variety. There was a high similarity observed among the four pairs of varieties studied using farmers' , researchers' and molecular analysis characterization. It is usually assumed that intensive selection within a population leads to the reduction of genetic variability and

ultimately to erosion of the basis for selection responses. However, the study showed that farmers' selection from modern varieties had high variation as compared to the modern varieties. This showed the continuous and dynamic process of varietal development existing in farmers' field as influenced by the selection pressure of farmers so that varieties are suited to environmental changes and farmers' objectives.

It could be stated that red rices originated from three possible sources: mutation, introgression with local and/or traditional red varieties, and contamination of seeds. The results of the genetic and agro-morphological characterization showed possibility of introgression from red rices. It was substantiated by the presence of red rices grown in several farmers' field in the community. The varieties planted in the surrounding farmers' fields were probable sources of genes that contributed to the presence of new red pericarp offtypes in a population. The process of seed selection, where a harvester may single out seed or plants in an attempt to obtain a new strain, may be very important to increase diversity in self-pollinated crops where hybrids between varieties occur at low rates.

Gender Influences on Crop Diversity Management

Men and women concerns varied according to their roles and positions, responsibilities and tasks. Men were mainly responsible for farming activities as this was considered as the major source of income of the family. Women had secondary involvement in rice production and management because they were responsible and burdened by reproductive work. However, women and children as part of family labor were important in times of major production activities (i.e., transplanting, harvesting). Women's major contribution shared with husbands were sowing of seeds, transplanting, water management, selecting and drying seeds, harvesting, storage and marketing. Productive work in rice farming was considered a male role. It was customary for men to do the heavy workload for practical reasons.

Women who were less burdened by child care had more time to spend in farming activities. This also showed that the life cycle of a family is influential in determining men and women contributions to rice farming activities. Women with small children were less involved in fieldwork compared to older women who had grown up children. Also, households in which there were older children to look after the younger ones had slightly higher women participation in production activities.

Men dominated the activities in seed management such as selection of seeds and seed exchange. However, seed drying and storage were shared between husbands and wives. Also, women contributed in decision making on what varieties to be planted for the next season. Husbands spend 17.6 hours in seed management while the wives, 15.63 hours.

In terms of the knowledge on rice varieties, men identified more varieties (54) compared to women (26).

Selection criteria were not greatly influenced by gender and socio-economic status as most of them prefer high-yielding varieties. However, the males decribed varieties with agronomic and morphological characteristics while females used more agronomic and gastronomic characteristics. This appears to reflect women's secondary involvement in rice production at the field level, as well as in food processing. The difference between men's and women's use of morphological characteristics may also be related to the predominance of men in the work of field observation.

Socio-economic Influence on Crop Diversity Management

Socio-economic status of farmers was another factor found of importance in the management of genetic diversity. It was seen that the middle socio-economic group was most actively involved in all production processes on the farms because of more time allocated to the fields. Farmers in the high socio-economic group had sufficient resources to hire laborers in some specific production activities while those who belong to the low socio-economic group had to work as laborers in other farmers' field.

Men in the three socio-economic groups had major responsibility in rice production. However, there was varying participation depending on the socio-economic level. Men from the low and middle groups were contributing more in specific activities while hired labor was much more used in high socio-economic groups. This was attributed to the capacity of the high socio-economic group to pay for hired laborers.

Family labor dominated in the low socio-economic groups. In most cases, males from the low socio-economic group worked as hired laborers to augment their income, and wives provided additional time and labor to look after their own farms. Therefore, women from low socio-economic groups were more active in rice production activities compared to the middle and high socio-economic groups. However, in seed management, husbands and wives from high socio-economic group had more shared tasks while husbands from low and middle socio-economic groups dominated most of the tasks. This may be attributed to the time available for women of high socio-economic groups who were least burdened with household tasks, child rearing and fieldwork in rice production.

Contributions to seed management by household members varied depending on the socio-economic groups. In most tasks, both husband and wife were in-charge in performing the activities. These were storage of seeds, drying of seeds and selection of variety for next season. Moreover, the

husbands were responsible for sourcing of seeds, seed selection and seed exchange. Women had no tasks in seed management. The high socio-economic group had more tasks shared between husband and wife compared to the low and middle socio-economic groups. These tasks were seed selection, storage of seeds, drying of seeds, selection of variety for next season and seed exchange. This might be attributed to the amount of time available for the women of the different socio-economic groups. Women of high socio-economic groups were older compared to the low and middle groups therefore they had less household work and no children to rear.

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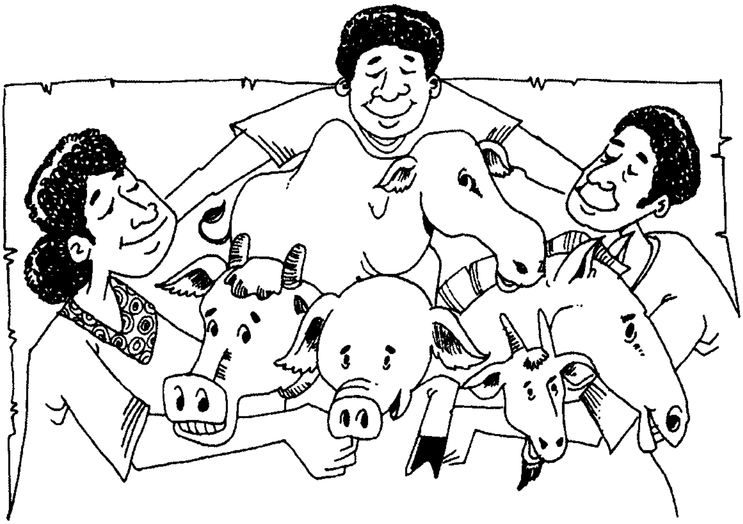
Livestock and Livelihoods



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.

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.

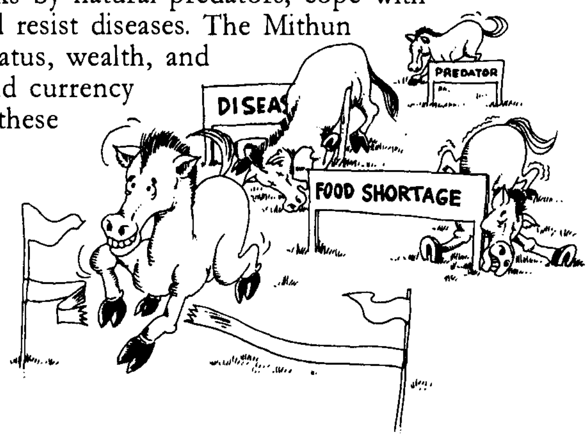
Breeds selected by these herders were essentially ones which could stand the stress of migration, droughts and periodic food and nutritional shortages.

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.



Crop-based Livestock Rearing Systems

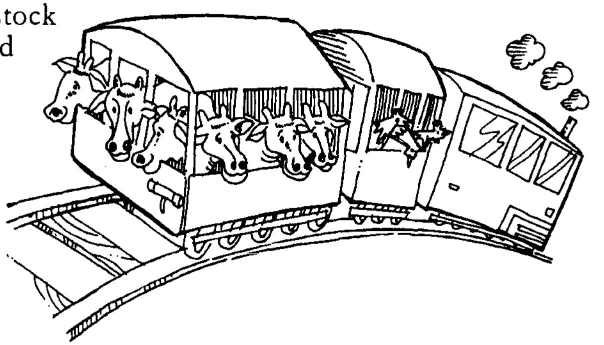
A major revolution in livestock farming happened thousand of years ago when crop farming and livestock rearing were brought together under mixed-crop livestock farming systems. Under these systems, by-products from agriculture (crop residue and straw) were used to feed animals. In exchange, animals had 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.

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.

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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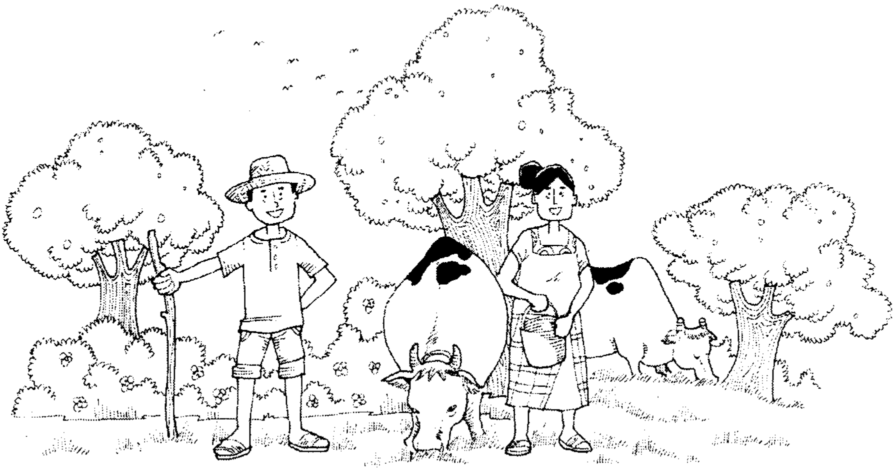
Sustaining Livelihoods through Animal Genetic Resources Conservation



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.

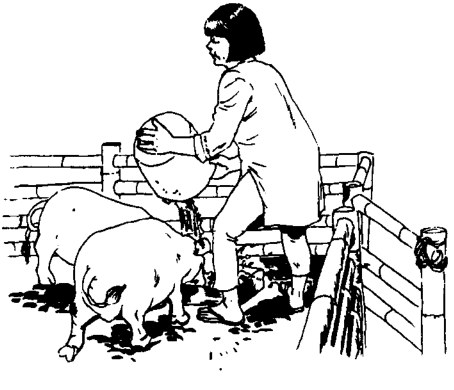
The complex, diverse, and risk-prone peasant livelihood systems of the poor living in marginal areas, and the marginalized living from scarce resources in higher potential areas, require animal genetic resources (AnGR) that are tolerant to harsh conditions, resistant to disease, productive and diverse.

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
- fulfills 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 sales of animals or their products	Consumer preferences may favor or reject products from certain breeds. 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 olerance, 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.).

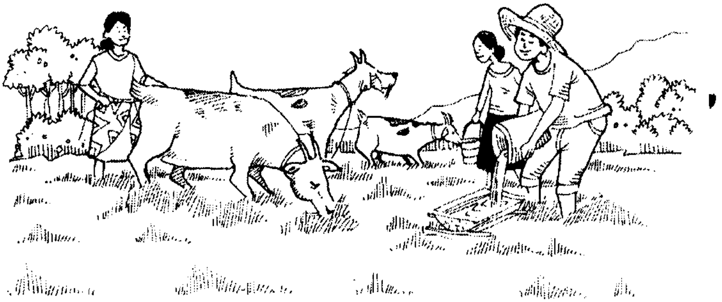
Many of the animal genetic resources most important to the poor are not improved breeds, but local breeds that still have important adaptation traits to unfavorable environments and that are able to thrive on low external input-type management.

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 socio-economic 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

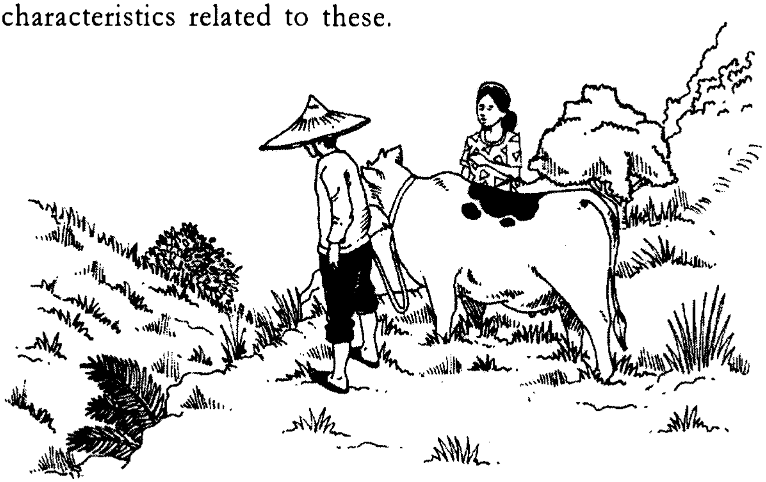
Trends in population demographics and location, e.g., urbanization, also technological changes in agroecosystems and marketing systems, can negatively affect AnGR. Commercial production systems tend towards uniformity of inputs, resources, and outputs, while livelihood-oriented systems thrive on diversity.

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 non-income 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

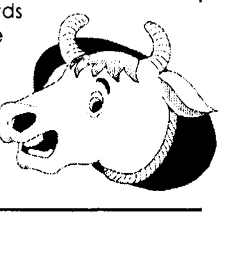
functions. Hence, the importance of local breeds as AnGR is not only their ability to fulfill livelihood functions, but also their genetic contribution to adaptive and other traits to crossbred animals.

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.

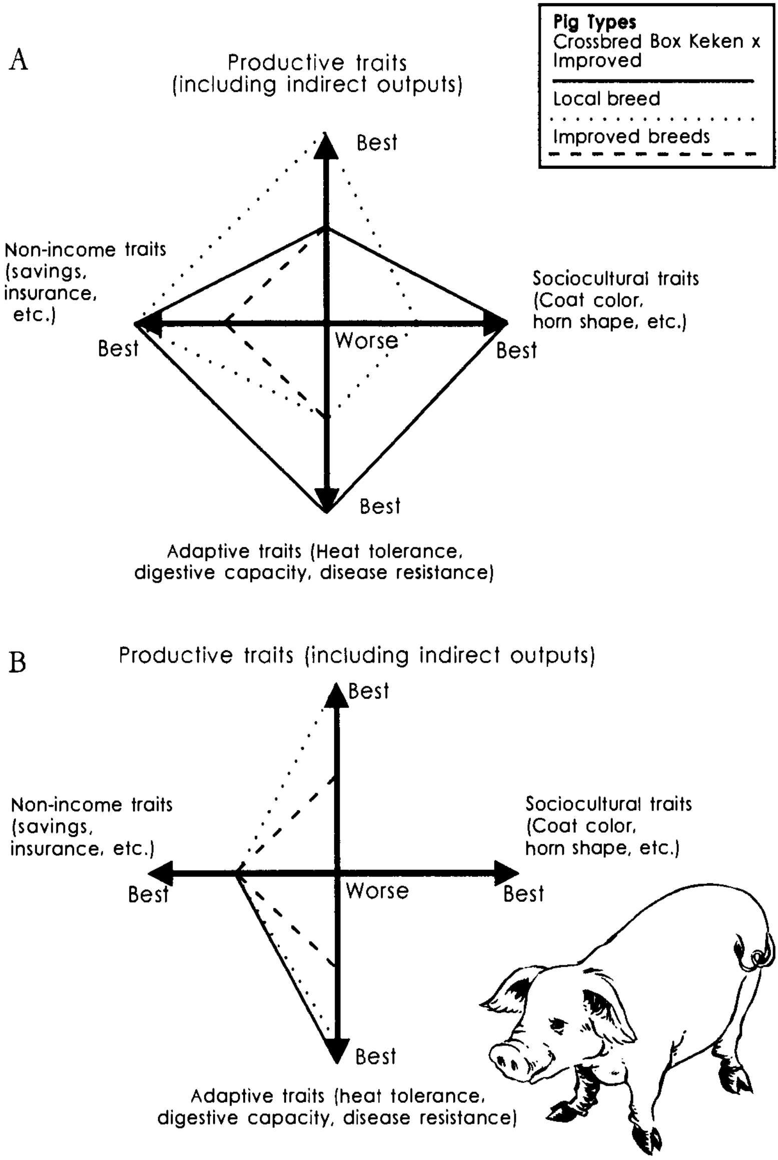
Ranking Trait Expressions of Livestock Breeds

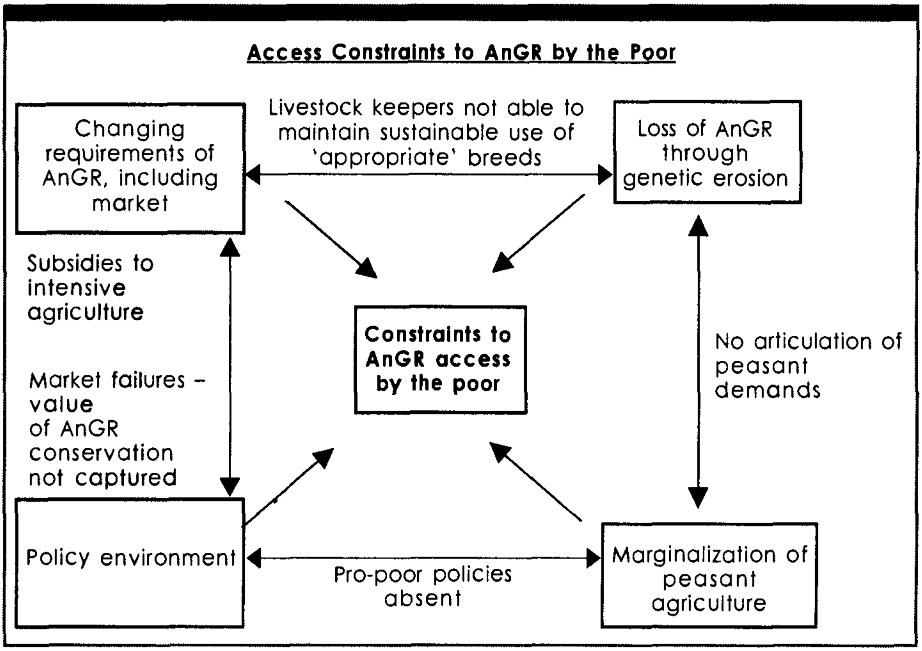
To make rational decisions that take a holistic account of livelihood functions, breeds could be compared using ranking (best to worst) of trait expression in common environments. Four general criteria can be identified—productive traits (PT), adaptive traits (AT), sociocultural traits (ST), and non-income 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 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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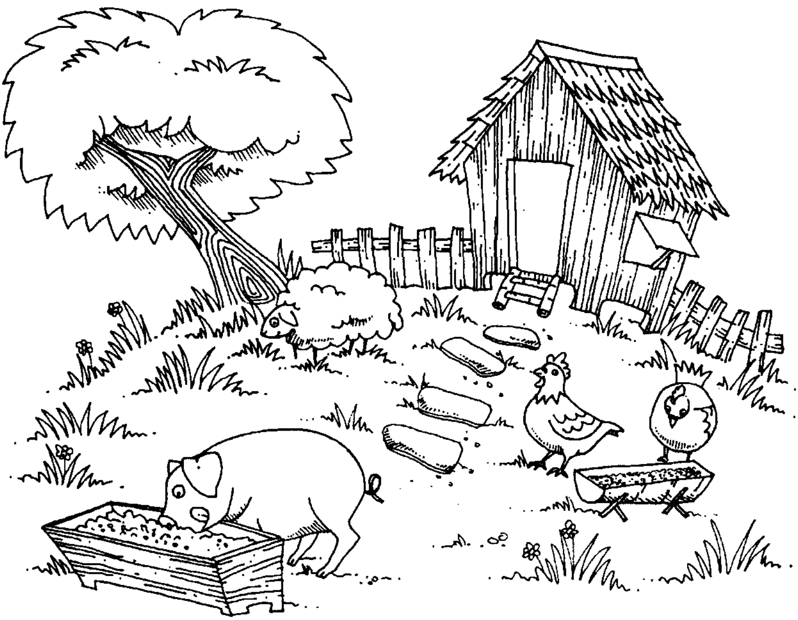
Diversity of Animals Adapted to Smallholder Systems



Generally, animal keepers can follow two alternative strategies: **adapt the environment to the need of the animals or keep animals adapted to the respective environment.** The first strategy is used in industrial animal production such as chicken batteries or large-scale pig fattening. Here, animals are divided into production animals and breeding stock. To take advantage of the economy of scale, production animals need to be uniform. For the specialized breeding stock, some diversity is desirable as breeding progress depends on selection, but industrialized animal production and efforts to maintain or enhance biodiversity remain antagonists.

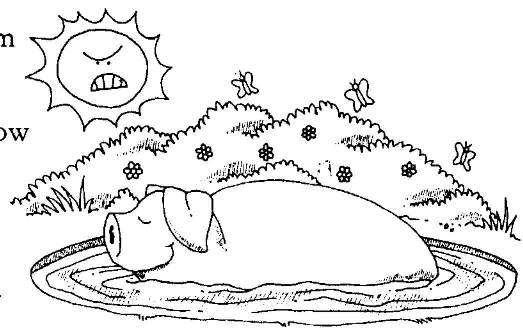
Smallholders and pastoralists follow the "keep animals adapted to the environment" approach. Environment in this sense is not restricted to natural conditions, but also includes the production systems. The physical environment greatly differs between locations, just as production systems differ according to available resources and economic conditions. Because of this, smallholders and pastoralists need different animal species and diverse types.

The common indicator for farm animal diversity is the number of breeds. However, smallholders and pastoralists do not need breeds but animals with certain characteristics. A discussion of these is the focus of this paper.

Adaptation to the Physical Environment

Smallholders and pastoralists and their animals often live in harsh environments. It can be hot and dry, hot and humid, or high and cold. Water and feed can be scarce, feed can be of low quality, and disease pressure high. Adaptation to these factors is largely based on genetics, but animals can "learn" to live under such stressful conditions. To delineate genetic and acquired behavioral adaptation is often difficult, if not impossible.

Adaptation to High Ambient Temperature



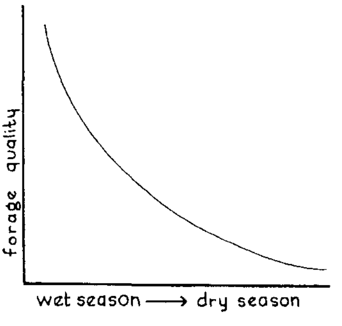
The great majority of domestic animals are warm blooded, and have to maintain the body temperature within a narrow range. In hot countries, they face the problem of how to get rid of their heat, produced by the physiological processes. In addition, sunshine warms up animals. Animals can avoid

sunshine, drink lots of water, wallow in ponds, block incoming radiation by a reflective (white) skin, insulate their skin with wool or pant to keep a cool head.

An effective way of reducing the heat load is reducing heat production. Unfortunately, growth, giving milk and producing eggs generate a lot of heat. Therefore, animals which do not grow so fast, give less milk or lay fewer eggs, produce less heat and have an advantage in a hot climate. Furthermore, animals with a genetic potential for high production have a high "basic metabolism", which is defined as "physiological turnover at rest, at a feeding level where animals neither gain nor lose weight." Local animals with a lower genetic capacity for production also tend to have a lower "basic metabolism", need less energy and feed to stay alive and therefore can cope better with heat stress. High production animals have higher maintenance requirements and therefore produce more heat than the animals adapted to a hot environment. It is not only because they are bigger, but also because they produce more heat per kilogram of live weight. The major source of heat in animal is food - intake and digestion. A reduction of food intake, hence heat produced during digestion, is therefore an efficient way to reduce heat stress. This leads to low milk output, fewer eggs and slower growth.

Adaptation to Low Feed Quality

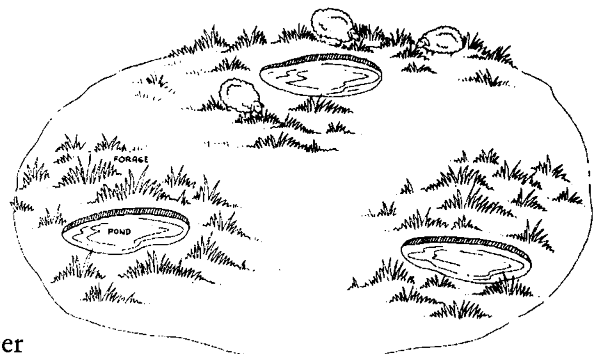
Having lower energy requirements is also an advantage if feed quality is low. When high quality feed is available, the modern breeds produce more than the local breeds. However, high-producing dairy cows lose weight when they are fed poor quality grass or straw, whereas adapted, local animals still grow, give some milk and reproduce. There is some



evidence that local cattle recycle nutrients internally more efficiently than do modern breeds. In pigs, indigenous breeds can utilize fibrous material such as grass much better than do modern high production breeds.

In many areas, forage quality varies greatly between seasons. In the early wet season, forage quality is high and declines as grasses mature. During the dry season, forage quality may be so low that maintenance requirements can no longer be met, and animals have to mobile their body reserves and lose weight. Furthermore, forage can run short towards the end of the dry season. Some animal breeds can reduce their basic metabolism during periods of weight loss, which makes the limited feed go further. When good quality forage is available again, lean animals grow faster than fat animals, and in comparison to animals which are supplemented during the dry season, non-supplemented animals make up much of the difference in weight during the favorable season. This compensatory growth is an adaptation to changing forage quality.

Adaptation to Low and Erratic Water Supply



In drylands, water points can be far apart - at times 50 km or more. Livestock which needs little water and does not have to go back to a water point every day can access larger areas of pastures and thus get more feed. It is well known that camels can go without drinking for up to a week, even in the dry season. There are, however, also donkey, goat, sheep and cattle breeds that can get along without drinking for several days. These animals

can take in large amounts of water quickly, but their overall water intake is lower than that of animals which are watered daily. Reduced water intake reduces feed intake and metabolic rate and therefore livestock can survive longer during a drought, when feed is very scarce.

Disease Resistance

Climate influences strongly the prevalence of parasites and disease and indigenous animals have developed resistance against and tolerance to them. Disease resistance also depends on the animals' condition, and weak animals are more prone to disease, whereas animals in good conditions can cope more easily with stress.

Genetic diversity in livestock is important with respect to disease, as disease-causing organisms continue to evolve. If a new strain of a disease or a new disease occurs in a country, animals with a narrow genetic base are either all affected or none. With genetically diverse livestock, the chances that some animals are not affected, when others die, increase.

Some examples:
Indigenous livestock is less affected by ticks and worms than imported ones. In tse-tse areas in Africa, indigenous cattle have developed some tolerance to the disease, whereas imported livestock die, if not treated with chemicals. In west Africa, local cattle, sheep and goats have developed resistance to heart water, a deadly disease for imported animals or crossbreds.

In general, good adaptation to harsh environments and high production are mutually exclusive. Even with selection within indigenous breeds for higher production, there is not much scope because this leads to animals which produce more heat, need more water and better feed and are probably less

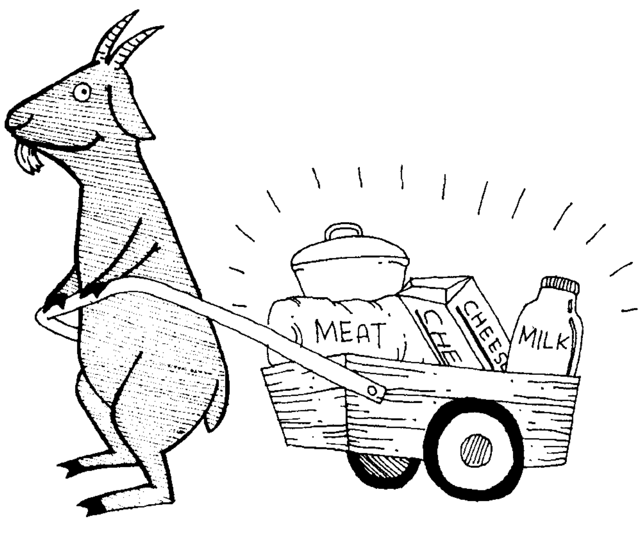
resistant to disease and parasites. This should be taken into account, when designing strategies for livestock development and conservation of farm animal genetic resources.

Adaptation to Smallholder and Pastoral Systems

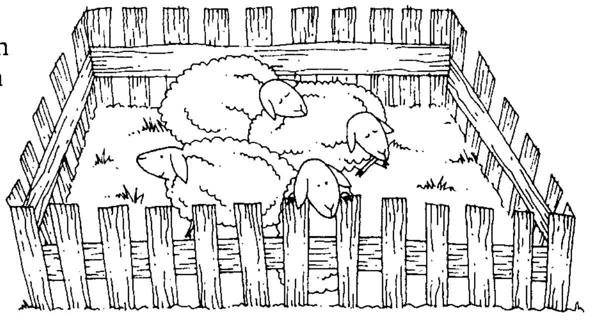
In "modern" animal production, livestock is kept for meat, milk, eggs, wool or hides. This is also important in smallholder and pastoral animal husbandry, but animals here serve also other important functions.

> All animals can be a form of investment and saving. Cattle, donkeys, camels, horses and buffaloes are used for draft and as beasts of burden; manure is used as fertilizer, for fuel and even building material; and many animals have cultural significance.

Smallholders and pastoralists also differ from "modern" animal production with respect to forage management. In modern systems, the requirements of animals are calculated, rations are formulated, and, if necessary, feed can be bought and imported. In contrast to that, smallholders and pastoralists have to optimize the use of the existing, limited forage. The different approaches also favor different genotypes.



The way animals are kept also influence the desired types. On extensive pastures in drylands, animals should be able to walk long distances. When they are herded, it is advantageous if they have a drive to stay together. When goats are kept in enclosures, it is of advantage if they are short legged and cannot jump the fence.



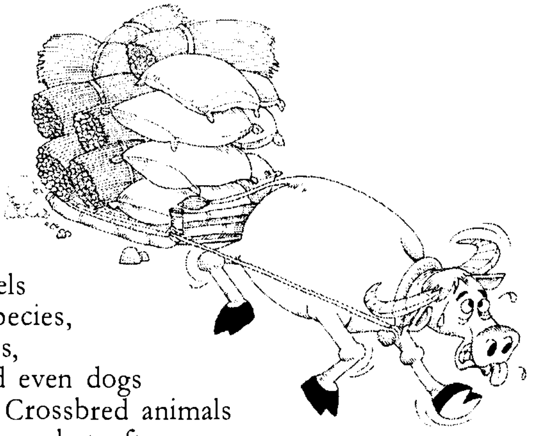
Within smallholder and pastoral systems, purposes or functions of animals strongly influence the type of animals and animal species used.

Multi-Purpose Livestock

Practically all domestic animals can be used for meat though culture and religion can limit its use. The types of animals used depend strongly on economics, especially on price ratios of liveweight to feed. As meat is comparatively cheap in most smallholder and pastoral areas, animals there have to do with natural forages and crop residues, and the uses of these forages for meat production have to be optimized. The types of animals required are those which grow reasonably well under these conditions.

For milk production, cattle, goats, buffaloes and camels are commonly used. The type of animals depends strongly on the access to markets. In mountainous areas, it makes little sense to keep high-producing dairy cows if roads are blocked by snow in winter and if the present dairy production is sufficient for household use. If the available forage on a farm is not sufficient for a cow, switching to smaller species, such as dairy goats, can be a viable option.

For producing manure, the animals need to stay alive, and available forage, including that of low quality, should be intensively used. Low maintenance requirements are an advantage.



Draft animals and beasts of burden are often used only for parts of the year. For the rest of the year, animals have to survive in reasonable conditions, without too much cost. Cattle, buffaloes, donkeys, horses and camels are the most important species, but there are other species, including sheep, goats and even dogs which locally carry loads. Crossbred animals might be bigger and stronger, but often additional draft power is not needed and therefore, the indigenous animals are usually preferred.

In the absence of banking services, animals are efficient "saving accounts". Often several species are combined: e.g., chicken as small change, sheep and goats for recurrent expenditures, such as school uniforms, and cattle for bigger expenditures. Animals kept as saving accounts require minimal care and therefore should not require expensive feed, should be docile and resistant to diseases. These characteristics are in favor of indigenous breeds.

Animals kept because of their cultural importance differ according to area and culture. We have to accept that in many areas, horses are regarded as more valuable than donkeys, even though donkeys require minimal care and are extremely useful. Animals may also be kept for other functions, e.g,. as "watch-dogs" (not only dogs, but also donkeys which can protect small ruminants against predators, or geese which are good "alarms").

Animals are usually kept for several purposes and therefore the type of animals actually kept is often a compromise. The importance of different functions varies over time. The conservation of farm animal genetic resources in smallholder and pastoral systems must, therefore, be dynamic and adaptive and not static.

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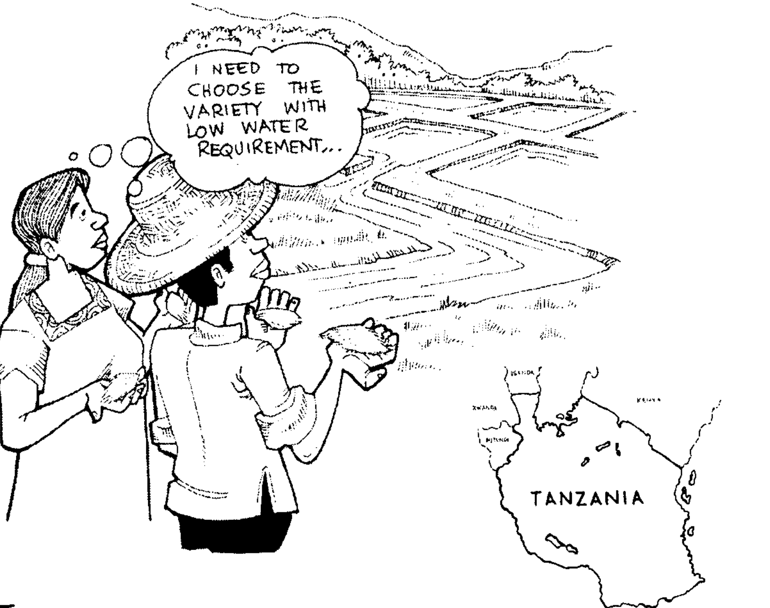
27

Changes in Criteria for Rice Cultivation in Usangu Plains, Tanzania



Nyelegete village is located on Usangu Plains, a semi-arid area comprising 1,500 square kilometers situated in the Southern Highlands of Tanzania, some 800 km from the capital Dar es Salaam. Usangu Plains has experienced a dynamic demographic change over a 30-year period with a rapidly increasing population resulting from immigration from surrounding areas. Rice cultivation was introduced in the Usangu plains by immigrants from India as early as the 1930s and expanded

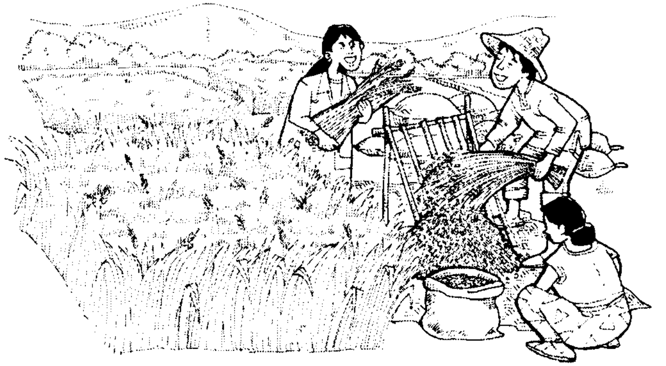
> The farming system changed during the commercialization period from a traditional pastoral society with extensive land use to an irrigated rice-based economy with intensive land use.

dramatically after the construction of a main irrigation canal in 1964 and farmers' subsequent construction of additional informal irrigation canals. Commercialization of rice production was restricted during the 1970s and 1980s by socialist policies of monopoly marketing parastatal organizations controlling input and output market prices.

Structural adjustment policies and liberalization of trade in the 1990s have greatly increased commercialization and resulted in intensified cultivation of maize and changes in cropping patterns. Commercialization intensified the farming system from a family-based cultivation of a diversity of varieties aimed at self-sufficiency and sale to the state, to rice production largely based on casual labor and sold on the private market leading to increased production, but also resulting in social differentiation and a reduction in the diversity of varieties cultivated.

Local Seed Production and Exchange

The commercialization of rice production in the 1990s has gradually transformed the traditional seed exchange system into an emerging family-based seed production system leading to increased specialization within the community. There exists a market for sale of seedlings at the time of planting, and every year some farmers will have a limited volume of excess seedlings, while other farmers will be in need of planting material. Seedlings are sold at a premium price of 20%-60% above the seed price.



Changes in Criteria for Cultivating Rice Varieties

Farmers on Usangu Plains have cultivated large number of rice varieties over the past three decades. Few landraces have remained in use for national research through extension services. However, many have been replaced by other modern varieties.

Table 1. Percentage of Rice Varieties Cultivated in Nyelegete Village, Usangu Plains

Rice varieties	1993/1994	1998/99
Kilombero	77%	87%
Fiya	14%	0%
Supa Mati	3%	13%
Pijo	3%	0%
Sesenera	3%	0%
	100%	100%

Source: Survey of randomly selected 30 households in 1994 and 1999

Table 1 indicates the dramatic changes in farmers' use of rice varieties in Usangu plains during the market liberalization and commercialization of rice production in the 1990s. The factors influencing these changes are outlined below.

- Productivity of grain while important, is not the only criteria for variety selection by farmers. Farmers maximize their total household rice production by using a range of varieties, which together enable them to optimize the use of their resource base.

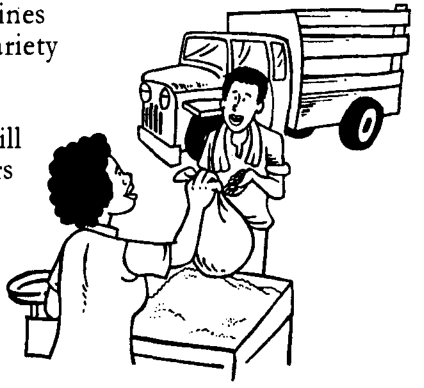
- The balance between access to land and availability of labor also influences farmers' choices of varieties: large land owners tend to sow late maturing rice varieties by broadcasting after early tractor ploughing, while farmers with limited land transplant early maturing varieties following ox-ploughing or hand hoeing.

- Water availability is another factor. For example, in Nyelegete village, the Fiya rice variety was popular in the 1993/94 season, as it is a late maturing modern variety with a high potential yield, high water demand and medium market demand and price and average taste. However, farmers living up-stream from the village have intensified rice production during the 1990s and thus diverting the water flow. As a result, farmers in Nyelegete village have been forced to increase their use of drought-tolerant and short-season rice varieties, which require less water over a shorter period. In practice, this means reducing the use of Fiya, is less drought-tolerant than Kilombero and an increased use of Supa Mati, which is early maturing.

In the 1970s, the Mbeya Primary Co-operative Union (the state-controlled monopoly marketing organization) encouraged the purchase of modern varieties. This policy, which was based on a modernization ideology, resulted in the loss of several local landraces. During the 1980s the blanket price policy of the Mbeya Primary Cooperative Union resulted in the increased use of high- yielding but relatively poor tasting varieties. When the cooperative was replaced by private traders during the 1990s, market demand for rice became variety specific, reflecting the preferences of Dar es Salaam consumers leading to price differentiation according to variety.

- Suitability of individual varieties to satisfy household requirements and preferences has traditionally been an important selection criterion for rice. However, its importance has been reduced as rice production has increasingly become commercialized and market demand has become an important criteria in variety selection.

- However, today, a trade-off between price and volume determines farmers' cultivation of variety mix. Poorly tasting rice varieties such as Pijo and Sesenera are, however, still produced by some farmers and sold to unskilled traders (such as truck drivers with space for a few extra bags) who are unable to tell the difference.



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28

Working with Farmers to Enhance Productivity of Local Cultivars in India

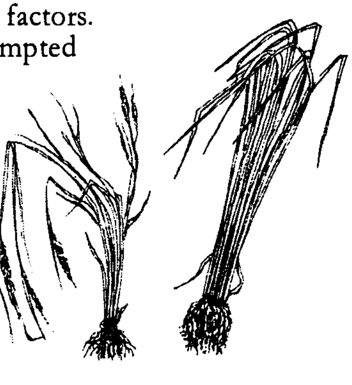
Local cultivars of many crops have been cultivated under marginal environments with little care for improved agronomic management practices. The productivity is often half of the potential but the qualities of such local cultivars ensure their local adaptation to the various biotic and abiotic factors of production. However, genetic erosion of local cultivars has increased through the diffusion of modern and high-yielding varieties. Improved varieties have high yield potential and yield is the important decisive variable in crop production. The lower productivity of local cultivars is one of the factors triggering the loss of traditional varieties and crop species.

Productivity enhancement in local cultivars through a change in their agronomic management or genetic improvement or by a combination of both can be a direct incentive to promote the on-farm conservation of local cultivars. Technological packages recommended by the agricultural extension systems are not site-specific and have ignored traditional knowledge and techniques developed by farmers through trial and error experiments. These packages developed for improved varieties are often not suitable for traditional cultivars. It is important to evolve site-specific farmer-friendly technologies, which have wider adoption value in a heterogeneous environment. The participatory mode of technology development helps generate improved agronomic practices.

The following case study illustrates how farmers evaluate technologies while adopting them, even if only incremental yield advantage is associated with the technique.

Promoting On-farm Conservation

Kollihills, located in the southern part of eastern Ghats in south India, is characterized by inter and intraspecies millet diversity. A *Malayali* tribal community inhabits the region. In the recent past, millet diversity has started declining and was on the verge of disappearance due to the introduction of cash crops and other socioeconomic factors. Different approaches have been attempted as direct and indirect incentives to promote on-farm conservation and to ensure local food security. Productivity enhancement is one intervention tried in "little" millet *(Panicum sumatrense)* cultivars using participatory approaches. Specific emphasis was given to the participation of women based on their greater participation in production.



"Little" Millet

The agronomical characters and ecology of the different landraces and cultivation practices were studied before initiating the activities. Thirty knowledgeable men and women farmers selected from all over the region served as a core group that assessed the constraints and opportunities in "little" millet cultivation. The potential areas for enhancing productivity were identified by the farmers. These included sowing methods, nutrient management, cropping system and drought management.

Participatory Learning and Decision-Making

A participatory adaptive research was undertaken to study and monitor productivity aspects of "little" millet. A demonstration plot was set up and a training program evolved in consultation with the core group members. Regular training programs were conducted in the field. In consultation with farmers, four different types of simple, low-cost interventions were designed: method of sowing and spacing, seed treatment methods, different sources of nutrients, and intercropping with cassava and pulses.

Two different types of landraces were cultivated and accordingly, experiments were designed to test one short-duration and one long-duration landrace. Farmers regularly monitored and evaluated the experiments at different growth phases using a set of indicators. They were actively involved right from the beginning, from constraints identification, design, layout, and criteria identification for treatments. Constant monitoring and evaluation activities were undertaken in the field including field evaluations at vegetative stage, flowering, and harvesting stage of the crop.

Farmer Preferences for Improved Agronomic Management Practices

Nutrient Management

Farmers preferred using lessons from the trial on nutrient management using biofertilizers, poultry, inorganic and farmyard manure. Biofertilizers gave a good response (30% increase in yield). The practice is very simple and could be applied either through seed treatment or soil application or both.

Seed Sowing and Hardening

In the sowing and seed hardening experiments, farmers appreciated the results but did not adopt them on their own farm due to management constraints: the traditional approach involves broadcasting of seeds in a leveled field, which hardly takes one labor day. In the line sowing approach, a 25-60% increase in yield was noted over the existing practice, but the limited availability of draught power, drudgery, undulating terrain, and high labor demand discouraged the adoption of the improved practice.

Similarly, in the seed hardening experiment, water soaking for 24 hours gave a 20% higher yield advantage. However, the unpredictability of monsoon and sowing time hindered its adoption. In the same way, intercropping experiments with cassava at different densities showed that short-maturity cultivars are suitable as intercrop. However, the different sowing times of the two crops involved more labor, and thus, prevented farmers from adopting the practice.

Perceptions on the agronomical practices varied between farmers and researchers. Researchers considered mostly the yield advantage, factor productivity, and cost-benefit analysis without looking at the environmental and farmer labor constraints, whereas farmers give more priority to factors that combine less management intensity and yield advantages. The participatory demonstration approach facilitated a discovery learning process in the field. The group learning process encouraged farmers to share experiences among themselves and to become active learners. Continuous monitoring and evaluation also helped the farmers to analyze and choose options.

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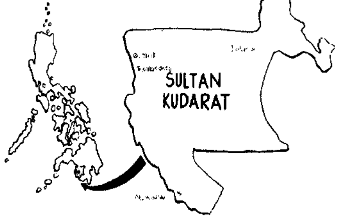
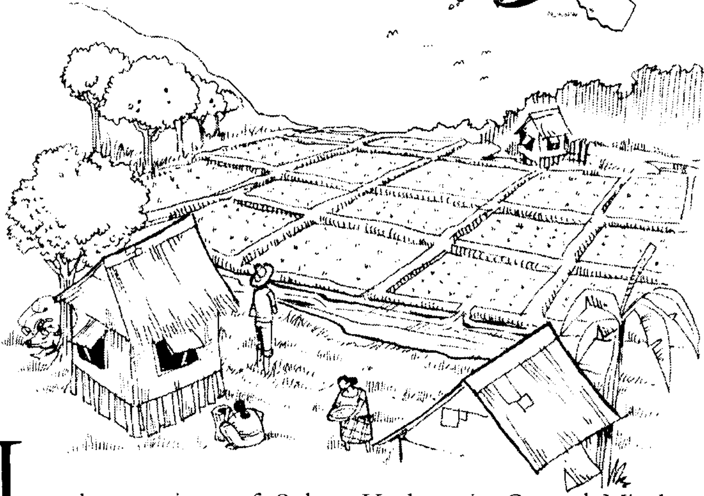
29

Seed Supply System In Commercially-Irrigated Areas:
A Case from Sultan Kudarat, Philippines





In the province of Sultan Kudarat in Central Mindanao, Philippines, the total irrigated rice area for the year 2001 was noted to be 94,705 hectares, with a production of 294,739 metric tons, averaging 3.88 metric tons per hectare. Of the entire province, the municipality of Lambayong is the most widely irrigated area.

The Rice Almanac accounts that in an irrigated rice area, average yields vary from 3 to 9 tons per hectare. In Lambayong, farmers have an average 5-6 tons of rice per hectare during the wet season (around 100-120 bags of 50 kg per bag), and 4-5 tons during the dry season. From these, it can be said that the municipality belongs to the high-to-medium yielding areas.

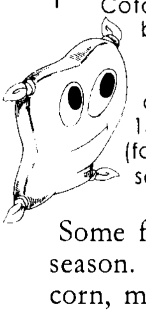
Normally, there are two major cropping seasons in Lambayong: wet and dry. Some communities that have good access to irrigation "sacrifice" a third cropping, usually right after the dry season, maximizing the water that is still available in the irrigation canals. The yield, however, is much lower than they normally get.

Commercially-Irrigated Rice Production Areas: Features and Consequences

The following characterize an area as commercially irrigated:

- presence of an institutionalized irrigation system;
- proximity or accessibility to agricultural markets;
- kind of varieties planted in the fields;
- interplay of the different actors involved in the seed supply system; and
- government programs that affect the whole rice production process.

Institutionalized in the mid- to the late 80s, (NIA-LAMRIS) is the main office handling irrigation services. The water source is the Kapingkong River, which is a tributary of the Allah River originating from Lake Maughan in South Cotabato. NIA-LAMRIS began construction in June 1984, and in 1999, it covered a total of 13,414.52 hectares (for both cropping seasons).



Irrigation System

The irrigation system is under the jurisdiction of the national government agency, but has been localized to cater to the farmers' needs.

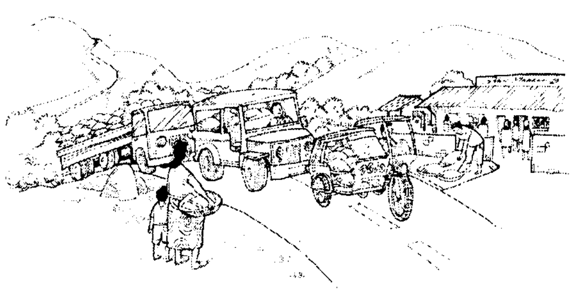
There are still areas in Lambayong that are not reached by the National Irrigation Authority - Lambayong River Irrigation System (NIA-LAMRIS). These areas are far from the concrete irrigation canals, and farmers have to source out their irrigation water from the streams and small water outlets. Some farmers have hydro-pumps which they use in the dry season. In some areas, farmers either plant another crop (i.e., corn, mungbean, onions, or watermelon) or just leave the area to fallow.

Agricultural Markets

The rice output of Lambayong is highly productive, thus, the market outlets for these products are necessary. The proximity of the municipality of Tacurong City makes marketing of the produce very convenient for Lambayong farmers. Farm-to-market roads are already well established, with several more under way. The national highway has been concreted to make transport of the products easier. Even small vehicles, such as multi-cabs (a 10-seater vehicle smaller than the 16-seater jeepney) and tricycles, can easily transport sacks of rice to the nearby city for selling. In most cases, however, the big trucks of traders go to the farms and pick-up the sacks of rice, especially for farms netting more than 200 sacks (for farmers with landholdings of more than 2 hectares).

The price of products for the second cropping is normally higher than the main (wet) cropping. The prices differ for wet and dry seeds, with the latter priced higher. Farmers most often prefer to sell their harvest wet or fresh from threshing, even if the price is lower (about P1.00 difference) because of the need for immediate income and the unavailability of drying space. Wet cropping price is lower because of the volume of products coming in, making the supply higher.

There is an imbalance in this economic aspect of rice production. The inputs (chemical sprays, fertilizers and seeds) are priced at high costs, but farmers' products are priced low. Though government programs allow for subsidies for some inputs (i.e., seeds) there is still no assurance of the price of the product upon harvest time. Farmers tied to loans cannot do anything with the price given by the traders. Control of markets is not in the hands of the farmers.



Seeds/Varietal Diversity

There is very limited varietal diversity in a commercially irrigated area. The varieties that the farmers plant become limited because of the demands in the market for high-yielding varieties. These are normally modern varieties, formally released by the Department of Agriculture (DA), the Philippine Rice Research Institute (PhilRice) and the International Rice Research Institute (IRRI). However, though formally released varieties are in-demand, farmers still practice selection from these modern varieties and continually plant farmers' selections.

Interplay of Actors

Different actors are involved in a commercially irrigated area, which are responsible on how the seed supply system of the area works. These are the:

- farmers;
- seed growers;
- the government agencies including the Municipal Agriculture Office (MAO), National Food Authority (NFA) and NIA;
- traders/businessmen; and
- farmers' cooperatives.

Central to the local seed supply are the farmers, or the farming communities. In Lambayong, there are over 54,000 farmers in irrigated rice areas. Other actors in commercial irrigated areas are the seed growers, who are producing certified seeds that they procure as foundation seeds from PhilRice. Seed growers in Lambayong are mostly big landowners and belong to rich families who migrated from Northern Luzon in the 1930s and 1940s. The DA is also an important actor in the area, being the main arm to implement the government's agriculture programs. Agriculture Technicians provide assistance to farmers in terms of information dissemination on the government programs, as well as coordinating with the farmers' associations in the communities with regards to project implementation.

In any commercial area, there is always the presence of traders (middlemen) and agricultural businessmen. The prices of products are controlled by agricultural businessmen, whose business

establishments are in the nearby city. These businesses do not only engage in buying products, they also sell products and farm inputs, even providing credit. Farmers who obtain inputs from these traders on loan are obligated to pay off through their harvest.

There are also farmers' cooperatives who buy the products, but only from farmer-members. These cooperatives in turn sell seeds back to farmer-members, while also delivering to the NFA. The NFA works with the DA in seed distribution programs, and the DA in turn distributes the seeds to farmer-beneficiaries in subsidized schemes. Farmers cannot directly deliver to the NFA unless they are members of a cooperative.

Government Programs

The Certified Seed Procurement and Distribution Program of the DA and NFA, and "Seeds for the Province" of the DA and Provincial Government are some examples of government programs that promote the use of certified seeds to attain the goal of increasing rice production in the area. Government funds are provided for the procurement of these seeds from the accredited seed growers. Usually, only one kind of variety is distributed to farmers, thus, limiting varietal diversity to a few modern varieties.

Currently, the hybridization program of the DA is being implemented. This introduces new hybrid varieties to be planted on over a thousand hectares in the municipality. Most of the first farmers to plant hybrid seeds are the big farmers and seed growers. Another government program is the

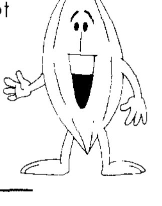
Sustainable Technology to Accelerate Rice Sufficiency (STARS). This is also a DA-led program in collaboration with a farmer-curator in planting new rice varieties for trial and to conduct a 'harvest festival' open to other farmers.

The synchronous planting program of the government, on the other hand, affects the number of varieties that the farmers need to plant. This program requires that all farmers plant at the same time to maximize the availability of water coming in, and use varieties of the same maturity to ensure harvesting at the same time. The DA recommends the use of only one to two varieties with the same number of maturity days.

The Interplay of the Formal and Informal System in a Commercially-Irrigated Rice Area

The flow of seeds in an area is facilitated by two systems: formal and informal system. These two systems have continuity, as observed in Lambayong. Though distinguishable from each other, the two systems have a connection. Though the general system working in Lambayong is the informal system, with farmers practicing the exchange of seeds (barter or in exchange of money or labor), the formal system (facilitated by the government agriculture agency) is still a main actor in distributing new varieties that have been formally developed.

> Though the communities in Lambayong benefited from the programs of the government, these programs do not really allow much for the innovations and participation of farmers. The programs distribute seeds that are sometimes not what the farmers need, or have characteristics that the farmers are not looking for. But because these are dole-out programs, they are just at the receiving end.



The seed growers are responsible for the multiplication of the newly recommended varieties to produce certified seeds. Seed growers either sell directly to farmers, or they produce under the government program. The

MAO also distributes seeds to farmers as part of their services and programs. These are passed through the local village council and local cooperatives.

There is still a need to distinguish whether the traders or businessmen would belong to the formal or the informal system. In some cases, they become agents of the formal system in terms of seed distribution or market. On the other hand, their direct involvement and dealings with the farmers make them also a part of the informal system. Either way, theirs is a role that could not be ignored because of their control of market prices.

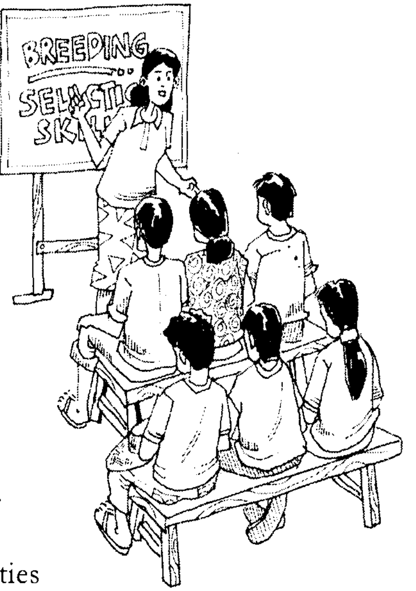
Responding to the Lambayong Situation

The situation in Lambayong being a commercially irrigated rice area may not be unique in terms of its productivity and agro-ecosystem. Addressing the identified problems or consequences that occurred may, however, vary. Government programs respond differently to these situations, resolving to dole-out programs and concentrating more on the productivity and profit of the farmers and the community as a whole. However, in maximizing profit, the other factors become forgotten such as social relations or community dynamics, the role of farmers, environment, market control and access, and the diversity of rice.

Community plant genetic resources (CPGR) projects in several communities of Lambayong have been set up. The projects, in the context of the community's rice production and seed supply systems, aim to increase the diversity of rice varieties in the community through participatory crop improvement method, and to empower farmers, strengthening their role in the production and seed supply system while engaging with the other actors and stakeholders in the existing system.

Introducing Diversity Back to Farmers' Fields

Varieties from farmers are sourced according to the characteristics and criteria that the farmers have identified. Through Farmers' Field Schools, the varieties are planted on communal farmers' fields for evaluation and adaptability trials, at the same time training the farmers in breeding and selection skills. The varieties that have "passed" the evaluation of farmers are now slowly being spread in the community, with the farmers participating in the field schools continuing the crop improvement methods. These varieties, and soon enough the varieties that they have also developed, will be part of the existing seed supply system as additional varieties to provide diversity.



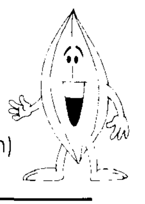
It is inevitable though that several varieties will be discarded as these are not suited to the area and do not have the characteristics that the farmers want. Thus, in developing the new varieties through breeding and selection, the farmers get to select 'parentals' that possess the characteristics that they prefer.

It was observed that as the area is highly market-integrated, Lambayong farmers do select characteristics suitable for market. High-yielding varieties are still top on their list, with long grain characteristics. Some select for good eating quality, but they mostly produce these for their own consumption and not for mass production.

Emphasizing the Role of Farmers

It is important to fully involve the farmers in any community endeavor for it to succeed. Once the farmers take on more skills in crop improvement and engage with the other stakeholders in the seed supply, theirs will be a more active role and not just at the receiving end. A more functional relationship could be developed between the formal seed sector and the informal seed sector, suitable and more sustainable in the context of a commercially irrigated area. In this context, farmers should really take on a more important role as they will be mainly responsible in adapting the new varieties, or discarding them. They are responsible in spreading the varieties through their practice of seed exchange.

The Southeast Asia Regional Initiatives for Community Empowerment (SEARICE) facilitates farmers' cross visits and participation in activities that enable the farmers to observe other farming systems, and integrate with other farmers. Seed exchanges also occur during these events, and thus they get hold of new varieties, at the same time acquiring new experiences and knowledge from other farmers. This enables them to gain back their confidence in controlling their own seed production, and, explore more on crop improvement. (http://www.searice.org.ph)



Working with the other Actors

It cannot be avoided, though, that there are several actors who see the farmers' activities/projects as a 'threat.' Some agriculture technicians of the government are not quite receptive of the project, especially concerning the introduction of new varieties. Because of their role in facilitating the distribution of newly-bred formally released varieties, they question the varieties that were introduced as whether these are registered under the Philippine Seed Board or whether they have already been tested.

Market Access and Control

With the vast effect that market has on the production system, this aspect should not be neglected. There are limited experiences in intervening with market forces, like engaging with farmers' cooperatives and engaging in discussions with marketing of organic rice. In some projects, marketing has already gone underway but there is still a need to better understand its dynamics, especially in the context of a highly commercial area as Lambayong. Farmers are asking about addressing marketing, especially for those who have already been practicing organic rice farming. They produce organic rice for their own consumption, but still practice chemical/ conventional farming methods to meet the demand of high rice productivity, their normal market.

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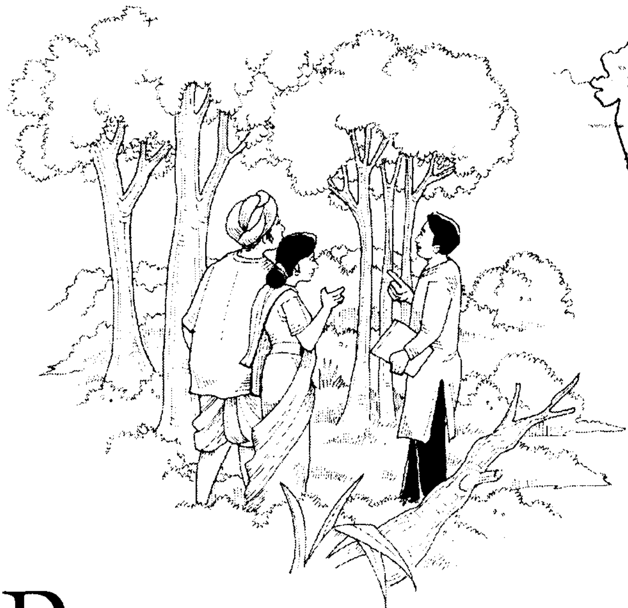
30

People's Biodiversity Registers: A Case from India



Peoples' Biodiversity Registers (PBR) can serve as an instrument to understand appropriate components in designing conservation efforts. A comprehensive PBR is relevant as its formulation involves community members while safeguarding many intricacies of the Convention on Biodiversity (CBD) articles on conservation, sustainable use and equitable sharing of benefits. The PBR can also protect intellectual property rights (IPR) of local communities as it is a database

Article 15 of Convention on Biodiversity (CBD) is based on four fundamental concepts:

- sovereign rights over genetic resources (15.1);
- facilitating access between contracting parties (15.2);
- access subject to mutually agreed terms (15.4); and
- access subject to prior informed consent (15.5).

These are possible, if a given country has high-quality documentation of its biological resources, traditional knowledge and community conservation systems at the village-level.

of traditional knowledge (TK) and intellectual properties (IP) of local tribal and rural communities on biological resources. PBR preparation follows three major objectives:

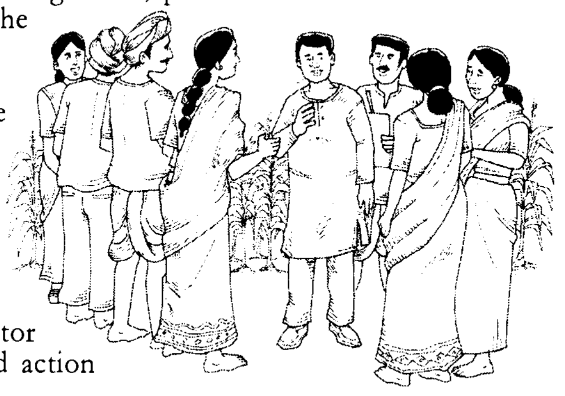
- develop and maintain an inventory of known biological resources at the village level (Grama Panchayaths or Village Government);
- chronicle local communities' knowledge about their biological heritage and foster a commitment among them to save, study and use key resources; and
- train youths to identify plant taxa, document traditional knowledge and understand biodiversity principles enshrined in conventions like CBD.

13 Steps in Preparing People's Biodiversity Registers (PBR): Experiences of MSSRF

Following a participatory process, the M.S. Swaminathan Research Founsation (MSSRF), identified 13 steps in preparing a comprehensive PBR.

1. Establishment of Biodiversity Management Committee (BMC)

The BMC consisted of 10-12 representatives from the grama panchayath system, NGOs, PBR experts, tribal development officials, forest officials, scientists and officers of agricultural institutions. A senior social worker acquainted BMC members with the existing social, political and institutional systems of society. The BMC ensured that people's interests are fully accounted in the study. It also facilitated the activities of the biodiversity conservation corps during the survey and implement/monitor recommendations and action plans.



2. Sensitization for the Study, Survey and Management

The BMC, along with community members, formed a consensus on the objectives, procedures and expected outcomes of the PBR survey. Problems and constraints hindering people's contributions in conservation and development were also identified. Village-level meetings facilitated by village youth clubs further discussed the required data and information to be identified and collected. They agreed on the methodology, assigned tasks and drew a work schedule with set deadlines. These meetings helped identify suitable members for the conservation corps and the village level biodiversity management committee (VBMC).

3. Formation of Biodiversity Conservation Corps (BCC)

The BCC consisted of 8-10 youth members drawn from youth clubs in different villages and served as collaborators in the study. The BCC participated in grama sabhas to introduce the concept and need for village level documentation of people's knowledge. They helped consultants and scientists study and document existing and potential mechanisms to improve the contributions of tribal societies to resource conservation. They also identified suitable follow-up action plans based on PBR results while serving as local level "ambassadors" for conservation and sustainable development.

4. Training in Identification and Collection of Data on Biological Resources and Traditional Knowledge

Members of BCC were trained in data collection and analysis, plant collection, processing and identification. They were familiarized with the concept of the biodiversity, objectives of CBD, issues relating to access to material, knowledge and benefit sharing. Leaders of local political and relevant institutions were informed about the reasons for the study. A summer school on "Plant Taxonomy" was also arranged for teachers and village youth to impart skills in scientific plant identification techniques.

5. Collection of Data

Seven data collection modes were used:

- review of literature on the district's natural resources;
- participatory rural appraisals (PRAs) at village level;
- household interviews with key actors in agriculture and resource management;
- individual interviews with village leaders and knowledgeable individuals;
- questionnaires for household heads of farming families;
- interviews with key actors of Panchayath Raj institutions and NGOs; and
- direct observations and vegetation survey.

The resources studied were: food crops, cash crops, domestic animals, timber yielding plants and other economically useful species, parasites, epiphytes, beneficial and harmful insects, spices, fruit yielding plants, grasses and feeds, medicinal species, mushrooms, fish, birds, sacred groves and other relevant agricultural biodiversity components.

6. Analysis and Validation of Data

A system's perspective was used to analyze communities' contributions in conserving and using genetic materials to understand individual cases of biodiversity conservation and management. The BMC visited sample sites to verify data. Procedures adopted to identify areas with critical genes having the potential for

commercial success, include: (a) identification of traditional varieties and their wild relatives; and (b) analysis of community profiles, knowledge systems and traditional farming practices. Data gathered were analyzed to shed light on the different working hypotheses.

7. Identification of Heritage Sites

Heritage sites are the core PBR areas of the surveyed villages. These were identified based on the wide occurrence of plant varieties and animal species and relatively intact knowledge of villagers about such resources. Heritage sites were selected after repeated surveys on biological diversity, traditional wisdom, healing practices and farm practices. These sites were identified as biodiversity conservation centers when the team had visited for species and environment monitoring.

8. Preparation of the People's Biodiversity Register

The BMC organized a team to prepare a detailed analytical report based on the data collected by the BCC. The PBR has two volumes: one describing information about the area's biological resources and the other, about communities' innovations and specific knowledge.

Volume I focused on:

Chapter 1. **Context for PBR Exercise** includes descriptive overview beginning with relevant information on issues related to PBR preparation and benefit sharing, and background information on the need for PBR

Chapter 2. **Objectives and Study Sites** includes the objectives of the PBR and the criteria used in site selection and salient features of the study area

Chapter 3. **PBR Methodologies and Approaches**

Chapter 4. **People and Agricultural Biodiversity** - provides an overview of the communities' knowledge systems.

Chapter 5. **Landscapes and Biodiversity** - highlights details of communities' biological resources

Chapter 6. **Ecological History** - provides the ecological history (landscape changes and past conservation efforts) of the studied villages.

Chapter 7. **Management Options** - includes the communities' management options, e.g., biodiversity elements requiring protection and species that can be used.

Chapter 8. **Recommendations** - provides action plans based on the results.

Chapter 9. **Summary and Conclusions**

Volume 2 highlighted the details of the communities' knowledge systems.

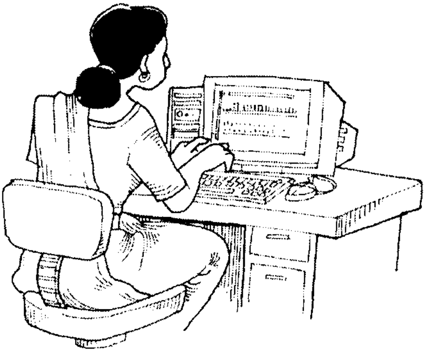
9. Procedures to Reward Knowledge Holders and Farmer Conservers

Recognizing and rewarding the contributions of local people in conservation and sustainable use involved can ensure the continued availability of plant genetic resources. Efforts were made to document details of conserving landraces and folk varieties done by rural and tribal women and men. A public discussion was arranged at panchayth involving political leaders and representatives of key stakeholders in which knowledge providers and farmer conservers were congratulated and recognized by giving them some awards.

10. Maintenance of People's Biodiversity Register

It was agreed to prepare three copies, one each for the Grama Panchayth (village government), the Youth Club identified for this purpose, and for the implementing institution. Annual updating of PBR is recommended to be done independently by local level or if necessary, with the guidance of the institution engaged earlier.

11. Computerization of Needed Information about Resources



Putting knowledge in public domain authenticates the source of information and affirms sovereign rights of society over such resources and knowledge. The information that could be shared without any fear was translated into English and encoded in a format prescribed by the BMC. Photos and accurate labels (e.g., scientific names) added credibility to the shared information.

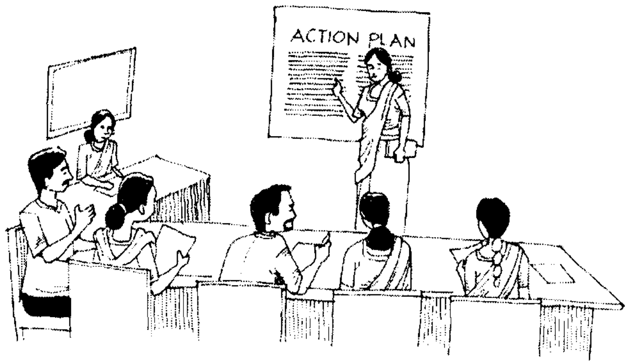
12. Development of Recommendations and Action Plans Based on Information in PBR

After the completion of PBR, a village level meeting was organized to form a consensus on the results and recommendations. The participants validated the information gathered, prioritized recommendations, studied their feasibility for implementation and prepared short, medium, and long-term action plans. Questions related to the type of recommendations and its impact, as well as implementation issues, were answered. Short- term action plans included those not requiring any political approval or large amount of financial resources.

A typical short -term plan is implementable within six months after the village level PBR meeting. Recommendations, action plans and expected outcomes are published separately to raise funds and for wider distribution.

13. Implementation of Short-term Action Plans

Responsibilities and detailed tasks of members were identified. Implementation was monitored by the village-level conservation committee though immediate visible impacts of actions plans were not expected. Long-term monitoring and evaluation system was envisioned to test the feasibility of implementing plans to improve the role and capacity of people in conservation and sustainable use of resources.



Lessons Learned and Future Prospects

Results of PBR in Pozhuthana, Thariyodu, Kottathara, Meppady and Grama Panchayaths are very promising in terms of conservation, enhancement, as well as sustainable and equitable use of biodiversity. The identification of resources and knowledge of these villages using the 13 steps helped understand people's needs and aspirations that enabled conservation and sustainable use of biodiversity. The PBR methodology enabled the team to work closely with village-level institutions, local people and political agencies. It also provided a framework to implement short-term action plans and improve the contributions of village men and women.

The PBR process produced several lessons. Documenting traditional knowledge on crop biodiversity involves several risks, unless there are strong laws and regulations to protect such indigenous knowledge. As such, people should be mobilized to pressure the government to pass pending bills and orders before the parliament. The possibilities of giving incentives to communities in cash or kind must be worked out. Conservation of resources and traditional knowledge is possible only if it becomes a people's movement. For that, people should internalize the concepts enshrined in the CBD such as save, study, use and share biodiversity within a country.

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31

Farmer Management of Sweetpotato Diversity in a Changing Livelihood System
A Case from Central Luzon, Philippines

Traditionally, efforts to conserve crop genetic resources by the formal agricultural research sector have been synonymous with establishing and maintaining *ex situ* germplasm collections. During various collection expeditions, teams of scientists collect passport data along with crop specimen. These passport data that are routinely collected consist of information on the physical environment, but rarely do they include information on the socio-cultural milieu from which the specimens were extracted.

Genetic resources conservation represents one of the main themes in Users' Perspectives With Agricultural Research and Development (UPWARD's) program agenda. In a continuous process of learning from field experiences, UPWARD's participatory approach to research and development on genetic resources conservation has evolved through several phases - from an initial focus on cultural dimensions, to an emphasis on agro-ecological and socio-economic factors, and more recently to the integration of a livelihood systems perspective.

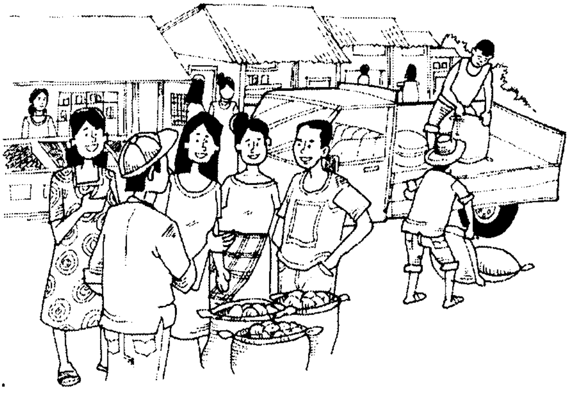
Documenting Cultural Dimension of Crop Diversity

It was only recently that conservation efforts began to recognize the value of documenting local knowledge and cultural information associated with crop genetic materials. As a complement to conventional gene banking, it helps systematize the associated knowledge, beliefs, social norms and decision-making patterns of local people.

Efforts to understand farmer management of cultivars, especially for sweetpotato, have a sound technical basis. Plant breeders recognize that in the process of crop distribution and cultivation, both natural and human selections result in a wide array of different cultivars. However, human selection is particularly effective in a vegetatively reproduced crop because individual variants can immediately be fixed and multiplied.

Assessing Agro-Ecological and Socio-Economic Influences

In the UPWARD program, the growing interest to systematically examine local systems of genetic resources conservation subsequently led to efforts for documenting the dynamics of maintaining rootcrop diversity in the Philippines. Findings from a set of field studies across the country revealed that it is not only important to understand what local people know and do to manage crop diversity. It is also important to consider how changes in the agro-ecological and socio-economic environment influence their decisions and actions.



Empirical studies revealed operational realities in local maintenance of rootcrop diversity. These include:

- how complex local production systems contribute to diversification of sweetpotato varieties;
- the evidence of agricultural "opportunism", particularly with respect to planting what is available when and where it is possible; and
- how communities collectively and unwittingly provide mechanisms for systematic maintenance that may be lacking in individual and household mechanisms.

Introducing a Livelihood Systems Framework

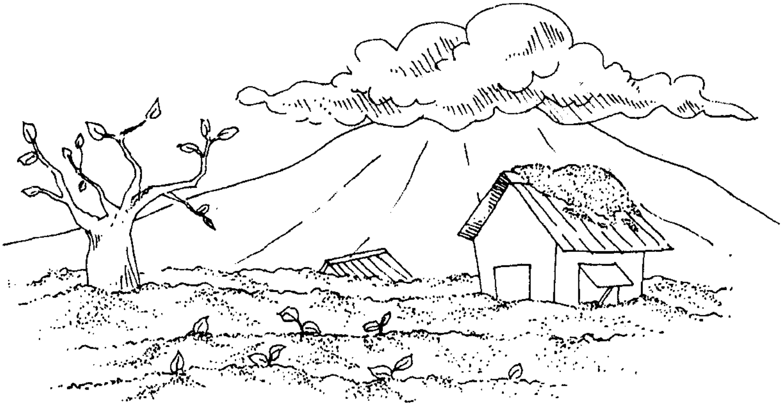
The complexity of livelihood systems has a direct effect on kinds and range of cultivar preferences. Decisions on choices of cultivars to maintain are functions of their intended uses to support livelihood and food security, such as:

- food source during crises and seasonal decline in food supply;
- feed material to support a primary livelihood of animal raising; and
- occasional cash crop.

Given the emerging perspective of conservation through use, the cultivars maintained by farming households are appropriately considered as "assets" and "resources" that support livelihood systems. These twin concepts that are central to a livelihood systems framework are highly relevant in genetic resources conservation because they help distinguish those cultivars that are simply stores of values and those that are applied to support immediate livelihood goals. Furthermore, the maintenance of cultivar diversity represents a particular strategy to gain access to assets and resources in achieving desired livelihood outcomes.

For UPWARD, adopting a livelihood systems perspective marks a significant step toward operationalizing "users' perspectives," by taking a research and development framework that better reflects users' view of rootcrop agriculture:

1) The inter-relationships among genetic resources conservation, sustainable crop management and postharvest-utilization as research and development themes of UPWARD.
2) The diverse portfolio of on-farm, off-farm and non-farm livelihoods that households engage in, of which sweetpotato livelihood is but a component of.
3) The multiplicity of actors with a livelihood system, associated with a particular crop such as sweetpotato.



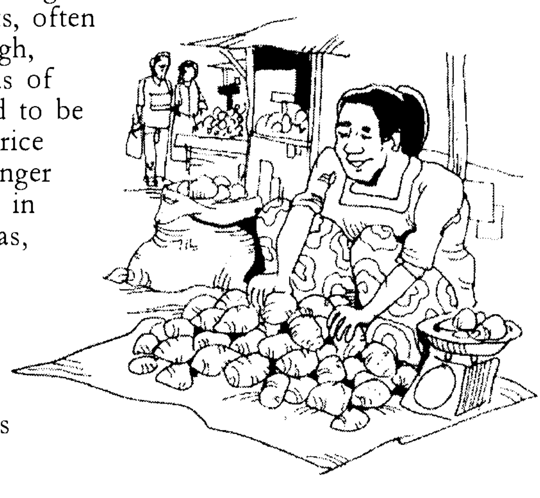
4) The non-economic and less tangible livelihood outcomes that are among the primary factors influencing household decision-making.

The Case of Sweetpotato Livelihood in Central Luzon, Philippines

In the last decade, the sweetpotato livelihood system in Central Luzon underwent major changes, brought about by factors related to the agro-environment, market and production conditions. These factors have made a direct impact on the livelihood system in general, and on farmer management of sweetpotato diversity.

Until the late 1980s when rice was the most economically important crop grown in the region, sweetpotato remained a supplementary cash and food crop. At that time, the dominant sweetpotato cultivars were those meeting the eating qualities preferred by the fresh market and consumers. Given ethnic and personal variations in consumer preferences, there was demand for eight sweetpotato cultivars.

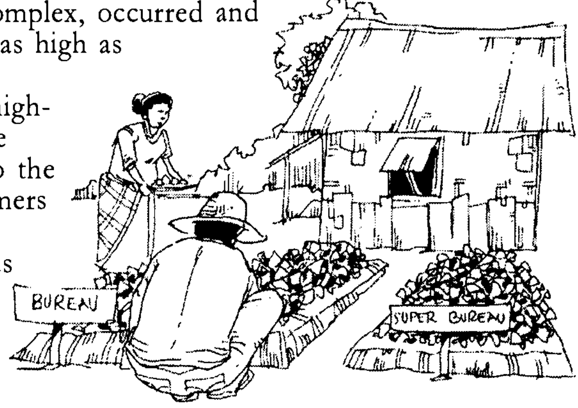
A major volcanic eruption in the region in 1991 resulted in agro-environmental changes in Central Luzon. Lahar deposits, often more than a meter high, flowed into thousands of hectares of what used to be fertile farmlands. As rice cultivation was no longer economically feasible in these lahar-laden areas, farmers turned to sweetpotato which was found to be one of the few cash crops that could survive under the less favorable growing conditions.



In the aftermath of the volcanic eruption, sweetpotato cultivation rapidly became a major livelihood activity for farming households in Central Luzon. As the emerging primary source of cash income in lahar-affected areas of the region, sweetpotato started to be cultivated on a highly commercial scale. With the fresh roots market in Manila serving as target destination, the choice of cultivars to maintain and grow was highly influenced by the preferences of urban consumers. Thus, four cultivars were reported to be the dominant cultivars in Central Luzon during the early 1990s.

The sweetpotato market further expanded in the mid-1990 when three starch plants were set up in Central Luzon. With a combined capacity of processing 130 tons of sweetpotato roots per day, the starch factories created an unprecedented high level of demand for sweetpotato. The factories, however, required roots with high starch content, and only accepted two cultivars meeting this requirement - Bureau and Superbureau. In seeking to take advantage of new sweetpotato livelihood opportunities offered by starch factories, farmers shifted to the cultivation of these two cultivars. By 1998, it was estimated that at least 80 percent of total area for sweetpotato production was devoted to these two varieties.

Soon after the sweetpotato starch industry in Central Luzon took off, a major disease, locally known as *kulot* and caused by a virus complex, occurred and caused crop loss of as high as 100 percent. Unfortunately, the high-starch varieties were highly susceptible to the disease, forcing farmers to abandon their sweetpotato fields as early as two weeks after planting when the symptoms appear.



By the late 1990s, the starch factories could no longer sustain operations due to the inadequate supply of sweetpotato roots. Among the factors that plagued the short-lived starch industry in Central Luzon were:

- the high disease incidence;
- lack of alternative high-starch varieties with low susceptibility;
- and problems in the marketing agreement between farmers and the factories.

The experience was an important lesson for farmers on the value of keeping a diverse portfolio of market options, and of cultivar diversity as a livelihood resource. Since then, farmers have re-oriented production toward the fresh roots market while also exploring new market opportunities provided by smaller-scale feed factories and processing enterprises. Recent field observations revealed the re-cultivation of other cultivars. Aside from the high-starch varieties, other dominant varieties have now included Taiwan, Inube, Bentong and Binicol.

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Women's Home Gardening in Two Rural Communities in Ecuador

Homegardens represent land use systems which involve deliberate management of multipurpose trees and shrubs within the compounds of individual houses. Annual and perennial agricultural crops are planted, and livestock are raised together in a small space.

These are areas cultivated by any household member for use in the home or to sell. Hence, included are backyard garden, kitchen garden, and house garden. While homegardens are considered good repositories of biodiversity because of the various functions in the households, they remain invisible in research and development agendas. Studies conducted about these areas have focused on structures and functions, or the types of plants that are being cultivated. These studies are important, but it is just as significant to understand how the home gardeners, usually women, maintain these areas, and to identify the kinds of problems they encounter.

Main crops cultivated in the two rural communities	
La Calera	Palmitpamba
Corn, potatoes, peas, beans, vegetable production	Sugarcane, banana, cassava

In Ecuador, two rural communities maintain homegardens. These are the community of La Calera in Canton Cotacachi, whose settlers are predominantly indigenous; and Palmitpamba in Nanegal parish whose inhabitants are mestizos. In La Calera, the main source of income is farming. However, the majority of the men work outside the community as government workers, while some travel to other countries to sell locally-made products. On the other hand, the majority of the people in Palmitopamba are engaged in sugarcane cultivation and processing.

The enduring and intimate relationship that exists between women and the environment can be understood from various perspectives. One explanation deals with the symbolic relation of women with nature, emphasizing how mother earth is associated with women in terms of their ability to reproduce and produce materials (e.g., milk) needed for survival. This can be equated with the ability of nature to provide the needed materials for human survival. On the other hand, some argue that women are closer to nature than men because of the material and utilitarian value of the environment. This theory is in fact well documented in the literature and can be traced back to the division of labor by gender or the man-the-hunter, woman-the-gatherer dichotomy.

Aside from providing food, women in these two communities are also in charge of their children's general health and well-being. Women in Palmitopamba grow herbal medicines in their gardens for common ailments such as colds, coughs, and minor cuts so they can personally treat their children in the absence of a doctor. A similar custom is practiced in La Calera where women also cultivate plants to heal common diseases.

> Women keep, maintain, propagate, and conserve various crops grown in their homegardens because they are aware that these materials are necessary for their survival.

Structure of Homegardens in the Two Communities

The homegardens in these two areas are usually located close to the house, and planted with various crops. Vegetables and other foodcrops are usually planted three to five meters away from the house, either at the back or the side, while a single crop (e.g., potato, beans, peas) is cultivated adjacent to the house. In some cases, a few crops are cultivated close to the house, and the rest are planted several meters away. The land area of homegardens ranges from 20 square meters to 300 square meters, depending on the economic status of the household. However, land area alone is not an indication of crop diversity. Low-income families with their smaller gardens tend to have more diversified crops than the high-income families, because the former do not have enough money to buy all their necessities, thereby depending on their gardens.

La Calera	Palmitopamba
• women include areas planted with a more uniform crop situated adjacent to the house, because the majority of the houses are located in the middle of the garden. • typical garden is surrounded with flowering plants and several trees	• typical homegarden has diverse combination of plants, but few medicinal plants and trees • high and low-income families have almost the same amount of land allocated for homegardens • for high-income families, they have less diverse plants in their gardens • no foodcrops are cultivated for home consumption • large portion of land is allocated for sugarcane and other commercial crops

Activities Related to Homegardens

Both indigenous women of La Calera, and mestizo women in Palmitopamba do not follow a specific layout in planting crops in their gardens. Most activities related to homegardens, such as land preparation, weeding and maintenance, are performed by women and children, although weeding is not performed regularly because women do not have time to do it.

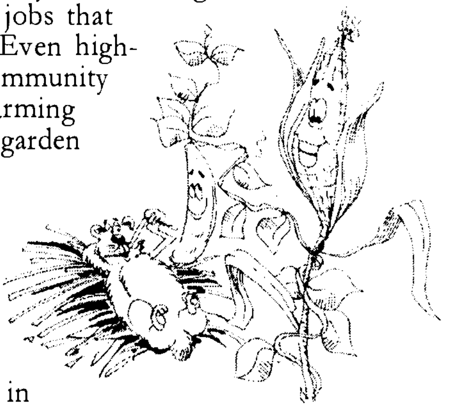
The method of land preparation for homegardens varies according to their size. A wooden plow is used when the land area is big enough for the cows to move around, while shovel and machete are used when the area is small (e.g., 2 x 4 meters). The man in the family prepares the land. Most plants are randomly scattered in the area except for flowering plants,

which women tend to cultivate in the front, or in areas that are highly visible to outsiders. Women weed regularly in areas where the staple crops grow and occasionally around plants cultivated closer to the house. Watering is generally done only during drought conditions.

The degree of market integration also influences the manner by which homegardens are maintained. Although both the indigenous and mestizo women perform multiple roles in the household, the latter have less time to attend to their gardens because of their income-generating activities. Mestizo women who belong to high-income groups are either engaged in processing sugarcane or in transporting the produce to the market. They also spend time preparing food for laborers and/or supervising their business.

> In La Calera, a woman who used to maintain a very diversified homegarden was elected for a government position. From then on, she began to spend less time on her homegarden because of the added responsibilities from her new position and the household chores that she still has to do. Thus, home gardening became a less prioritized activity. This only illustrates how women have to sacrifice some aspects of their lives once they assume new, non-conventional roles.

On the other hand, the majority of the indigenous women do not have outside jobs that demand full-time attention. Even high-income women from this community still engage in subsistence farming and depend mainly on their garden for food.



Except for crops such as potatoes, beans, peas, and corn, harvesting is done in both villages on a staggered basis and only when the produce is needed in the household. In the indigenous community, corn and beans are usually planted during September and October and harvested eight months later while potatoes and peas are

cultivated and harvested during the months when corn and beans are not planted. For these types of crops, relay cropping is practiced with corn being followed by potatoes. Corn is always mixed with beans, while potatoes are intercropped with peas. The mixing of corn and beans is a practical agricultural strategy. Corn serves as poles for beans, therefore saving the gardeners time and energy in putting up poles. Corn stalks are also fed to guinea pigs and eaten like sugarcane. Beans help replenish the nutrients of the soil by fixing nitrogen.

New Trends in Home Gardening

Women belonging to low-income groups appear to have cultivated fewer vegetables in the past and are planning to cultivate more vegetable crops in the future. This trend can be attributed to the country's current poor economic situation. Foodcrops cultivated in the garden are valued not only for food but for their commercial uses as well. Instead of buying food, these women need only to harvest from their homegardens and sell any extra produce.

Furthermore, low-income and middle-income groups plan to cultivate more cereal and vegetable crops. However, high-income groups tend not to prioritize these crops because they can afford to buy staple food and vegetables from the market. They would rather use their time for income-generating activities. Most likely, these women plan to allot a larger portion of their land to crops such as sugarcane, which can be of high value in the market.

The impact of modern agriculture on the two areas resulted in the people's tendency to allocate more land for crops with high commercial value.

Based on women's projections, more vegetables, fruit trees and ornamental plants will be added to the homegardens. A factor that could have increased the interspecific crop diversity is the exchange of planting materials (seeds or actual plants) among women.

In summary, maintenance or abandonment of homegardens is a reflection of the decisions women have to make in their everyday lives. Because homegardens are a good source of food and nutrients for the family and provide an additional source of income in the household, some women continue to cultivate and maintain various crops in the garden. Not only does propagation of homegarden crops help in the conservation of foodcrop diversity, it also provides flexibility for women who rely on different species of crops with various characteristics. These attributes meet household's specifications for different uses and play an important role in the maintenance of the ecosystem.

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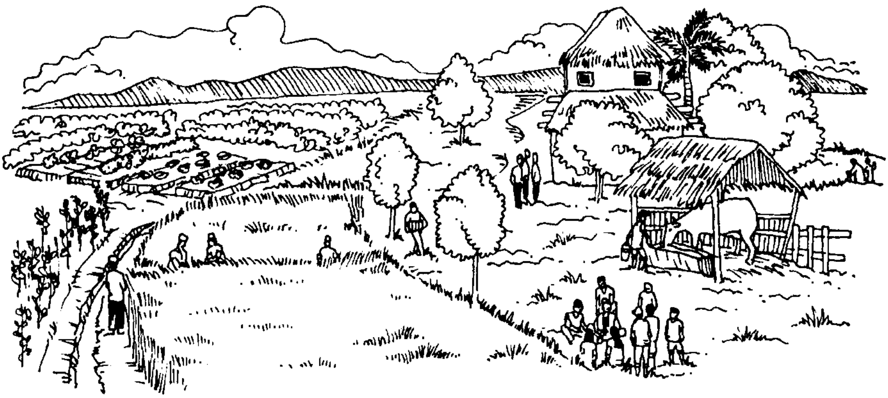
Maintaining Crop Genetic Diversity On-farm through Farmers' Networks



Individual farmers and farming communities have been playing an important role in conserving agricultural diversity. They are not only the custodians, but also managers of the crop diversity and they maintain the dynamic processes of crop evolution and adaptation. In the process, they have developed their own management strategies, which cover the informal seed system.

Who Conserves Genetic Diversity On-Farm?

Most community members grow different cultivars, but some farmers maintain a wide range of diversity more than others in the community. These farmers play a significant role in the flow of genetic materials. Such individuals, referred to as "nodal farmers", occupy a relatively more central position in the informal network of biodiversity management on-farm.

Nodal farmers are those who:

- grow more cultivars including important and rare landraces, and are perceived as diversity minded farmers of the community;
- constantly search for new diversity from within or outside the village and select for variable farm environments; and
- bring in and/or give out genetic materials within and outside the community.

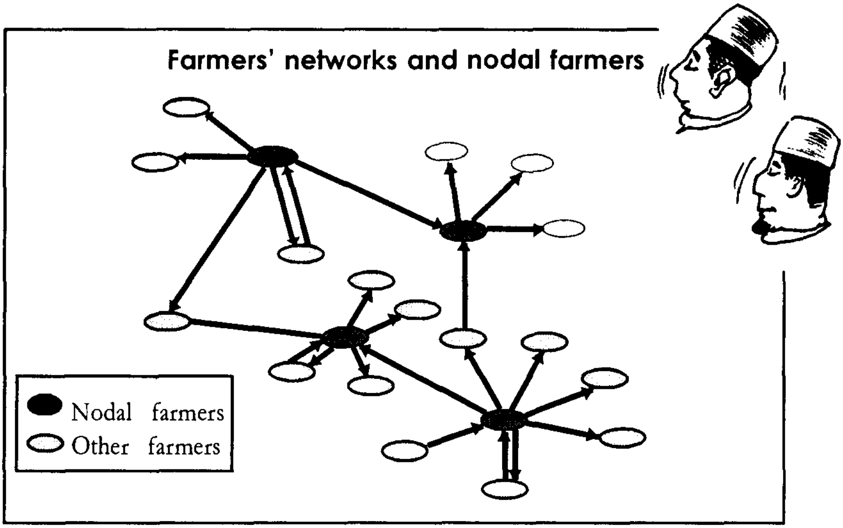
Nodal farmers in Nepal are resource-endowed farmers who have:

- larger landholdings
- more land parcels with varying farm environments
- more heads of livestock
- higher educational level
- more market participation

How is Genetic Diversity Conserved On-farm?

Crop diversity is maintained through the combined action of natural processes and human selection. The role of farmers and their social practices influence their system of seed management, storage and sharing mechanism. This system of farmers' seed management is influenced by the informal flow of genetic materials, which largely contributes to creating diversity on-farm. The flow of genetic materials occurs through farmers' social networks.

Nodal farmers in the community networks are key in maintaining crop diversity on-farm and managing the processes involved in it. They select and maintain high diversity of cultivars at the individual farm, as well as at the landscape levels, frequently exchange cultivars with a relatively large number of individuals. They try to introduce new diversity from different sources, and act as a knowledge and information source in the community. An example of a seed flow network of farmers in a study village is shown in the figure.



A Tale of Two Hill Communities in Nepal:
Informal Seed Flow through Farmers' Networks

In Nepal, a farmer seed flow network study was carried out on a rice crop in Begnas village, a midhill community, and Kachorwa village in the terai plains. The study showed that planting materials were: (i) exchanged (53-60%) on barter basis (either grain for seed or seed for seed but of different cultivars); (ii) given as gifts (17-25%); and (iii) purchased from within or outside the community (9-16%). These exchanges are done for different reasons such as shortage or to replace poor quality seed, interest in growing better cultivars observed in other farmers' fields, keenness to test new cultivars, or the need for suitable cultivars to replace existing ones. Cultivars involved in these flows numbered 42 in Begnas and 35 in Kachorwa. This material flow occurred through farmers' networks found among men-men, men-women (men led), women-men (women led), and women-women networks. Similarly, the networks were not based within a specific economic category, with members belonging to different socioeconomic groups. Both men and women farmers were nodal persons in the community, who were distributed within the community settlements. No barrier exists among the members of the gender and wealth categories in the flow of genetic materials and knowledge associated with them. These farmers are creating a dynamic process of diversity on-farm through germplasm and knowledge-based information flows. Information includes traits of materials, management practices, or varietal performance under different conditions as well as uses associated with the materials.

Analyzing Farmers' Networks

Exploring and mapping seed flows and the processes involved in maintaining diversity in a community can be effectively done through the network analysis approach. A network in a social system refers to the interpersonal relationship of a set of persons connected together through a flow of information, goods, or implementation of joint activities or other social bonds. Analyzing the networks of a social system traces such relationships, identifies nodal persons in the system, and captures the context of the social relations within which players participate. This helps to clarify the dynamic processes involved in maintaining crop diversity.

Questions to ask about the flow of genetic materials:

- From whom do you usually get seed?
- During the last three years, from whom have you obtained seeds/planting materials?
- To whom do you usually provide seed?
- During the last three years, to whom have you given seeds/ planting materials?
- Who usually come to you to ask for planting materials?
- In the last two years, who have come to you to obtain planting materials?

Sociometric Survey

The most common source for acquiring network data is the sociometric survey that obtains relational/linking data among individuals in a social system. In this method, respondents are asked to indicate the names of individuals in their sociometric relationship. To identify such knowledgeable persons, respondents are asked to name men and women farmers whom they perceive as the most knowledgeable in the community on matters related to seed, selection of good planting materials, production environments of different cultivars, diversity conservation and use; who are research and diversity minded; and who form opinions in the community. This type of information can also be obtained from focus group discussion (FGD) with men and women farmers.

Sampling Designs

Different sampling techniques can be used such as: (i) census of an intact system/community, i.e., nonsampling; (ii) representative sampling of an intact system/community; and (iii) snowball sampling. Each sampling method has its advantages and disadvantages. Of these, the most common and widely used sampling procedure is snowball sampling. This involves sampling an initial group of respondents or "starters", who provide data on sociometric links. The sociometrically indicated individuals then become the second-stage respondents. These second-stage respondents consequently lead to the third-stage respondents and so on, following a multistage design in which respondents at each stage sociometrically determine who the respondents are in the following stage.

Network mapping is then done from the relational data obtained from the survey. Nodal farmers are identified by using criteria such as: higher frequency of mentions of their names as source of seed in the community, their links with other individuals in obtaining and providing genetic materials for themselves from within or outside the community, maintaining relatively high diversity, and perceived source of knowledge.

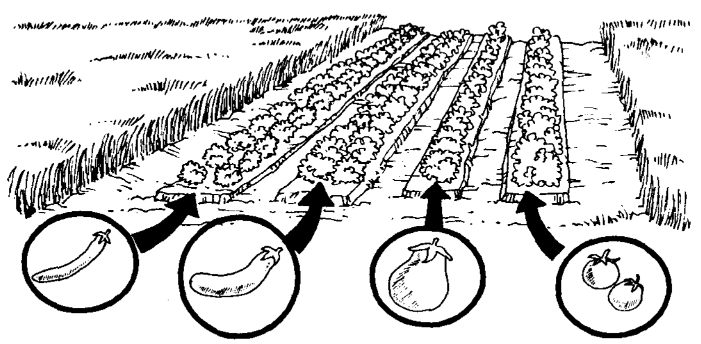
Implications of Farmers' Networks for Conservation and Use

Strengthening On-farm Conservation

Understanding the patterns of social networks and identifying the nodal farmers in a community would enhance conservation efforts. Nodal farmers identified through this process can be tapped in conservation and management of useful plant genetic resources as they have been maintaining a high level of diversity. Strengthening the linkage between these farmers and the other members of the community would enhance on-farm conservation of agricultural biodiversity.

Deploying Diversity

Involving a large number of farmers in a community for participatory plant breeding (PPB) is not possible or practical. This is why it is important to take advantage of existing social networks in PPB processes. Nodal farmers constantly try out new planting materials and make selections in various farm environments. These individuals could be involved in deploying diversity through participatory variety/landrace selection and PPB, giving farmers a greater control of the breeding process. Participation of nodal farmers follows the course of natural farmer-to-farmer seed diffusion through their networks. Imparting new breeding skills to such individuals could further enhance their capacity.



Strengthening the Seed Supply System

Access to sufficient seed, particularly of desired or preferred varieties, would encourage farmers to maintain wide crop and varietal diversity on farm. Effective exchange of seed at the local level depends on the interaction of different sections of the community. To enhance the informal seed supply system, greater contact among community members, through nodal farmers could be encouraged. In addition, community members could be involved in the seed production.

Training Farmers and Disseminating Local Cultivars

Nodal farmers could be effectively used as resource persons on local crops, diversity, their management, and associated knowledge. This would strengthen farmer-to-farmer dissemination. They could also be involved in the development of extension messages on local cultivars and knowledge as well as on conservation and use; and in community biodiversity registration (CBR).

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About the Collaborating Institutions

The International Potato Center (CIP) is a scientific, non-profit institution engaged in research and related activities on potato, sweetpotato, Andean root and tuber crops, and natural resources and mountain ecologies. CIP is a Future Harvest Center supported by the Consultative Group on International Agricultural Research (CGIAR).

Centro International dela Papa (CIP)
P.O Box 1558, Lima, Peru
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Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) GmbH has been operating as a service company in international development cooperation since 1975. The primary goal of GTZ's work is to improve the living and working conditions of people in the partner countries and sustain the natural basis for life. GTZ deals with a range of issues and tasks. In the area of agricultural biodiversity, they include, for example, international agricultural research in cooperation with IPGRI as a contribution to the *in situ* conservation of plant genetic resources, a network for plant genetic resources in Central America, promotion of seed production by self-help groups in southern Africa and and propagating disease-tolerant farm animals in West Africa.

P.O. Box 5180, 65726
Eschborn, Germany
Tel: (0049-6196) 79-1432
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International Development Research Center (IDRC) is a public corporation created by the parliament of Canada in 1970 to help developing countries use science and technology to find practical, long term solutions to the social, economic and environmental problems they face. Support is directed toward developing an indigenous research capacity to sustain policies and technologies developing countries need to build healthier, more equitable and more prosperous societies

P.O. Box 8500
Ottawa, ON, Canada K1G 3H9
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International Plant Genetic Resources Institute (IPGRI) is an autonomous international scientific organization, supported by the Consultative Group on International Agricultural Research (CGIAR). IPGRI's mandate is to advance the conservation and use of genetic diversity for the well-being of present and future generations. IPGRI has its headquarters in Maccarese, near Rome, Italy, with offices in more than 20 other countries worldwide. The Institute operates through three programs: (1) the Plant Genetic Resources Program, (2) the CGIAR Genetic Resources Support Program and (3) the International Network for the Improvement of Banana and Plantain (INIBAP).

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Southeast Asia Regional Initiatives for Community Empowerment (SEARICE) has been engaged in work with farmers, indigenous peoples, workers and urban poor with concerns such as appropriate technology, community health, land issues and other people-centered development works since its establishment in 1977. In 1989, SEARICE focused its efforts in the community-based conservation, development and utilization of plant genetic resources and in policy advocacy and lobbying work related to the issues in agricultural biodiversity, biotechnology, intellectual property rights and access to genetic resources. These activities are implemented in varying degrees in different countries in Southeast Asia.

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Users' Perspectives With Agricultural Research and Development (UPWARD) is a network of Asian agricultural researchers and development workers dedicated to the involvement of farming households, processors, consumers and other users of agricultural technology in rootcrop research and development. It is sponsored by the International Potato Center (CIP) with funding from The Government of The Netherlands.

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