# Conservation and Sustainable Use of Agricultural Biodiversity

## A SOURCEBOOK

March 2003

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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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# Acknowledgements

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# A Role For Diversity Fairs:
## Experiences from Nepal and Vietnam



Traditionally, local seed markets and fairs constitute an important part of the informal seed exchange system in the villages of many developing countries. Local markets and haat bazaar (weekly fairs or agricultural fairs) provide a good opportunity for the exchange of seeds and knowledge. In recent years, such informal systems have been threatened by increased commercialization and private sector intervention in seed production and distribution.

A unique approach to on-farm conservation in Nepal and Vietnam proved successful in increasing awareness of local crop genetic resources and the importance of maintaining agricultural biodiversity on-farm. Currently, diversity fairs are being used to locate diversity and recognize custodians of this diversity, enhance farmer participation and inspire management of rich diversity.

While diversity fairs are not new to the local communities in some countries, the community-organized diversity fairs focus exclusively on indigenous landraces. The idea is still innovative in many countries where diversity fairs can be popularized in rural areas to promote on-farm conservation.

The goals of this effort are:

- to sensitize farming communities and grassroots institutions to institutionalize diversity fairs at regular intervals;
- to develop ways that inspire local groups to establish community seed banks; and
- to promote farmers' selection, seed exchange and the actual distribution of new diversity so that evolution and local adaptation of local crop genetic resources remain central and in the hands of local farming communities.


## Purposes of Diversity Fairs

Experiences of Nepal, India, Vietnam and Latin America reveal that the objectives of diversity fairs can be set by the local community and research team to suit their local context that promotes on-farm conservation process.

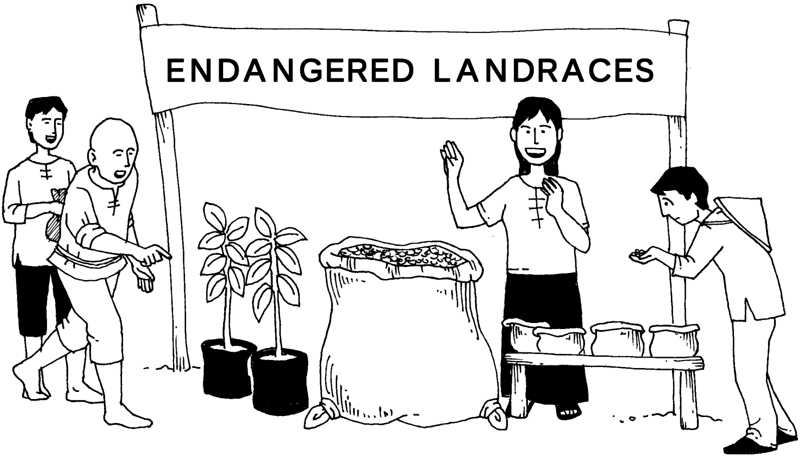
Farmers consciously search for new diversity from different sources. It could be from relatives, neighbors, local seed markets, seed companies, formal agricultural system and diversity fairs. This local system is very dynamic but there are growing pressures on farmers to look for more competitive cultivars.

The *in situ* project uses diversity fairs as a participatory research and development tool in Nepal and Vietnam. It aims to create a competition between farmer groups at a regular basis in order to:

- recognize farmers who maintain a large genetic diversity, possess a good deal of associated knowledge, and act as a source of information for others;
- locate the area of high diversity;
- identify and locate most endangered landraces;
- identify key custodians who maintain high genetic diversity and their reasons for it;
- provide genebanks with samples collected for *ex situ* conservation;
- prepare an inventory of crop genetic resources;
- identify main source of informal seed supply within the community;
- understand reasons of growing diverse genetic resources in terms of use and economic, cultural, religious, breeding and ecological values; and
- empower local community to have control over their genetic resources and develop a sense of ownership using the concept of community genebank, linking both informal and formal seed supply systems.

## Potential Significance of Diversity Fairs

- Diversity fairs strengthen the traditional seed supply system. This method is also able to locate genetic diversity and custodians of Plant Genetic Resources (PGR) more precisely than the conventional exploration missions.




- It also allows scientists and farmers to understand and categorize what are abundant, common, rare, endangered and lost genetic resources. Genetic diversity collected in the village can then be characterized and evaluated *in situ* in the form of a "Diversity Block" to measure genetic structure using agro-morpho traits based upon farmer descriptors.
- First hand information can be obtained from real farmers to understand why farmers grow landraces, when and where they grow landraces and how they maintain and use them at local levels through informal participatory rural appraisal with real custodians.
- We need to find ways to assist the continued selection of local landraces that conserve local useful genes or population. This is the stage where participatory plant breeding (PPB) and other value-adding activities play an important role in on-farm conservation.

- If genetic resources are going to be conserved on-farm, it must happen as a spin-off of farmers' productive (development) activities. This means that conservation must be put into a context of development.


**Community Biodiversity Register**

Farmer groups in Begnas village in Nepal keep an inventory of farmers' varieties, including rare and endangered species, in the Community Biodiversity Register (CBR). A CBR is a record of all landraces in a community, including information of their custodians, passport data (e.g., agro-morphological, agro-ecological characteristics) their significance. CBR affirms the value of indigenous knowledge of resources and encourages their continued use and conservation. This can be a very useful way of monitoring agricultural biodiversity and also develop options for adding benefits of local diversity at local level. In the future, this CBR may also lead to networking among key household seed stores, which maintain rare and high diversity, to form a decentralized community genebank.

## References:

De, N. and N. Tin. 1999. Diversity Fair in Tra Cu, Vietnam. *In situ* Project Progress Report. Can Tho University.

Rijal, D.K., K.B. Kadayat, K.P. Baral, Y.R. Pandey, R.B. Rana, A. Subedi, K.D. Joshi, K.K. Sherchand and B.R. Sthapit. 1998. Diversity Fairs Strengthen On-farm Conservation. APO Newsletter No. 26.

Upadhyay, M.P., D. Rijal, P. Chaudhary, S.P. Khatiwada, D.M. Shakya, P. Tiwari, D. Pandey, R.B. Rana, R.K. Tiwari, A. Subedi and B.R. Sthapit. 2001. Promoting Conservation and Utilization of Agrobiodiversity through Diversity Fair. Paper presented at the National Workshop of *In situ* Conservation of Agricultural Biodiversity in Lumle, Nepal from 24-26 April 2001.

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# Increasing Seed Diversity through Community Seed Fairs in Zimbabwe



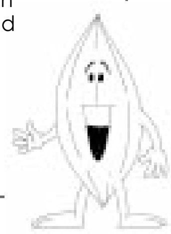
A community seed fair is a relatively new concept that is gaining wide adaptation in Zimbabwe's farming community. It was introduced in 1994 by the Intermediate Technology Development Group (ITDG) through its Chivi Food Security Project. Over the past years, various field green shows and farmer agricultural shows where all branches of agriculture were exhibited (i.e., animals, horticulture, crops and poultry) have been organized. The shows emphasize crop uniformity and distinctiveness of agricultural materials.

Community seed fairs are organized to assess individual and community crop diversity and how it is maintained and conserved by farmers. These seed fairs are also used to generate information about local level seed production capacities, and to provide opportunities for farmers to trade, exchange and share their germplasm between and among themselves.

## Evolution of Seed Fairs in Zimbabwe

The Chivi Food Security Project used the Participatory Technology Development (PTD) process in introducing the concept of seed fairs. Later on, this PTD process evolved into the Participatory Extension Approach (PEA), designed to make the farmers understand and engage in all stages of project planning and implementation.

The Participatory Extension Approach (PEA) has the following steps:
**Step 1.** Awareness Raising
**Step 2.** Baseline Studies include wealth ranking, institutional studies and study into current practices
**Step 3.** Needs Assessment
**Step 4.** Solution Seeking
**Step 5.** Community Planning
**Step 6.** Monitoring and Evaluation



The application of PEA revealed the following needs regarding crop and seed diversity:

- lack of crops and crop varieties suitable to farmers' environment and circumstances;
- limited seed availability of suitable crop varieties, considered as the cause of chronic food insecurity in the Ward; and
- lack of varietal knowledge.

Through the PEA, which gave emphasis to the farmers' own experiences, an array of solutions evolved to address the needs:

- **varietal trials** using both traditional and modern varieties with deliberate efforts to identify varieties that farmers used before the advent of hybrids;
- **field days** which were done in varietal experiment sites and used to appraise the varieties right from the field;
- **exposure trips** to other farms where farmers in similar circumstances articulated their experiences, which visitors adapt to their own environments; and
- **seed fairs** where dry seeds were exhibited, allowing farmers to judge crop varietal diversity in their community.

## Purpose of Seed Fairs

Seed fairs aim to give farmers a venue to display their crops and varieties that create opportunities to:

- exchange knowledge and experiences on the old and new crops that they grow;
- create opportunities for seed exchanges or arrange future exchanges;
- instill confidence among farmers through a healthy and productive competition;
- allow farmer-organizations to display their capabilities;
- create market linkages; and
- create social interaction.

## Organizing and Judging Seed Fairs

Seed fairs are farmers' events and projects with backstop support from local extension workers. Overall responsibilities, including drafting the program of activities, logistics and venue were managed by the farmers. Facilitating organizations (i.e., Community Technology Development Trust or CTDT) do not contribute any funds to the event although they provide guarantees for the prizes during competitions. A seed fair is usually set up using the following modalities:

- The identified farmer-organization leads in planning and conducting the seed fair.
- Farmers exhibit all their crops and varieties on individual stands.
- Seed fairs are entirely farmer-managed and held at ward level.
- Farmers decide who to invite as guests.
- Farmers contribute money or materials used for prizes.
- Farmers define their own judging criteria.
- Judges may be sought from any relevant institution (e.g., the District Agritex office).
- Private sector participation is mainly to support and guarantee the prizes or increase the amount of prizes and other support.

- Food arrangements are done entirely by farmers with support from others.
- Seed fair is done only for a day.
- Both crops and livestock are displayed, depending on what farmers want.
- Products can be displayed in any way (e.g., sorghum can be exhibited as the head, the grain, the flour and the chapatti that is made from the flour).
- Arts and crafts can be included depending on available prizes and farmers' criteria.

Farmers formulate the judging criteria. Usually, they include: (a) the extent of crop and variety diversity; (b) crop and seeds quality; and (c) the display. Impartial judges are invited from different wards composed mainly of agricultural extension workers and representatives from the CTDT. After judging, farmers trade and exchange their seeds or make arrangements for future exchanges.

Prizes are not monetary, rather, they include seeds and agricultural equipment ranging from sorghum seed packs, pearl millet seed packs, cowpea seed, okra seed, plow shares, hoes and wheel barrows.

## Impacts of Seed Fairs


Through the seed fairs, farmers' efforts in sustaining crop diversity are highlighted. The recognizable impacts are:

- generation of practical information about farmers' indigenous knowledge, innovations and technologies about seed production systems;
- farmers, extension personnel, researchers, policymakers and other development agencies are enabled to practically evaluate the level of diversity within an area;
- promotion of opportunities for gene flows within the formal and informal sector;

- maintenance of diversity and seed quality through a healthy spirit of competition among farmers;
- creation of easy methods to assess and monitor genetic erosion as well as seed availability before the next cropping season;
- a forum for farmers to have access to crop diversity within the area, and exchange knowledge, innovations and technologies on crop diversity; and
- promotion of crop diversity and variability as an on-farm agricultural biodiversity conservation strategy to broaden the base for food security and self-sufficiency.

During seed fairs, farmers display a diverse range of crops and varieties that are currently under cultivation. From these displays, it becomes feasible to determine:

- crop diversity and crop varietal diversity in a given area;
- quality of seeds;
- crop/variety with low frequency of entry can be noted and farmers are encouraged to account for the low frequency through consultations (e.g., could the material be under threat of genetic erosion or was anyone discouraging them from growing the crop/ variety); and
- whether genetic erosion is occurring by comparing current entries with those of past records.

## Lessons Learned through Seed Fairs

Through years of experience in conducting seed fairs, some valuable lessons have been gathered. Mainly, it should really be a farmer-based activity except for some backstop support from other organizations. To gain optimum and relevant impacts, seed fairs should:

- address real and felt needs;
- be linked to institutional capacity building;
- be holistic or be a part of a bigger picture; and
- start at the grassroot level.

Farmers embark on germplasm collection of all types not just for seed fairs, but also to ensure household food security. This practice broadens the genetic base of their cultivated materials, which is a great advantage as varieties can be duplicated in the same villages, thus, minimizing the risks of erosion. If one farmer loses a variety, another farmer will be able to supply. Promotion of farmer-based seed fairs and empowering farmers to organize seed fairs is a positive route to sustainable utilization of plant genetic resources.

## Wider Adaptation

- Nine districts in Zimbabwe are now doing seed fairs. These districts include Nyanga, Chivi, Mudzi, Mutoko, UMP, Chiredzi and Tsholotso.
- Agritex is now slowly adopting the practice.
- NGOs lead in the promotion of seed fairs. The main NGOs involved are: Community Technology Development Trust; Commutech; Intermediate Technology Development Group (Southern Africa); ITDG; VecoZimbabwe; and Chwarura Development Association.
- Increased diversity is observed yearly at the seed fairs compared to the previous fair.

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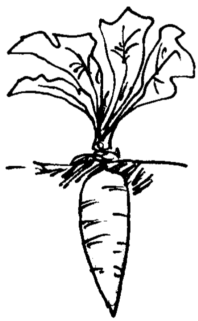
# Grassroots Seed Network Preserves Food Crops Diversity in Australia


Australia is different from any other Asian country in that there is not a long-term or homogenous way of life that is connected to the land to tap for seed varieties. Every crop grown for consumption, besides the odd native Australian bush food, has arrived only in the last 213 years. The English brought their parsnips, Italians their varieties of capsicums and tomatoes, Greeks their excellent spinaches and eggplants, Middle Eastern people their chick peas and garlics, Southeast Asians their many spices, and the Japanese, seaweed, *miso* and *wasabi*.

Culturally, Australia is thus a mix of these and many other cultures that make up its population. Despite its large area, Australia is one of the most urbanized countries of the world, with about 85% of the population living in cities of over 100,000 people. Of course the majority of people eat produce from large-scale monocultures. However, there is a long tradition of backyard vegetable gardening in the spreading suburbs, hence the familiarity with growing food plants.

## The Seed Savers' Network

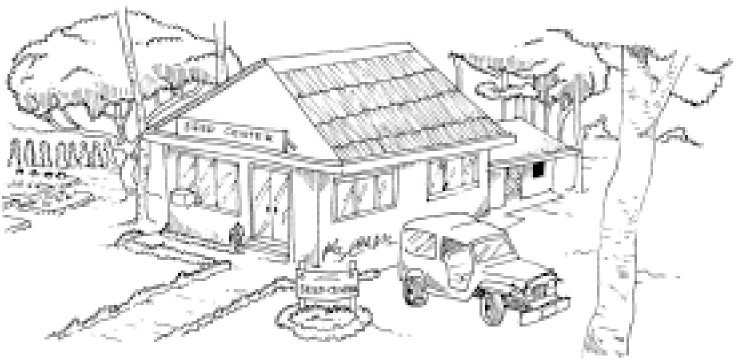


A grassroots organization, the Seed Savers' Network has taken on the task of preservir the diversity of species and varieties of foo plants to help sustain the food plant genetic system in this continent. The network was founded in 1986 by Jude and Michael Fantc

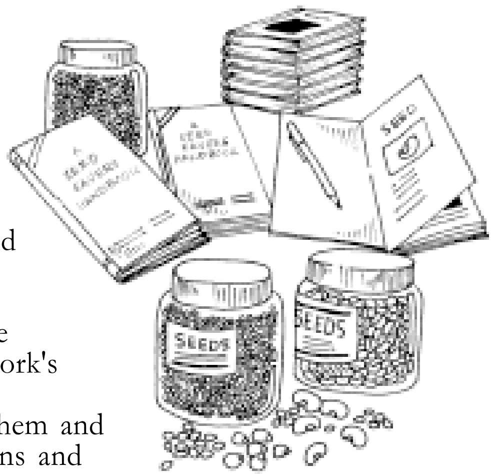
The Seed Savers' Network has focused atte on varieties that do well in biodiverse smal systems by:

- appealing to the general public for seeds ot traditional varieties of food plants;
- popularizing seed saving of these plants;
- organizing their exchange among growers in all parts of Australia; and
- including seed of food plants in trials and bulking quantities of these varieties at its seed center and through a network of experienced seed savers.

How does the network operate? The network gets seed samples from the public who hear of the network's work through the media or through friends, and from subscribers of its newsletter. These individuals act as generators of rare traditional varieties. The network connects seed savers who exchange their seeds with the seed bank and with other subscribers to the network.



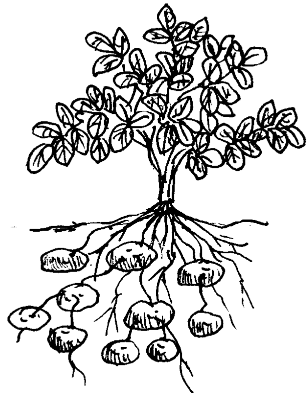

The network maintains the Seed Center, a seed bank where incoming seed batches are accepted and documented, tested for viability, stored in a low-tech insect-proof system and packed for distribution to subscribers and community projects. The Seed Center maintains its gardens that are both species and variety diverse. There is a strong program of growing batches of seeds for comparative trials, for producing more seed and for teaching seed-saving techniques to interested people in workshops and trainings.




Seed Savers' Network also publishes materials such as the Seed Savers' Handbook and a semi-annual newsletter, which lists available seeds, articles and features about seed issues and seed networks, feedback from generators and custodians, and news from local seed networks. Subscription and sales of the Handbook support the network's efforts of publicizing issues, educating the public about them and giving them practical solutions and trials in the Seed Center's gardens. The network also gets funding for its work on community seed banking in developing countries.

## Strategies to Encourage Local Seed Saving and Genetic Preservation

### Training



The network offers and organizes training at its seed center for people who work in agricultural projects. So far, about 20 people from Australia, other developed countries, and developing countries have been trained under long-term internships. These people have worked on seed projects in Solomon Islands, Cambodia, Cuba, Ecuador, India, Japan and East Timor. Training in community seed banking is also being offered in several countries of the Pacific, Caribbean, Africa, South, East and Southeast Asia.

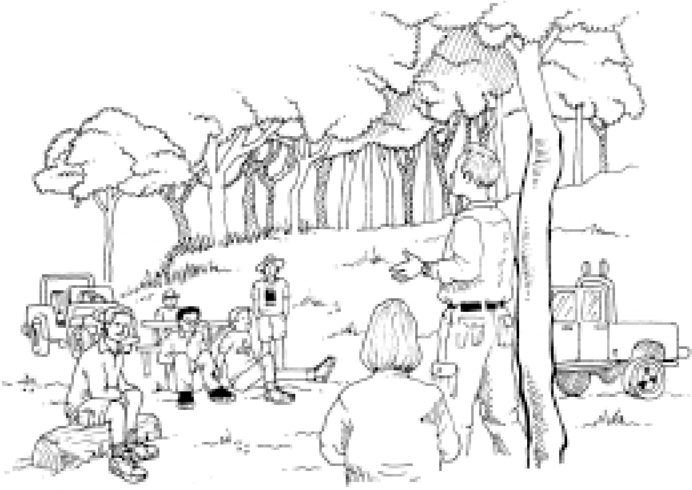
### Establishment of Local Seed Networks

When the Network was established in 1986, there was minimal interest in issues of ownership of plants with the passing of patent laws in Australia. There was also a definite trend away from the actual practice of seed saving in the garden and on-farm. Hence, conducting a national public awareness campaign on saving seeds was imperative. Collection and redissemination of those few non-commercial seeds were undertaken. Many years later, with the increasing popularity of genetically-modified food and crops in Australia, there is enough expertise in seed saving and public interest in the genetic make-up of food and in conserving biodiversity. The expertise is enough to devolve the seed saving work to local networks, which help gardeners with locally-adapted varieties.

For the last two years, Seed Savers' Network has encouraged the formation of these local seed networks. To date, there are 20 such local seed networks in the country; some are independent, but most are attached to some kind of growers' group, including gardeners' clubs, which mostly attract retired people, organic farmers and community gardeners.

## Information Sharing

The Network maintains its own web site (www.seedsavers.net), which offers an information resource to subscribers and other interested persons. In the future, there is a plan to publish seed lists of the various networks on the internet to encourage active seed exchange among them.



## Reference:

Fanton, Michel & Jude. 1993. A Seed Savers' Handbook.

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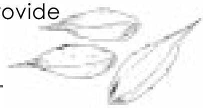
# Training Farmers in Seed Selection to Conserve Traditional Plant Varieties:
## A Case from Bhutan


Farmers, the custodians and managers of local agricultural biodiversity, need to be armed with technical knowledge and skills to enhance their effectiveness as grassroots conservationists and plant breeders.

Various techniques are used to provide farmers with training and technical information on plant genetic resources conservation. Hands-on training or

**Farmer Field Schools**

Farmer field schools or FFS are a popular community-based learning vehicle combining aspects of community organizing and adult education principles. Learning occurs in the field and through discovery-based experiences or simple experiments or exercises, enhanced by various learning and teaching aids. It is designed to develop skills and capacities of farmers. Extension workers or facilitators provide technical inputs and guidance.



experiential learning and Farmer Field Schools (FFS) are effective mechanisms for imparting important information about conservation and use of traditional and local plant varieties.

In Bhutan, a training on rice seed selection for 15 women and men farmers was conducted to:

- help enhance indigenous knowledge of selecting good rice seeds;
- introduce participants to an alternative method of rice seed selection and storing for the next season; and
- familiarize farmer-participants with all stages of biodiversity conservation activities.

## Farmers' Training

The training was conducted as a follow-up to a one-day baseline survey on rice plant genetic resources undertaken in Thangu Village in Thedsho Geog in Wangduephodrang, Bhutan. Thirteen female and two male farmers were interviewed by the extension staff to gather benchmark data.

Research staff from the Renewable Natural Resources Research Center-Bajo (RNRRC- Bajo) served as resource persons for the training. Some components of the FFS approach were also used during the training. The following topics were discussed: importance of good seeds, characteristics of good seed, improving seed quality and other related topics. The importance of good seed selection in conserving traditional plant varieties was emphasized.

In addition to the lecture-discussions using examples and actual seeds, posters and other printed materials were used to enhance the learning process. Most importantly, after the presentations, farmers were given hands-on experiential learning in the field. The rice field was their classroom.

Practical exercises on seed selection were designed to expose them to all phases of the selection process-from selection to threshing, cleaning, labeling, to storing. Trainers were hands-on to provide guidance and further reinforce the learning.

Farmers were asked to select and prepare 5kg of seed of three popular local varieties. Seeds were stored in the research center to avoid mixing with seed from other farmers' varieties. Farmers can withdraw the seed at the time of sowing. The research center kept half a kilogram seed of each variety for further pureline and mass selection.

The simple field-level farmer training activity is useful and more effective because it provides the farmers with practical hands-on experiences while learning.

## Key Information About Selecting Good Seed

**Why is good seed important?**

- Good seeds are the start of good crops
- Good seeds contain more food and produce healthier, heavier seedlings with more roots
- Good seeds result in uniform germination and growth
- Healthy seedlings grow faster after transplanting

**What are the characteristics of good seeds?**

- Cultivar purity
- Free from weed seeds
- Uniformly-large seeds
- Free from seed-borne diseases
- Have low moisture content
- Have high germination capacity

**Why are there mixed or bad seeds?**

- Developmental variation when grown under different environments, soil conditions and elevations.
- Mechanical mixture when sowing, storing, transplanting, and threshing.
- Natural crossing with undesirable types, diseased plants, off-type plants and selective influence of certain diseases.

**What should be done to improve seed quality?**

- Rouging at different crop stages: vegetative, flowering and at maturity
- Cleaning
- Drying
- Storing in a good place

**Steps Involved in Improving Seed Quality**

1. Characterize the variety to be selected using the following morphological characteristics:
   - Plant height
   - Erectness of leaves
   - Tillering ability
   - Panicle size
   - Grain type/size

2. Select enough good panicles from rice plants at least 1 meter away from the borders.

3. Process the seeds: thresh, clean, sundry and store in a new container.

4. Label the container properly to avoid mixing with other varieties.

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# Community Seed Banks for Semi-arid Agriculture in Zimbabwe



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

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

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

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

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

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

## Objective of a Community Seed Bank

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

## Structure of a Community Seed Bank

The structure of the community seed bank is designed after intensive consultation with farmers, taking into consideration their preferences and expectations of the services that it should provide.

Most facilities constructed in Zimbabwe constitute the following compartments:

## Germplasm Conservation Room

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

## Selected and Preferred Crop Cultivars Conservation Room

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

### Seed Storage and Distribution Room

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

### Farmer Meeting Room

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

### An Office

Day to day transactions are conducted in this room.

## Management of the Community Seed Banks

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

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

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

## Farmer Training

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

> In Zimbabwe, most training programs have been done by the lead NGOs, for instance, Community Technology Development Trust (CTDT) in collaboration with the National Genebank.

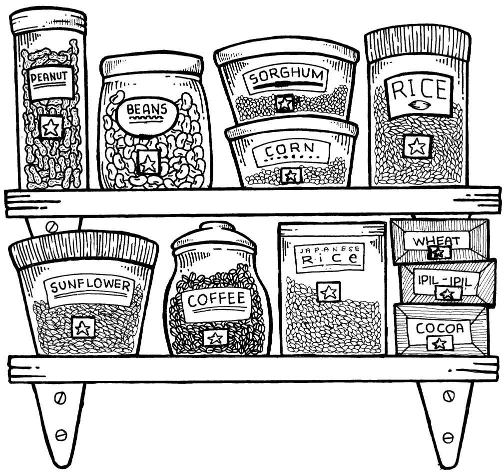
Issues covered in the training programs include:

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

## Benefits of Community Seed Banks

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

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



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


3. Knowledge and information is exchanged about the traits and characteristics of new varieties.

## Recommendations

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

- on-farm characterization and evaluation of materials collected and stored at the seed bank in order to understand their attributes;
- monitoring of seed viability of stored materials by crop and variety;
- determination of the longevity of stored germplasm by crop and variety;

- development of regeneration timeframes of stored materials by crop and variety;
- inventory of characteristic preferences of farmers by crop and variety;
- determination of moisture levels ideal for seed storage under such conditions; and
- determination of quantities of strategic seed reserve required as drought mitigation and management strategy.

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

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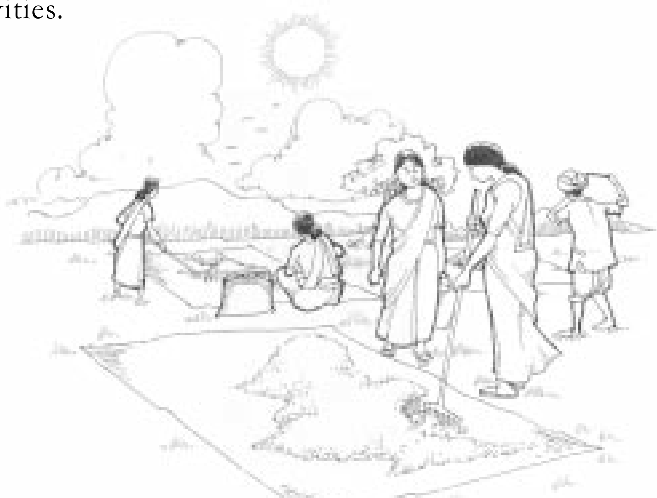
# Institutionalizing Traditional Seed Exchange Networks through Community Seed Banks in Kollihills, India


Most small and marginal farmers are self sufficient in seeds of preferred cultivars and resort to seed exchange with neighboring farmers only following a drought or other emergencies. This 'self-contained' traditional seed system serves as a backup source of seed for the region or community.

Various exchange mechanisms are practiced to exchange seed between individuals and include barter and exchange based on social obligations decided by the community. The practice is informal and varies between locations and is strongly influenced by cultural traditions and relationships. The horizontal seed networking among farmers in different communities is a traditional approach that ensures the availability of seeds.

The introduction of high-yielding varieties and commercial crops affected the availability of seeds of traditional cultivars. Strengthening the access and availability of traditional varieties helps promote on-farm conservation.

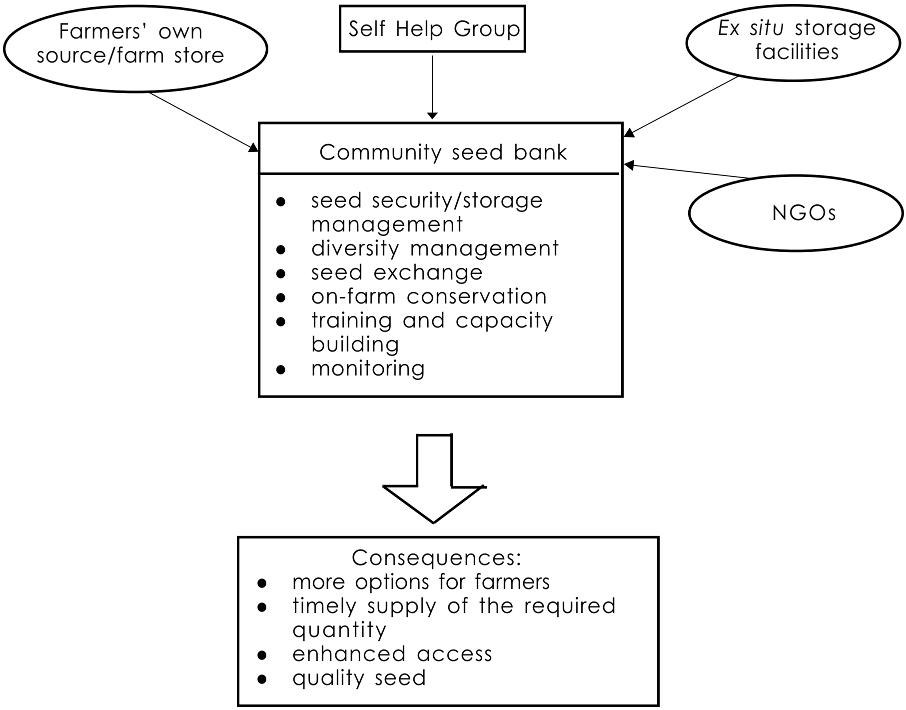
In Kollihills, south India, which is known for its inter and intraspecific minor millet diversity, the seed system is characterized by local seed production, selection, storage, and exchange among local communities. One-tenth of the harvested quantity is normally stored as a seed material. Exchange takes place among relatives and neighbors and generally seed could be given to all. Repayment is a must and customary, sometimes motivating the farmer to revitalize the cultivation. Women play a dominant role in seed management and decision-making, and undertake all seed production activities.



## Establishing a Community Seed Bank

Seed exchange is common and takes place at the individual level. The practice may be institutionalized through a community seed bank (CSB) as a common property resource. Such seed banks, managed by the local communities, could be established at the village or community level to facilitate seed availability. The establishment of such seed banks must build upon traditional practice.

**Seed exchange network in villages**



Community seed banks are established and operated through a seed exchange network in the village managed by a group of local people. The objectives are to:

- ensure the sustainable supply of required planting materials;
- serve as a community based *ex situ* conservation facility and as a backup source; and
- enhance the access and availability of locally adapted crops and their varieties.

A Self Help Group, consisting of 10-15 women and men farmers, manages the unit. The SHGs are primarily credit-based institutions that are recognized by the formal banking system. Two selected women from the group serve as seed bank managers. Necessary training and capacity building programs are organized periodically, essentially focused on seed quality, monitoring, storage and management.

**Local Ethics and Norms Followed in the Exchange Process**

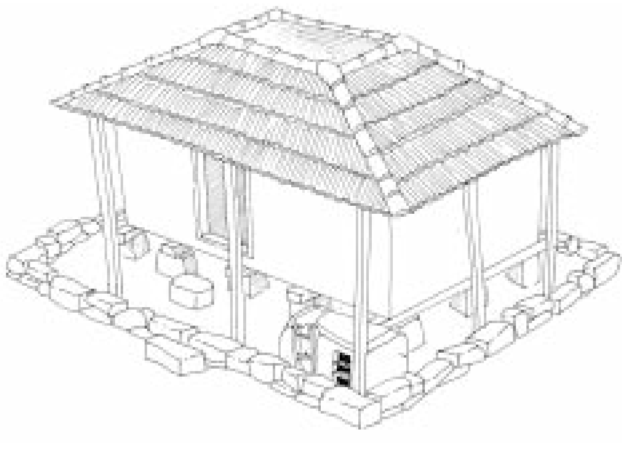
- The borrower has to return two or one-and-a-half times the quantity of the seed borrowed.
- The transaction is through the exchange of seeds and never through cash.
- Seed has to be returned; otherwise, borrowers will not be able to avail of this seed support again.
- If the quantity is not returned after a crop harvest in the year, the interest doubles.
- If the quantity is not returned, the village *panchayat* meetings are used to resolve the matter.
- The lender ensures the seed quality and trusts the "neighborhood certification". If the quality is poor, with inert dust particles and chaffs, the lender cleans it before the transaction.
- Materials are exchanged for products having equal value. For example, little millet and Italian millet are not exchanged for paddy because paddy gives only nearly 60% of the edible part after threshing. Little millet and Italian millet give around 75% of the edible portion, leaving the husk.
- Similarly, products that need to be processed are never exchanged unless they have been converted into useful products. For example, a landrace of Italian millet *killanthinai* could be threshed easily with less energy than *koranthinai,* hence, they cannot be exchanged.

The system links a formal *ex situ* system to a dynamic *in situ* system. The bank maintains a core and working collections of the accessions.

The design for the seed storage facility is derived from the '*Thombai*', a traditional grain storage structure built with red soil, paddy/wild grass straw, and wood. The size of the structure is 5" x 9" with a capacity of 500-900 kg of seed material.

**Thombai** is a traditional grain strorage structure; size varies from small compartment within a house to a separate hut-like structure near the home. The general structure is located 2-3 inches above the ground level to avoid rat damage. Generally, there are two compartments inside and closed on all four sides with a small opening at the top. The roof materials are millet straw in earlier days and slowly it shifts towards tiles and asbestos and aluminum sheets.

There are two types of ownership: individual single household; and kinship basis by more than one household and at the community level. Size of the granary directly correlates with the landholding categories. Women usually manage the granary and use plant-based materials as a storage pest repellent like pungam *(Pongamia glabera)* dried leaves.



Considering local preferences, the required quantity of preferred varieties of seed are mobilized. Seeds are distributed on a loan basis to local farmers and recovered after harvest. The exchange uses the traditional mode of transaction; if a person borrows one unit of seed before planting, she/he returns two units of the seed to the seed bank after harvest.

**Traditional Methods of Seed Storage**

Seeds are stored in the fruits of *Lagenaria ciseraria* and also in the leafy granary made from the leaves of *Bauhinia vahlii*. The Konda Reddy women mix domestic ash to the seeds and preserve them in earthen pots. Only during sowing time are the seeds touched to avoid contamination.

Source: Ethnobotany and agrobiodiversity conservation practices of Konda Reddys of Papikonda Hills in East Godavari District, Andhra Pradesh, India. T Ravishankar, M.S. Swaminathan Research Foundation, A.P., India.

(Website: http://www.mssrf.org)

The managers ensure the germination and physical purity of the seed material while lending and getting it back. Also they constantly monitor the seed stock for storage pests. The availability of the seed stock in the bank and the balance sheet is discussed in monthly group meetings. The SHG members informally pass information on available varieties and quantities to neighboring farmers.

The bank offers community services such as seed security, conservation in the original agro-system, exchange, and revitalization in addition to the indirect incentive of diversity management for society. Five such CSBs operate in Kollihills.

Community seed banks are good tools to revive the conservation traditions of rural and tribal communities. In on-farm conservation sites where agricultural biodiversity is under threat with limiting farmers' options, CSB could be a tool for revitalizing on-farm conservation and for providing farmers with options.

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# Participatory Approaches to Crop Improvement

# *In Situ* Conservation of Agricultural Biodiversity Through Participatory Plant Breeding in Nepal


For the last decades, agricultural scientists have responded to the threat of genetic erosion by developing a worldwide network of genebanks and botanical gardens for conserving the available useful genetic resources *ex situ*. Many farmers' varieties or landraces are the products of *in situ* conservation and they may contain co-adapted gene complexes that have evolved over decades. *In situ* conservation has the capacity to store large number

> *In situ* (on-farm) conservation of landraces means maintenance in farmers' fields and home orchards where they originated. On-farm conservation is generally used to describe a process by which farmers maintain their traditional crop varieties that they have developed and which they continue to manage and improve upon.

of alleles and genotypes compared with *ex situ*. In addition, genebank facilities do not conserve farmers' traditional knowledge of crop selection, management and maintenance process in the development of local cultivars. Likewise, they cannot ensure the continued access and use of these resources by farmers.

However, in developing countries, an integrated approach to conservation may be required to combine different *ex situ* and *in situ* conservation methods depending on:

- biology;
- costs;
- resource availability;
- technical capacity;
- users' needs; and
- threats to the gene pool.

Nevertheless, both systems have complementary roles in the conservation and utilization of genetic resources.

From the perspective of the farming community, *in situ* conservation is an important source of biodiversity-based livelihoods as it meets 95% of basic food and nutrition requirements. *In situ* conservation has the potential to:

- conserve the evolutionary processes of local adaptation of crops to their environments;

- conserve diversity at all levels - the ecosystem, the species, and the genetic diversity within species;
- conserve ecosystem services critical to the functioning of the Earth's life-support system;
- improve the livelihoods for resource-poor farmers through economic and social development;
- maintain or increase farmers' control over and access to crop genetic resources;
- ensure that farmers' efforts are an integral part of national plant genetic resources (PGRs) systems and involve farmers directly in developing options for adding benefits of local crop diversity; and
- link farming community to gene bank for conservation and utilization.

The importance of conservation of agricultural biodiversity for the future of global food security lies in its potential to supply germplasm to crop breeders' and other users' future needs.

## How Farmers Manage Local Crop Diversity *In Situ*

Crop genetic diversity present in farming systems has been maintained through the combined action of natural and human selection. Human selection and management; natural selection from the surrounding environment (i.e., soil type, climate, disease pests, and competitions); and population structure (i.e., mutation rates, migration, population size, isolation, breeding systems and genetic drift) affect crop diversity in agricultural systems. In the process of planting, managing, selecting, roguing, harvesting and processing, farmers make decisions on their crops that affect the genetic diversity of the crop populations. Over time, a farmer may alter the genetic structure of a crop population by selecting plants with preferred agro-morphological or quality characteristics.

## Understanding Social Seed Networks and Informal Seed System

There are certain individual farmers who maintain a relatively larger number of diversity than other members of the community. Such farmers are considered to be the "nodal farmers" of the community. These "nodal farmers" are said to:

- search for new diversity, select, maintain and share within and outside the community;
- grow higher numbers of cultivars including important and rare landraces;
- constantly look for new cultivars for their variable farm environments;
- play important roles in the flow of genetic materials within and outside their community; and
- be more knowledgeable in seed and production environments related matters.

Nodal farmers have been found to play an important role in seed flow in the informal seed system. They were selected as collaborators in the Participatory Plant Breeding (PPB) program in Nepal. Nodal farmers have been found playing important roles in these seed flows through social networks.

- They give out seeds to other farmers within and outside the community.

- They bring in the materials from other farmers within and outside the community.
- These farmers create a dynamic process of seed germplasm flows and exchange.

## PPB's Contribution to *In Situ* Conservation Strategy

PPB is a strategy to enhance *in situ* conservation through use. PPB and *in situ* conservation both encourage farmers to continue to select and manage local crop populations.

**Participatory Plant Breeding is considered as a strategy to:**

- strengthen the process of *in situ* conservation;
- increase competitive-ness of landraces ;
- strengthen local seed system for sustainable development;
- deploy diversity for sustainable ecosystems;
- ensure access to a choice of diversity;
- broaden the base of local crop diversity; and
- enhance biodiversity and increase productivity.

With an increased level of farmer participation and decentralized testing, PPB can enhance deployment of genetic diversity and also broaden the base of local crop diversity in a sustainable manner. Increased varietal diversity deployed among farmers' fields as well as within them is the key to reducing vulnerability to disease and pest epidemics. The process also ensures farmers better access and control of acceptable germplasm.

# Roles of Farmer and Breeder During PPB Process

| Fundamental steps | Nature of participation | Farmer | Breeder |
|---|---|---|---|
| Goal setting | Consultative | • opinions and views considered from diverse focus group discussions (FGDs) | • identify nodal farmers using Farmer Network Analysis |
| Generating new diversity | Collaborative | • participate in training on reproductive biology and crossing techniques (capacity building on principles and concept) | • key role |
| Selection | Collaborative | • site selection<br>• rejection of bulk population<br>• selection within and between population<br>• post-harvest selection<br>• quality assessment<br>• trade-off multi-traits vs yield | • screening incoming germplasm<br>• screening disease/pest resistance<br>• selection-early generations<br>• training -heritability, reproductive biology |
| Variety release and distribution | Collaborative or collegiate participation | • strengthening informal seed supply system<br>• distribution of PPB products through social seed networks (e.g., nodal farmers) | • prepare proposal for release or monitoring of spread<br>• flexible seed regulatory framework |

(Modified from Sthapit and Jarvis, 1999)

## Basic Features of PPB that Enhance On-farm Conservation of Agricultural Biodiversity

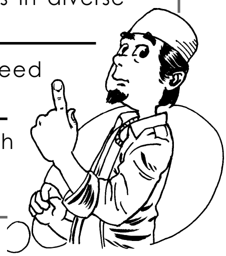
The following were the identified feature for enhancing on-farm conservation of agricultural biodiversity.

- farmers' role in setting breeding goals and parent selection
- at least one parent should be well-adapted to the local (target) environment
- decentralized *in situ* testing to reduce GxE interaction as selection is always in the target environment, and under farmers' actual management conditions
- large F2 and F3 populations are grown to increase the possibility of identifying transgressive segregants
- skill enhancement of farmer breeders in conceptual aspect of plant breeding (e.g., reproductive biology, heritability and selection)
- farmer participation is built in to eliminate advancement of poorly preferred varieties and to address culturally, ecologically, and economically important traits

## Participatory Plant Breeding Process

In order to strengthen capacity of farmers and their local institutions on *in-situ* management of local crop diversity, the following process of PPB can be used.

| | |
|---|---|
| **1** | Locate crops, ecosystems and communities. |
| **2** | Encourage local institutions to conduct diversity fairs with the objectives of community sensitization to locate unique diversity and understand and promote access of materials and information. |
| **3** | Understand local crop diversity by analysis of amount of distribution of crop diversity and their uses. |
| **4** | Participatorily assess preferred and unwanted traits in both common and rare landraces. |
| **5** | Develop options for adding benefits of local diversity by three strategies: (a) improve local landrace itself in order to make it competitive and economically attractive; (b) improve access of locally adapted genetic resources; and (c) increase the demand of local material by better processing, packaging, marketing and creating new opportunities in ecotourism, local food culture and blending with modern food products. |
| **6** | Set breeding goals and roles of community and institutions. |
| **7** | Selection of diversity by diverse farmers in diverse natural and management conditions. |
| **8** | Strengthen local seed system for seed diffusion. |
| **9** | Promote *in situ* conservation through better utilization and awareness. |



## Consolidating Farmers' Roles in PPB

The goal of *in situ* conservation is to encourage farmers to select and maintain local crop diversity for their own benefit.

The PPB process will enhance plant breeding skills of local institutions and farmers to search new diversity, select preferred traits, evaluate and maintain diversity. It is also important to promote decentralized testing of materials and participatory post-harvest evaluation of materials for diverse uses. It is a common practice in formal breeding systems to use productive, uniform land for trials. In contrast, the participating farmers avoid risk by testing the new materials on their worst land, where there are serious biotic or abiotic stresses, and then growing them on better fields if they like it.

It was also learned that farmer strategies for choosing test plots and agronomic practices differ from the conventional plant breeders. Therefore, considerable flexibility in testing and evaluation methods is needed in order to encourage farmers to select and maintain the seed of their choice. Farmers have good knowledge of variation on their total land parcels and they do have strategies to diversify their crops and varieties by changing, selecting, rotating, mixing and exchanging seed to tap new opportunities and also to combat evolving pathogens and pests.

## Using Social Seed Networks and Nodal Farmers for *In situ* Testing of Variable Materials

The process should also be linked with informal social network of seed supply so that the PPB products are exchanged, sold or given as gifts. Nodal farmers can be involved in enhancing farmer-to-farmer dissemination of genetic materials. Expertise of the nodal farmers in the selection and maintenance of genetic materials can be effectively used in PPB. Likewise, capacity building of nodal farmers' participatory plant breeding may enhance diversity on a large scale.

A network of nodal farmers can act as conservation farmers and their farms can be used as "Community Genebank." Their involvement in the community biodiversity registration (CBR), and link to development opportunities can be very effective.

## Strengthening Seed Supply

Access of local adapted seed is often reported as a constraint for production. Nodal farmers can be involved in seed production of PPB products and its distribution strengthens informal seed systems. At the community level, a network of nodal farmers can be a sustainable way of managing local level seed production and distribution.

## Strengthening Access to Materials and Information

Periodic organization of diversity fairs is an effective participatory method to promote exchange of materials and information. PPB products can be displayed, sold and bartered with grain in order to provide direct benefits to farmer-breeders.

## References:

Eyzaguirre, P. and Iwanaga. 1995. Farmers' Contribution to Maintaining Genetic Diversity in Crops, and its Role Within the Total Genetic Resources System. In: Participatory Plant Breeding, Proc. of a Workshop on PPB, 26-29 July, 1995, Wageningen, The Netherlands and IPGRI, Italy.

Sthapit, B.R., K.D. Joshi and J.R. Witcombe. 1996. Farmer Participatory Crop Improvement III. Participatory Plant Breeding: A Case Study for Rice in Nepal. Expl. Agric. 32:479-496.

Sthapit, B.R. and D. Jarvis. 1999. Participatory Plant Breeding for On-farm Conservation. LEISA, 15:40-41.

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# Impacts of Participatory Varietal Selection and Participatory Plant Breeding on Crop Diversity


Some sectors regard modern varieties (MVs) as a cause of losing traditional varieties, while 'locally adapted' traditional varieties are considered to be of greater value to farmers than modern varieties. Hence, grassroots non-government organizations (NGOs), accepting these assumptions, propose interventions such as the establishment of village seed banks to preserve traditional cultivars and recommend active measures to conserve traditional varieties, thus, preventing or slowing the introduction of MVs. (Ravishankar and Selvam, 1996).

Others believe that MVs play an essential role in the agricultural system and that more participatory methods would help preserve biodiversity in cropping systems involving MVs. This supports the viewpoint that preventing access to new varieties is both technically difficult and ethically dubious as it denies farmers - often those in greatest need - the economic benefits accruing from cultivating new varieties. Accepting that MVs are essential for adding to the amount and value of production also means accepting that they will have impacts--both positive and negative--on varietal biodiversity.

Over the last 100 years, there was a dramatic growth in agricultural productivity; world crop yields increased between two-and four-fold depending on the crop. An estimated 20-40% of this increase has been achieved by genetic modifications and breeding. "The introduction of new genes and genetic modifications through crossing existing crop varieties with wild relatives is valued at approximately $115 billion per year worldwide in crop yield increases." (Pimentel, *et al.*)

**Measuring Biodiversity in Crops**

The simplest measure of diversity - the average diversity - is the dissimilarity between all possible pairs of the varieties farmers grow in a specified area (although in practice measuring dissimilarity is not simple). However, agricultural biodiversity is not just a function of how many cultivars farmers grow and how dissimilar they are to each other.

An agroecosystem with many cultivars but only a few occupying most of the area is more genetically vulnerable than an area where cultivars are more evenly distributed. The reduced diversity caused by one or few varieties occupying much of the cultivated area can be estimated by using a weighted diversity. Given equal genetic dissimilarities among cultivars, weighted diversity will decrease proportionally with increases in inequalities in the areas devoted to the cultivars.

Biodiversity can also be considered over time--temporal diversity--as well as space. As one cultivar replaces another, there is a temporary increase in biodiversity over time because, until the replacement is complete, there are two cultivars in the farmers' fields instead of one.

## Participatory Approaches to Plant Breeding and Varietal Selection

There are two methods of farmer participation in the plant breeding process: (a) participatory varietal selection or PVS; and (b) participatory plant breeding (PPB). In PVS, farmers are given varieties (finished products from plant breeding) for testing in their own fields. After a successful PVS program, the varieties preferred by farmers can be used as parents in a breeding program where farmers participate as active collaborators. This involves breeding and selection to create new varieties and is called PPB. Others use the term PPB more broadly to include PVS.

**A PVS program has four stages:**

- participatory surveys to discover what varieties farmers are growing;
- a search and procurement process for suitable new varieties (or their creation by plant breeding);
- farmers' experimentation on the new varieties in their own fields; and
- wider dissemination of the identified improved varieties.

This assumes that there are existing varieties which are better than those currently grown, but farmers simply never had the opportunity to try them. This assumption has proven to be almost invariably correct.

## The Impact of PVS on Biodiversity

Varieties tested in PVS can rapidly spread from farmer to farmer. In areas with high biodiversity, the rapid spread of an introduced variety can have a major impact on increasing average diversity and, if it becomes the predominant variety, it can reduce weighted diversity. However, marginal areas, where farmers still grow landraces, do not necessarily have high biodiversity and extremely marginal environments have low biodiversity. In many cases, high diversity is the result of high environmental diversity where there is a patchwork of more favorable and less favorable environments, such as:

- mountainous environments where there are marked changes in altitude and aspect over short distances; or in
- dry areas where there is variability in the soil's capacity to retain water and changes in topography that give different amounts of run off.

High potential production systems usually have low weighted diversity because, under the technology transfer extension systems of developing countries, very few varieties are recommended. However, despite having few recommendations, there are more varieties that have been bred and released for favorable areas than for marginal ones. Hence, the availability of a greater varietal choice in favorable areas makes it likely that PVS will lead to the adoption of several varieties. This will increase both average and weighted diversities. Despite the commonly assumed uniformity of high potential production systems, new varieties can occupy specific niches in the farming system.

> In many cases, high diversity is the result of high environmental diversity where there is a patchwork of more favorable and less favorable environments.

As the fit between niches and varieties improves so does the overall productivity of the system. Farmers' preferences for different varieties to fit niches should help maintain biodiversity.

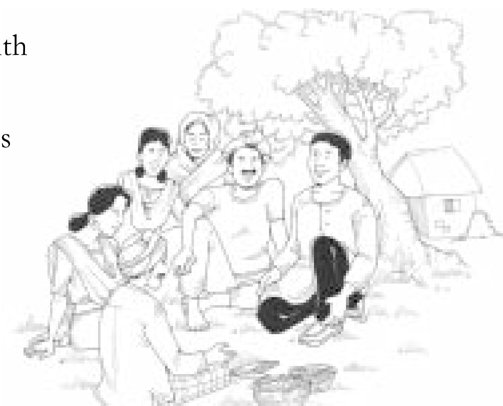
**The greatest increase in biodiversity from PVS will occur when:**

- existing biodiversity in farmers' varieties is low;
- these varieties are partially replaced by a new variety or varieties;
- there are many new varieties;
- when the new varieties have a high genetic dissimilarity with the existing varieties; and
- when all the new varieties occupy similar areas (weighted diversity tends to be less when one variety occupies a large area).

PVS tends to increase the rate at which varieties are replaced. This results in higher biodiversity when measured over time by a comparison of biodiversity between two dates (temporal diversity is a maximum of 1 if, between the given dates, all the varieties are entirely replaced by new ones and the old and new varieties are completely unrelated). High temporal diversity imparts more durable resistance to pests and pathogens that have less time to evolve and overcome host-plant resistances.

## Types of PVS

Testing new varieties with farmers can be done in many ways. As there is no set protocol, methods can vary with the circumstances of the researchers and the farmers. Nonetheless, generalizations can be made concerning the resources required for different methods.



Two methods were compared in India and Nepal, namely: (a) Farmer Managed Participatory Research (FAMPAR) that uses many resources; and (b) informal research and development (IRD) that is much less resource demanding. In both methods, released and pre-released varieties are selected inside and outside the target region and are given to farmers for testing. Results of the comparison are summarized in table 1.

**Table 1. Steps Used in the FAMPAR and IRD Methods for PVS**

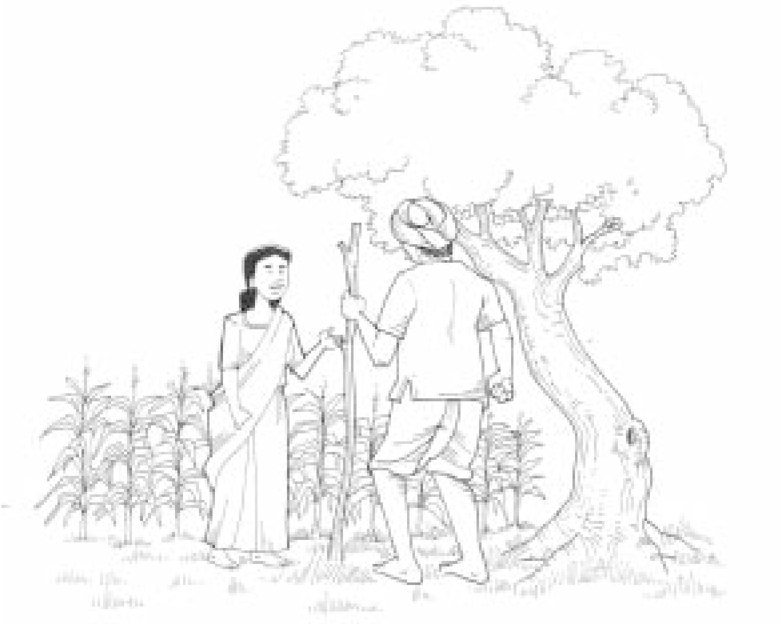
| Process | FAMPAR approach | IRD approach |
|---|---|---|
| Farmer identification | Well-being ranking, focus group discussion (FGD) to identify farmers from different well-being categories. | Farmer identification and distribution of IRD sets across well-being category done by the local communities using their best judgement. |
| Trial plot selection and demarcation | Joint visits both by farmers and researchers. | Plot selection left to farmers. |
| Regular monitoring of the trial plots | Joint visits both by farmers and researchers. | Not done. |
| Participatory evaluation through farm walk | Participating and other farmers, along with researchers, visit most of the trial plots . | Not done. |
| Focus group discussion (FGD) | After the farm walk, narrative summary and preference ranking of varieties, and overall preference/s. | Not done. |
| Participatory yield measurement | Researchers measure the plot size and farmers record the total yield. | Not done. |

| Process | FAMPAR approach | IRD approach |
|---|---|---|
| Household level questionnaire (HLQ) | Researchers visit participating households to evaluate the post-harvest traits of the varieties. | Not done. |
| Monitoring the adoption and spread of varieties | Semi-structured interview with initial and subsequent adopters to study acceptance and spread. | Evaluation by anecdote of acceptance and spread. |

IRD is cheaper because it uses less intensive evaluation. It was proven effective for popularizing new varieties by Lumle Agricultural Research Centre, Nepal. In IRD, small quantities of seeds are supplied to farmers without monitoring or participatory evaluation during the growing season. Instead, farmers' perceptions are evaluated after harvest by informal interviews. FAMPAR trials are designed to satisfy the needs of research and extension while IRD is mainly for extension. There are no significant differences between varieties that farmers adopted in India and Nepal for both PVS methods. Hence, IRD is an effective way to rapidly increase biodiversity as it allows new varieties to spread from individual farmers who received seed, thus, maximizing the impact of farmer-to-farmer spread. In practice, the optimal approach is to use an appropriate combination of FAMPAR and IRD.

## Participatory Plant Breeding (PPB) with Collaborative Participation

The collaborative form of participation involves farmers undertaking PPB activities for themselves by, for example, growing variable material in their own fields and making their own selections from it. This benefits crop biodiversity, particularly in the fields of collaborating farmers, because they grow a highly diverse range of novel germplasm in place of their usual crop. If the PPB material then spreads from farmer to farmer, biodiversity will increase in other farmers' fields, but initially these benefits will be greater in areas neighboring the PPB program site.



In outbreeding crops, such as maize, a more limited range of diversity can be given to farmers as more resources are required to create one open-pollinated variety compared with one inbred line in an inbreeding crop. If collaborative methods prove possible - both a minimum population size and genetic isolation from other populations are required - then there will be an immediate increase in diversity in the fields of the collaborating farmers. Moreover, a single population can carry a large reservoir of variability, particularly if a low selection pressure was applied during the initial random-mating generations. It is difficult to generalize on the consequences of PPB in outbreeding crops because the ways by which different farmers select and maintain seeds are important in determining eventual changes in varietal diversity.

The extent to which diversity will increase depends on the PPB method used and whether the crop is an inbreeder or outbreeder.

In inbreeding crops, such as rice, wheat and barley, PPB is not constrained by isolation distances and population sizes. Many methods are possible, but those that greatly enhance biodiversity are the ones that give farmers the greatest genetic diversity. These are bulk-breeding methods in which farmers are given bulks derived from a cross between diverse parents. These bulks can be produced by methods, such as single-seed descent, that are designed to create higher between-plant variability in the later generations by minimizing selection during the early generations. Bulk seed, produced by breeders, is given to farmers at a sufficiently advanced generation to produce in their fields highly heterogeneous populations of nearly homozygous plants.

PPB can produce a greater range of varieties that meet farmers' needs than centralized breeding, because fewer varieties are rejected for having undesirable quality traits, height or maturity. Indeed, most PPB programs result in a wide range of desirable cultivars that can be widely tested and promoted through FAMPAR and IRD techniques.

## References:

Ravishankar, T. & V. Selvam. 1996. Contributions of Tribal Communities in the Conservation of Traditional Cultivars. In: Proceedings of Conference on Using Diversity and Maintaining Genetic Resources on Farm. International Development Research Centre, New Delhi, India. pp 268-274.

Witcombe, J. R., K.D. Joshi, B.R. Sthapit. 1996. Farmer Participatory Crop Improvement. In: Varietal Selection and Breeding Methods and their Impact on Biodiversity. Experimental Agriculture 32: 445-460.

Witcombe, J.R. 1999a. Does Plant Breeding Lead to a Loss of Genetic Diversity? In: Wood, D. and J.M. Lenne (Eds.), Agrobiodiversity: Characterization, Utilization and Management. CABI Publishing, Oxon. pp. 245-272.

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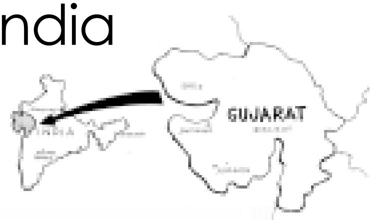
# Farmers as Plant Breeders
## Three Cases from India




Farmers not only conserve landraces but they also develop new varieties through their own selection and crossing procedures. Farmers have always been known to make selections in the available diversity through natural mutations, mixtures or outcrossing. Sometimes, diversity also comes about due to natural stresses, which create selection pressure. This provides opportunity for less common characters to become noticeable. For instance, if a few rice plants survive in a flooded field, farmers may select these plants and accordingly develop a flood-tolerant variety.

The Honey Bee network has documented a large number of these examples over the last 12 years and three cases are described here, all from India. In each case, farmers' unique ability to observe and select a distinctive variety has brought out the potential of farmers to breed varieties.

The Honey Bee network emphasizes the need for accountability of the formal research system to people whose knowledge is often used to improve formal research work without acknowledgement, reciprocity or sharing of benefits.

The Honey Bee Network has documented more than 10,000 innovations either of contemporary origin or based on outstanding traditional knowledge primarily from India but also from other parts of the world. Many of these innovations are extremely simple and can improve efficiency of farm workers, women, small farmers and artisans.

The network was launched seven years ago and operates in 75 countries.

## Case One - Farmer's Selections

### An Eye for Detail, Diversity and Deviance

Thakershibhai Savalia, a 70 year-old farmer from Pankhan village in Saurashtra, a dry part of Gujarat, has a very keen eye for variation in the field. In 1987, when there was a severe drought, most of his groundnut crops had withered. However, he found two healthy plants, which seemed different from the rest. He marked these and observed their growth every day. After maturity, he used the seed to multiply and within five years, through recurrent selection, he developed a variety, which he initially named as *Morla* (i.e., like a peacock) because its pod resembled a peacock's beak. It had a very good oil content aside from two unique traits: (a) the lack of ridges on the pod; and (b) a strong peg.

*Morla* also had better than average disease and pest resistance as well as better drought tolerance than other varieties. It also had an extremely good taste. The stronger peg and lesser ridges helped in digging out the groundnuts after maturity. Pods are less likely to be left in the soil, requiring a second or third digging. Through word of mouth, the variety spread to more than 40 villages in the last few years.

While the variety was rejected in the All India Coordinated Research trials conducted by the Indian Council of Agricultural Research (ICAR), farmers in the region continue to grow it. Thakershibhai is very keen to get varietal protection for his selection.

## Case Two - A Pigeon Pea Variety with Pink Flowers

Dhudabhai Punjabhai Patel of Gadha village, Sabarkantha district, Gujarat, selected a few odd plants in a field sown with BDN-2 variety. These plants were neither affected by pest or disease, and also had a different flowering and pod-bearing pattern from the other plants. The plants had pink flowers when most pigeon pea varieties have yellow flowers which attract the pests. The new type had more pods with 5 - 6 seeds per pod. Most of the pod-bearing branches were on the upper part of the plant, thus, making it easier for women to harvest them.

The yield was satisfactory (25 to 30 quintals per hectare) even at low fertilization level. It was also resistant to wilt and was early maturing. The farmer named the variety *Gadha Dudhabhai Punjabhai* - 1 (GDP-1). The cooking time for the dried pulse was short. The grain was bolder and more suitable for certain recipes. In 1994, this farmer-bred variety has been registered with the National Bureau of Plant Genetic Resources. Mansukhbhai Ramjibhai Murani has also selected a pigeon pea mutant from the BDN-2 variety. This has bigger leaves, 4 - 5 seeds per pod, equal pod bearing on each branch, requires less water, and seems resistant to the sucking pests. Its flowers are red outside and yellow from inside and provided a good yield.

## Case 3 - Sundaram

### A Penchant for Innovative Plant Selections

Sundaram is one of the most enterprising young breeders and experimenter discovered by the Honey Bee Network. He has developed a very innovative agroforestry system in arid parts of Rajasthan with rainfall less than 20 inches per year. He has also developed numerous vegetable varieties as well as pulses and spices through selection in farmers' fields. He has made unique selections, which even the formal research system has not done. One of his first outstanding selections was a variety of chili with three times more color value than the best variety in India. It also has 50% higher yield than the popular improved variety and twice the market value than the other available varieties.

Among his notable selections are:

- two garlic varieties with earlier maturity than the rest, one of these varieties has a better yield than all the improved varieties released by the formal research system;
- six onion varieties with higher productivity than the improved released varieties;
- six cluster bean varieties, four of which are free from powdery mildew and two from leaf curl disease;
- a sesamum variety which is resistant to drought and free from red rot disease plus other single varieties of green gram, fenu greek, chickpea and cumin which are all disease- and pest-resistant;
- 13 coriander varieties which are resistant to both blight and wilt, some of which also showed synchronous maturity; and
- 22 pearl millet varieties, which are free from black smut, 19 of which are free from downey mildew.

There are numerous programs on so-called participatory breeding around the world. But somehow, when asked to share examples of varieties developed by farmers, the international community seldom provides the necessary responses. This indicates that there are not enough farmer-breeders in the world or maybe, these innovative farmer-breeders are not the main focus of researchers engaged in so-called participatory breeding.

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# Applying the Farmer Field Schools Approach to Genetic Resources Conservation

The Farmer Field Schools (FFS) is a season-long group learning methodology, where farmers discover on their own, through simple field experiments, potential solutions to their field problems. These community-based learning groups may consist of 20 – 30 farmers, usually participating in weekly sessions for the whole duration of crop production. Extension workers or trainers provide technical inputs and facilitation. A group field is set-up as a common learning area from which hands-on exercises on ecological aspects are studied.

Originally applied in integrated pest management (IPM), this educational process has been adapted in Plant Genetic Resources Conservation, Development and Use (PGR CDU). In the process, new information is generated either to validate existing knowledge or to fill gaps while at the same time, developing the capacity of farmers to conduct crop improvement research for improved production.

## Steps

In applying the FFS approach, here are some basic guidelines that may be used.

### Step 1. Start-Up Activities

- The team, together with the trainers, gives courtesy call to officials and explain to them what FFS PGR CDU is. A particular village, for implementation of the project, is identified.
- Interested and committed farmer participants are selected. In the selection process, balance among male and female participants is ensured.
- Criteria for site selection for field trial are set. With the farmer participants, the common learning area where the field studies will be set-up for one season is selected.

## Step 2. Baseline Establishment

To establish the current PGR situation in the community, the following tools are used during a community meeting:

- Map of (rice) plant genetic resources in the village
- Matrix of rice varieties and their characteristics (strengths and weaknesses)
- Diagram of sources of plant genetic resources
- Matrix of farmers' skills
- Matrix ranking of pair-wise comparison of farmer's enumerated breeding objectives

**Objectives of Baseline Establishment:**

- To establish the situation of plant genetic resources according to farmer perception.
- To establish the situation of farmers' skills and knowledge in plant genetic resources management and breeding according to their perception.
- To enable the trainer/researcher to understand the situation and farmers' perception and begin to share his knowledge and facilitate farmers' data gathering and analysis
- To motivate farmers to look into their plant genetic resources situation, and act.

## Step 3. The Planning Meeting

Before the actual conduct of FFS, a planning meeting is held with selected participants for:

- validation of the biodiversity situation in the locality;
- validation of characteristics of local varieties;
- identifying desired varietal characteristics;
- plant breeding systems; and
- developing workplans for the first season.

## Step 4. Field Studies

The field studies can be likened to experimental plots only. They are designed, maintained and monitored by farmers. The studies are set-up in farmers' field(s).

The Field Studies, although they can be undertaken independently, are linked into one process.

- **Varietal Evaluation Study (VES)**
  Farmers identify their preferred varieties which they then will multiply, distribute and plant in their fields.

- **Seed Rehabilitation Study**
  If the preferred variety from the VES has deteriorated (with mixtures and impurities), farmers may opt to rehabilitate them before they are used as parent materials. In some cases, farmers rehabilitate the seeds of traditional rice varieties for conservation and improvement. Seed rehabilitation studies sometimes result in the development of pure lines and later distinct variants of the variety being rehabilitated.

- **Plant Breeding Study**
  Farmers use their preferred varieties from the VES as parent materials for crosses. Farmers synchronize the flowering dates of preferred parents.

- **Selection Study**
  Segregating populations or lines of different generations are evaluated and farmers select the best plant or bulk the population. The use of different generations in the study allows farmers to experience handling the different generations. They are able to have a good picture of the selection process from the segregating population.

Different crosses are recommended to ensure diversity, preferably obtain segregating materials from crosses between traditional varieties or traditional varieties with improved varieties.

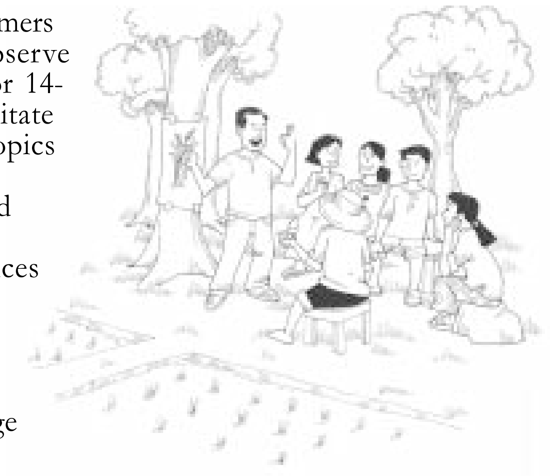
It is not necessary to do all the field studies in one season. The frequency and kind of field studies to implement depend on the interest and capability of the farmers' group, based on their initial assessment.

Some farmers are assigned to take care of and monitor the field studies for the entire season. This leads to the development of a core group of farmers with specialized skills in each of the topics. The core groups have the responsibility to help other farmers gain the different skills.

During the season, it is important for each small group in the FFS to share experiences and understand how their studies are all linked together. For this reason, it is suggested that the studies be set up in one field to facilitate observations and collective learning.

## Step 5. Learning Sessions, Special Topics and Field Exercises

The groups of farmers meet weekly to observe the field studies for 14-20 weeks. To facilitate learning, special topics (for conceptual understanding) and field exercises (for hands-on experiences on topics) are developed. The timing of the field exercises depends on the growth stage of the plant.



Team building exercises may be facilitated by trainers to enhance the learning process.

**Possible special topics and field exercises for the season are:**

- What is biodiversity and plant genetic resources?
- Understanding loss of biodiversity
- Review of agroecosystems analysis
- Conservation of plant genetic resources
- The plant breeding cycle
- Two systems of plant breeding
- The rice plant: overview of the agronomy, morphology and growth stages
- Reproductive characteristics of rice
- Genes, genetic and phenotypic segregation
- Selecting a mate: setting the criteria for parentals
- Techniques in rice breeding
- Criteria for selection of varieties
- Selection techniques for segregating materials

## Step 6. End of the Season Activities

Towards the end of the season, a Farmers' Field Day (FFD) is organized by the farmer group. In the FFD, other stakeholders – farmers from the same village or neighboring village, village officials, policy makers, researchers, development workers and others – are invited for a reporting of the results of the field studies. Farmers also take the opportunity to lobby local officials to support their activities and share the results and process with other interested farmers.

Sometimes, farmers also organize a taste test of the produce, in time for the FFD, to involve other stakeholders in the assessment of the varieties/lines they are experimenting with.

## Conclusions

The use of FFS to strengthen farmers' management, conservation and development of their plant genetic resources proved effective. The spread of materials and skills is faster than in other methods (e.g., direct community organizing, curatorship).

However, actual experiences yielded a number of concerns that have to be addressed:

- Initially, trainers may have difficulty in combining participatory methodologies with highly technical input on PGR conservation and development, but after one season of field experience and refresher trainings and a defined curriculum, the difficulty may be lessened if not totally eliminated.
- Difficulties in obtaining crosses (for line selection studies), according to ecosystem and farmers' preferences and objective of increasing diversity while increasing production, may be encountered. Some research institutions may be reluctant to get involved or some may not have the needed materials.
- Quality vs. Quantity of implementation - It is easy to expand operations with FFS but the quality of implementation may be at stake. Unlike Integrated Pest Management (IPM), PGR development goes beyond one season.
- Question on sustainability of farmers' efforts - To sustain current efforts there is a need to get the support of local government units to institutionalize support.

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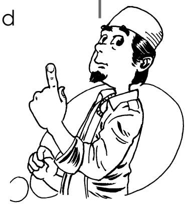
# Strengthening Community-Based, On-Farm Conservation of Agricultural Biodiversity

## Experiences from Nepal


On-farm conservation of agricultural biodiversity requires a recognition that farmers control the decision making process; and that conservation is concerned with the maintenance of the capacity of animals, or crop plants to change and adapt. Good participatory practices strengthen local capacity to manage on-farm conservation.

Good practices are those practices, that are practical, cost-efficient, sustainable, and have the potential for scaling up in wider geographical, institutional and socio-cultural context.

> Good practice is a system, organization or process, which, over time maintains, enhances and creates crop genetic diversity, and ensures their availability to and from farmers and other actors for improved livelihoods on a sustainable basis (UNEP/IPGRI, 2002).



Several practices have been tested for effective implementation of the above-mentioned steps. However, the following are considered good practices for community-based on-farm conservation in Nepal:

- participatory extent and distribution (four square diversity) analysis;
- social seed networks;
- participatory community sensitization;
- diversity fairs;
- diversity blocks;
- diversity kits;
- community biodiversity register; and
- participatory plant breeding.

**General Steps Needed to Strengthen Community-Based, On-Farm Conservation of Agricultural Biodiversity**

Develop understanding of local context and local diversity
↓
Sensitize farming communities and key stakeholders
↓
Improve access to materials and knowledge
↓
Locate, characterize and assess diversity
↓
Manage community biodiversity information systems for monitoring diversity
↓
Develop options of adding benefits to community
↓
Increase consumer demand for rare, threatened and traditional crops and food culture
↓
Improve the materials and creating new opportunities for livelihoods

# Participatory Extent and Distribution Analysis for Understanding Local Crop Diversity

Farming communities have always maintained substantial amounts of genetic diversity for food and agriculture. Local knowledge and culture can be considered as integral parts of agricultural biodiversity, because it is the human activity of agriculture, which maintains this biodiversity. It is, therefore, critical to understand local circumstances (i.e., local crop diversity, local knowledge, customs and food culture, local seed system and local institutions) before strengthening the capacity of community-based conservation strategies. There are many participatory rural appraisal tools that can be used for rapid biodiversity assessment and situation analysis. However, they are not particularly useful as diagnostic tools for participatory understanding of the richness and evenness of local crop diversity and its linkages with people's livelihoods.

## Social Seed Network

The informal seed system is a key element of on-farm conservation of local crop diversity. This is integrated into a social network of rural communication. Some farmers maintain a relatively large range of diversity, search for new diversity, select, maintain and share within and outside the community. Such farmers are considered to be the "nodal farmers" of the community.

Recently, the local CBO Development and Environment Protection Club (DEPC) has recognized the nodal farmers in Nepal. They can be effectively involved in community biodiversity registration (CBR) and linked to development opportunities.

## Participatory Community Sensitization

Community participation is central to the community-based, on-farm conservation of agricultural biodiversity and use. Community participation can be strengthened through sensitization of farming community and consumers through public awareness. However, this strategy for *in situ* crop conservation will only succeed if indigenous communities and grassroots organizations are involved at different stages, while adressing their needs and problems. Many *in situ* conservation projects become unsustainable because of lack of efforts to strengthen community dynamics.

The project in Nepal successfully employed the following practices to strengthen community participation for effective implementation of the *in situ* conservation:

## Village Workshop

The village workshop is used to inform the local government as well as the local community about the purpose of the project; build rapport with village leaders during the initial stage and identify key contact persons and foster community participation.

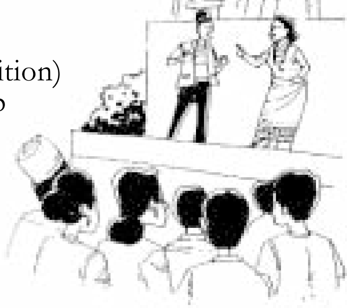
## Social and Resource Mapping

Social and resource mapping is an integral part of site characterization once the villages are selected for the project activity.

## *Gramin Kabita Yatra*

*Gramin Kabita Yatra*, (rural poetry journey) uses local poets to sensitize farming community to conservation issues. They create poems highlighting the value of *in situ* conservation with local examples.

## *Lokgeet Pratiyogita*



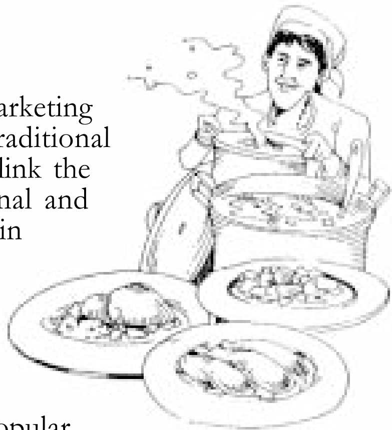
*Lokgeet Pratiyogita* (folk song competition) is conducted amongst farmers' group during the World Environment Day to assess their level of awareness about on-farm conservation at farmers' group level.

## *Gramin Sadak Natak*

*Gramin Sadak Natak* (rural roadside drama) has play writers who spend a few nights in the village to pick up a local story base for the drama. Local farmers and professional actors take part in the street drama to sensitize fellow farmers on the value of plant diversity using poetry, dance and songs at local socio-cultural setting.

## Traditional Food Fair

The traditional food fair is a marketing concept, which adds value to traditional crops and products. It helps to link the market with eco-tourism (national and international) and food culture in order to promote local products and local cuisine.



## Diversity Fair

The diversity fair is the most popular and useful participatory method for sensitizing from local community to Minister levels. From the farmers' perspective, diversity fair is the best way to participate in project activities to share information and materials. From the PGR researchers perspective, this is an entry point to reach the farming community; to locate genetic diversity; and to identify custodians of genetic resources more precisely than the conventional exploration mission.

> Diversity fair has been found to be a simple and low cost approach for locating biodiversity. It helps to identify custodians of rare and unique crop genetic resources and local knowledge, and establish links for future studies.

## Diversity Block

The diversity block is a technique to characterize local landraces under conditions of typical farmer management. Germplasm to be grown in the diversity block may be selected from the materials displayed in diversity fairs or from community member's seed stocks. Farmers using traditional practices manage the crops, while farmers and scientists monitor the plants to observe and record agromorphological characteristics. In Nepal, it was used to measure and analyze agromorphological characters and to validate farmer descriptors. Farmers were invited to watch the diversity block in the field and determine whether the farmers are consistent in naming and describing varieties.

## A Diversity Kit


Diversity kit is a set of small quantity of different seeds made available to farmers. Seed harvested from diversity blocks could be used to assemble a diversity kit, which is given to farmers during interview as a gift. This kind of informal research and development encourages farmers to search for, select and maintain fixed lines and promote deployment of diversity *in situ*.

## Community Biodiversity Register

A community biodiversity register is a community-based record (CBR) kept in a register book or electronic format by community members or local institutions. A CBR aims to monitor local crop diversity at the community level and to encourage local communities to develop their own conservation strategies.

## Participatory Plant Breeding

Participatory plant breeding (PPB) consolidates the role of farmers in plant breeding. The process allows farmers to understand existing local crop diversity; underlying strengths and weaknesses of available genetic resources; and search for preferred traits. PPB also offers skills to farmers to select fixed or variable materials and maintain seed in traditional ways. PPB, together with integrated pest and nutrient management, empowers farmers to manage their genetic and natural resources in a sustainable manner.

**Understanding constraints and opportunities in the development of relevant participatory approaches**

An important task for the development of participatory approaches to conservation and use of plant genetic resources is to better understand the constraints and opportunities for dissemination among farmers.

This must be done through analysis and enhanced understanding at three levels:

- **Impact assessment analysis of on-going participatory projects.** There are several anecdotal evidences of positive project outcomes. However, there is only a limited systematic understanding of trade-offs between different project objectives, participatory methods applied, project impact on farming systems, and different social groups, among others.

- **Better understanding of the institutional set-ups and policy frameworks constraining up-scaling of the participatory approaches.** The implementation of the new approaches in a policy and institutional framework created under the conventional "transfer of technology approach."

- **Improved understanding of the diversity in technological needs among farmers.** A different agrobiological, social and economical conditions and the role of genetic diversity in different production systems will be produced.

Source: Esbern Friis-Hansen and Rikke Grand Olivera

## References:

Friis Hansen, E. & B. Sthapit, eds. 2000. Participatory Approaches to the Conservation and Use of Plant Genetic Resources. IPGRI, Rome.

Jarvis, D., B. Sthapit and L. Seras, (eds.) 2000. Conserving Agricultural Biodiversity *In Situ*: A Scientific Basis for Sustainable Agriculture. Proceedings of a Workshop, Pokhara, Nepal.

Jarvis, D.I., L. Myer, H. Klemik, L. Guarino, M. Smale, A.H.D. Brown, M. Sadiki, B. Sthapit and T. Hodgkin. 2000. A Training Guide for *In Situ* Conservation On-farm. International Plant Genetic Resources Institute, Rome, Italy. 161p.

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# Participatory Approaches to Crop Improvement in Nepal


During the early twentieth century, the process of conventional crop improvement was highly centralized. It poorly addressed the actual needs and preferences of farmers for they only had the options to accept or reject a few finished crop varieties. Moreover, the crop varieties developed through formal breeding have largely been suitable for resource rich and high production

The participatory approaches applied to crop improvement in Nepal include Informal Research and Development (IRD), Participatory Variety Selection (PVS) and Participatory Plant Breeding (PPB). Besides, there are tremendous opportunities of these approaches to integrate with other disciplines such as Farmer Field School (FFS) and *in situ* crop conservation. The integration helps reduce the cost of the project and leads to sustainability.

environments. This indicates that yield gaps and adoption are problems of the conventional breeding system. At the time, scientists seldom recognize the knowledge and participation of farmers. These shortcomings forced the scientists to re-think and develop a new concept that is need-oriented and addresses diverse socioeconomic conditions, production environments, and management practices. Thus, the concept of Participatory Crop Improvement (PCI) came into existence.

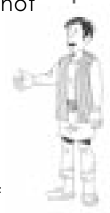
The main advantage of PCI over conventional breeding is that it involves farmers in developing, adapting and adopting new varieties; setting breeding goals; and selecting parents according to their requirements. Level of participation, however, varies with the nature and objectives of the project and availability of resources. It develops among different organizations and farmers the spirit of working closely together and appreciating each other's capability and contributions. The strengths and capabilities of different stakeholders are also fully utilized in an integrated form. This is why these processes are now taking worldwide acceptance.

# Participatory Variety Selection (PVS)

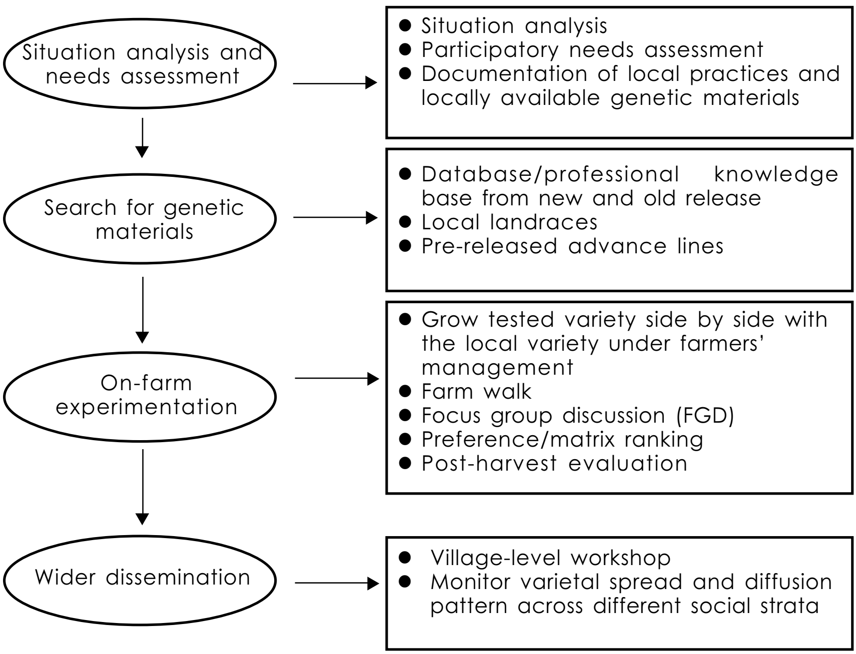
PVS is the selection of released or pre-released advance lines (including landraces) by farmers in their target environments using their own selection criteria. Basically, PVS:

- provides varietal choices to the targeted farmers under their specific environmental conditions;
- promotes participatory approaches to test; and
- select and disseminate the preferred variety.

> PVS overcomes the problem of poor adoption rates of the farmers' preferred varieties. PVS does not only help farmers to adopt the new varieties but also helps in increasing the on-farm agricultural biodiversity by providing choice of varieties to farmers.



**PVS process and participatory tools used**



## PVS and Agricultural Biodiversity

Local Initiatives for Biodiversity, Research and Development (LI-BIRD) has been doing PVS since its inception in different parts of Nepal on different crops (cereals and legumes). PVS has helped farmers to:

- adopt many new varieties of different crops;
- increase the productivity and production of the major food crops; and
- improve on-farm agricultural biodiversity.

PPB as a strategy for biodiversity enhancement and production can be achieved if PPB products are spread through informal farmer-to-farmer seed supply systems.

LI-BIRD, in a joint program with the Nepal Agriculture Research Council (NARC) and the International Plant Genetic Resources Institute (IPGRI), has been using this approach for *in situ* conservation of rice landraces in Pokhara valley and Bara district of Nepal.

Increased agricultural biodiversity has considerably reduced the chances of complete crop failure in cases of adverse biotic and abiotic stresses.

The study by LI-BIRD showed significant changes in the numbers of major crops varieties grown by farmers in the project sites before and after PVS intervention. The number of rice varieties grown in the project sites increased 60% in Gulmi, 89% in Syangja and 42% in Mahottari after the project. The number of maize varieties grown in these sites increased to 100% both in Gulmi and Mahottari, and 62% in

Syangja. Similarly, the number of wheat varieties increased to 150% in Gulmi, 100% in Syangja and Mahottari respectively. PVS has been instrumental in increasing both the number of varieties and the area coverage by these varieties in different parts of project areas of LI-BIRD (Figure 1).

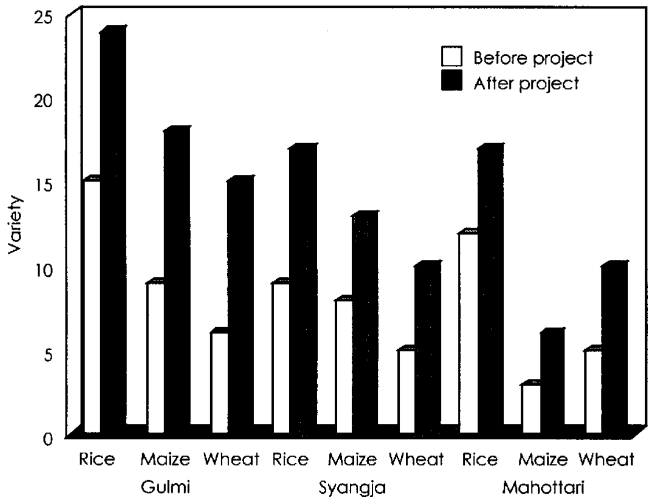



Figure 1. Number of popularly grown varieties before and after project intervention of LI-BIRD in project areas of Gulmi, Syangja and Mahottari districts.

## Participatory Plant Breeding (PPB)

PPB is a breeding process in which farmers and plant breeders jointly select cultivars from segregating materials under a target environment. The other forms of PPB may also include activities such as germplasm enhancement through pureline or mass selection. PPB could either be consultative or collaborative, based on the typology of farmer participation suggested. Therefore, success of PPB rests on the blending of comparative strengths of farmers, breeder and social scientists involved in the process.

The use of consultative or collaborative methods as well as choosing the right level of farmers' participation depends on: crops; capacity of the participant farmers; willingness; and availability of breeder and researcher resources. However, PPB commences only after PVS.

| Consultative PPB | Collaborative PPB |
|---|---|
| • farmers are consulted to set breeding goals<br>• farmers choose appropriate parents and testing sites | • farmers set breeding goals<br>• farmers grow segregating genetic material<br>• the best plants are selected in their own production environments |

PPB has been proposed as a strategy to enhance *in-situ* conservation through users. The breeding strategy that employs crossing of landraces with modern cultivars adds value to the landraces. This makes these landraces more attractive to farmers for continued cultivation.

**PPB Process and Participatory Tools Used**

| Process | Participatory Tools |
|---|---|
| **1. Need identification and setting breeding goals** | |
| • Understating the reasons for growing diverse varieties | RRA/Participatory Rapid Appraisal (PRA): Village level workshop, focus group discussion (FGD), preference matrix ranking, diversity fair, community biodiversity register (CBR) |
| • Setting breeding goals and roles jointly to meet immediate need | FGD |
| **2. Parent selection and generating new diversity** | |
| • Identification and use of locally adapted varieties as parent materials | Diversity block, PRA, FGD |

**PPB Process and Participatory Tools Used**

| Process | Participatory Tools |
|---|---|
| **3. Selection of research plots and expert farmer role identification** | |
| • Identification and selection of knowledgeable farmers having interest in PPB works | Farmers network analysis (FNA), FGD, expert farmers, CBOs joint farm walk to exchangeable knowledge between breeders and farmers |
| • Farmers assume role of selecting suitable cultivars from the segregating materials | Diversity fairs |
| • Management of research activities under farmers' condition and setting selection criteria | Researcher designed-farmers managed; farmers' selection criteria |
| **4. Selection of segregating lines** | |
| • Decentralized selection of segregating lines (variable population) by farmers under target environments breeders | Farm walk, FGD, farm school, preference ranking, selection of lines jointly by population and farmers |
| • Post-harvest evaluation using gender perspective | Micro-milling and visual observation, participatory assessment, preference ranking |
| **5. Variety release and distribution** | |
| • Varietal spread through informal seed supply | Ball and string techniques |
| • Release variety on the basis of mother baby trial result, and varietal spread data | Mother and baby trials, PRA monitoring |

## Linkage Between PVS and PPB

### PVS Realizing Its Limits

- Possibilities of PVS have been exhausted
- Search process in PVS failed to identify any suitable cultivars for the testing
- Farmers identified a new problem in existing cultivars

### PPB Strategy

- Demand-led approach
- Low cross-high population size strategy
- Provide better choice of varieties
- At least one parent should be a landrace or locally adapted cultivar
- Screened under target habitat utilizing farmers selection criteria and knowledge
- Farmers are involved at much earlier stages of breeding process
- Mother-baby trials for generating scientific data as well as disseminating PPB results
- Linking PPB with formal research systems through collaboration for disease screening and multi-location testing of PPB products.

### Scaling Up

- Scaling up of PPB products preferred by farmers through informal seed supply as well as formal variety release systems
- Baby trials for dissemination of PPB products

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# Millet Conservation in Southern India

Minor millets are grown over seven million hectares of land in India, producing five million tons of grains. The richness of millet varieties in the drylands of southern India is similar to the diversity seen in Africa. Finger millet alone accounts for 2.6 million hectares, producing 3 million tons and providing staple food for people in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Maharashtra and Bihar.

Millets in Indian diets are classified as coarse cereals with small grains having 2.1 – 7.1 gm/1000 grain weight. Well-filled grains have 1.4 – 5.1 ml/1000 grain volume. They have spherical to oval shape with colored seed coats. Millet is relished mostly by the rural population in southern India for its nutritional value, being a rich source of carbohydrates and minerals, such as calcium, phosphorous and iron.

The major millet varieties in India are: (a) sorghum *(Sorghum bicolor)*; and (b) pearl millet *(Pennisetum typhoides)*. The minor millet varieties are the following:

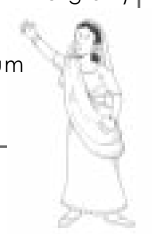
**Minor Millet Varieties**

| Local Name | Scientific Name |
|---|---|
| Finger millet | *Eleusine coracana* |
| Kodo millet | *Paspalum serobiculatum* |
| Proso millet | *Panicum miliaceum* |
| Foxtail millet | *Sateria italica* |
| Barnyard millet | *Echinoclova colona* |
| Little millet | *Panicum sumatrance* |
| Job's tears | *Coix lachryma – Jobi* |

On the other hand, the finger millet varieties are the following:

**Finger Millet Varieties**

| Name of Variety | Type of Earhead Formation | Maturity |
|---|---|---|
| *Hullubili* | Green, open type (GOT) | Medium |
| *Gudabili* | Green, compact type (GCT) | Late |
| *Kari Gidda* | Violet, compact type (VCT) | Late |
| *Jenu Mudde* | GOT | Late |
| *Madayyanagiri* | Violet, open type (VOT) | Late |
| *Hasiru Kambi* | GOT | Late |
| *Dodda Ragi* | GOT | Late |
| *Bili Ragi* | GOT | Late |
| *Balepatte* | GOT | Medium |
| *Kari Marakalu* | GOT | Late |
| *Majjige ragi* | GOT | Early (White grain) |
| *Majjige ragi* | GCT | Early (White grain) |
| *Rudrajade* | VCT | Late |
| *Jade Shankara* | GCT | Late |
| *Pichakaddi ragi* | Dark brown, compact type (DBCT) | Medium |



The rich inter- and intra-species diversity of millets in India has narrowed considerably due to:

- neglect, resulting from government policies designating millets as low-value crops;
- introduction of high-yielding finger millet variety (HYV) (in Karnataka) and major millets like pearl millet (in Rajasthan) and sorghum (in Maharashtra);
- increase in area planted to cash crops; and
- problems in processing.

## Crops Sown with *Ragi* in Mixed Cropping System

*Ragi* is usually intercropped with mustard. Other intercrops include niger, field bean, castor, cow pea, red gram and other millet varieties such as foxtail, pearl millet, jowar and little millet. *Ragi* is sown with mustard because mustard flowers bloom during the early stages of the *ragi* crop and attracts lady bird beetles, locally called *gulagangi hulla* -- a predator of aphids, attacking the *ragi* crop. In case of rain failure, mustard acts as an insurance crop.

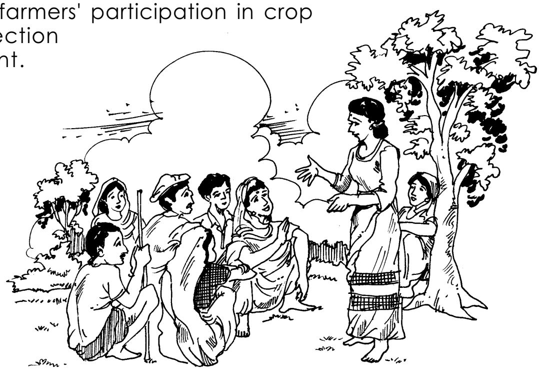
Red gram is an intercrop providing *ragi* with nitrogen, hence, it is grown in rotation with several non-leguminous crops. Red gram, on its own, requires very little irrigation owing to its deep taproots, as such it does not compete with other crops where soil moisture and fertility are limited. Red gram enriches the soil with its heavy leaf-fall and opens up the soil, allowing water to infiltrate its deep root system. Niger is grown either as pure or as mixed crop with finger millet. It is traditionally grown as a border crop around *ragi* to prevent trespassing by cattle. Farmers continuously grow various crop combinations to maximize their resources and meet their basic needs. The introduction of high-yielding varieties (HYVs) has resulted in the disappearance of many indigenous varieties.

## Crop Improvement Through Participatory Varietal Selection: The Case of Finger Millet Variety *Pichakaddi*

This experiment was conducted by the Green Foundation. It provided the initial steps toward a participatory crop improvement program.

The aims of the Green Foundation in the conservation of genetic resources are to:

- regenerate/distribute staple crops like millets and other allied crops;
- promote on-farm conservation through training of farmers as seed keepers; and
- encourage farmers' participation in crop varietal selection improvement.

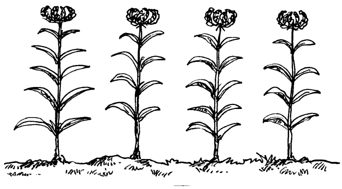


*Pichakaddi ragi* is a landrace sustained by farmers for the past 20-25 years. The reasons farmers maintain this variety are the following:

- performs well under rainfed conditions;
- is drought resistant;
- well-suited to marginal environments;
- it provides straw preferred by livestock; and
- one measure of *ragi* flour of this variety equals to two measures of the improved variety.

**Criteria for Choosing a Variety**

**General Requirements**



- Must be of medium duration
- Medium to tall growing
- Withstand environmental variation (drought tolerant; pests and disease resistant; and non shattering during heavy rainfall and at lodging conditions)
- Non-lodging type
- High tillering and multiple branching
- Uniform maturity
- Good response in marginal lands
- No on-plant germination if undue rainfall interferes with the harvest
- High yields with low inputs

**For Marketing**

- High-yield
- Big ear head size
- Long and closed fingers
- Big grain size
- More layers of seed on each finger
- Heavy ear heads
- High test weight

**For Food**

Human

- Red color with sweet taste
- Straw should be hard and palatable
- Small amount should give enough satisfaction

**For Animal**

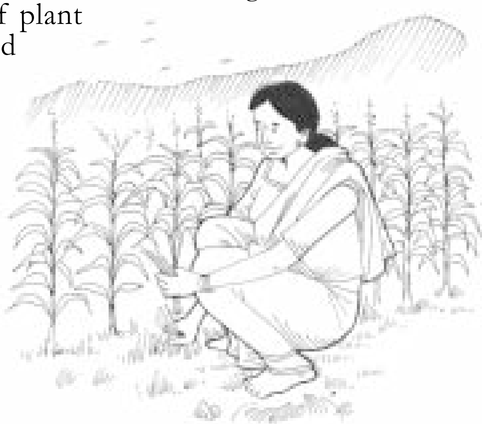
- Straw yield should be high
- Straw should be thin and slender with long stem
- Straw must be sweet, as it is preferred by the cattle

**Note**: These criteria are based on a village-level Participatory Rural Appraisal.

However, when the Green Foundation started this study, farmers were confronted with problems of poor performance of *Pichakaddi ragi* such as poor growth and less productive tillers.

Some of the assumptions which justified participatory varietal selection improvement are the following:

- there are good quality *Pichakaddi* landraces;
- farmers can identify the landrace based on their local indigenous knowledge;
- farmers can pinpoint traits of the landrace;
- farmers concur that seeds of the local landrace are impure and they need to be "purified" ;
- the improvement of productivity of *ragi* landraces requires good seed sources;
- farmers continuing to grow *Pichakaddi ragi* under traditional farming systems would be the best source of seeds;
- agronomic features were recorded and compared using the farmers' taxonomic knowledge; and
- detailed analysis of plant performance (based on a set of components) provided a practical methodology to pursue refinement until a pure *Pichakaddi ragi* race is restored.



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# Integrating *In situ* and *Ex situ* Conservation with On-farm Use:
## The Case of Bhutan


Bhutan is a small landlocked country located in the Eastern Himalayas. One of the significant features in Bhutan is the North-South Black mountain range, separating the East from the West geographical, ethnically and climatically. Three major geographical zones are recognized on altitudes - foothills, middle mountain and high mountain - but each with very diverse environments, ecosystems and landscapes. The environmental diversity is reflected in the natural vegetation as well as in the crops and cropping systems, making Bhutan an important center of genetic diversity.

A unique feature of the country is that, conserving its biodiversity and natural environment is firmly embodied in its culture and national policy and not sacrificed by short-term economic benefits.

The agricultural production in Bhutan largely depends on the ability of farmers to use agricultural biodiversity to cope with ecologically difficult and variable environments. Modern varieties of rice have been adopted in limited areas. However, in other regions not reached by agricultural research, most farmers still prefer locally developed and adapted farmer varieties for a number of reasons. Yield security, through better adaptation to the environment, taste and a variety of uses in the local household are some of the factors for their continued use of local varieties. Hence, a pool of genetic diversity is maintained *in situ* through use.

There is no reason why, through environmentally differentiated research in plant breeding, improved varieties could not be developed for such environments. However, the economics of such research are problematic due to limited acreage of areas sharing a common, and often in itself diverse environment. Hence, Bhutan provides an interesting situation to involve farmers in crop improvement by improving their access to genetic diversity relevant to their environmental conditions. This can be done by increasing their ability to use such diversity while maintaining the adaptive cultural and agronomic characteristics, and satisfying household requirements in a largely community-centered subsistence agriculture. As genetic diversity still has a functional ecological role in the cropping stystems, conservation and use are integrated. The importance of genetic diversity in livelihood strategies of small subsistence farmers would seem to be undervalued in institutional plant breeding.

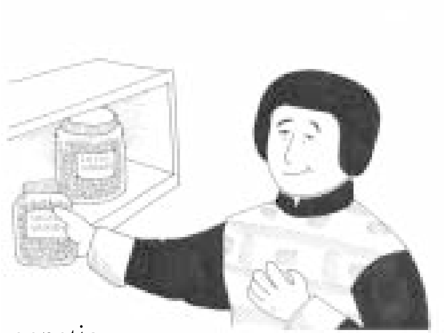
## Genetic Resources Conservation Program of Bhutan

The Agricultural Biodiversity Center (Genebank) is structured within the National Biodiversity Program in the Ministry of Agriculture. Standard genebank facilities are established for *ex situ* conservation as well as operational procedures of collection, documentation and management. Such facilities are needed, one way or another, by any genetic conservation program. The operational program is less standardized.

In conceptualizing the genetic resources program of Bhutan, the following considerations served as guide.

- There did not seem to be an urgent need for immediate and wide-scale collection because modern varieties are not widely accepted. Hence, most genetic diversity is still maintained *in situ* through use. Instead, understanding the available genetic diversity, as a basis for future collection, was emphasized.

- The dominant role of farmers in crop improvement and seed production suggests the need for close integration of conservation and crop improvement in the farmer seed system.



- The direct benefits of the genetic resources program should be felt by the farmers to solicit their support.

To satisfy the above considerations, an operational strategy was designed, emphasizing in the first phase genetic resource surveys with only limited collection and preparing for on-farm participatory activities.

## Genetic Resources Surveys

Because the adoption of modern varieties is not as yet a serious problem in Bhutan, a better understanding of the status of genetic diversity should be the focus. This is essential in rationalizing actual collection activities for long-term *ex-situ* conservation in the genebank.

Genetic resources surveys should be clearly focused to provide information on the extent, distribution and status of genetic diversity of agricultural crops in farmers' fields.

A common problem of surveys is that more information is collected than is needed for a particular objective, complicating analysis. Hence, economy in data collection is imperative. Essentially, the cropping systems and cultural practices, the crops grown, number of landraces per crop, the nature of the seed system (on-farm/exchange/gender roles etc), the dynamics or replacement rate of varieties/landraces and the economic use of the harvested product are some of the initial information needed. At this stage, it is not considered necessary to collect information from farmers on the characteristics of individual landraces, since that will be done during actual collection at a later stage. Undoubtedly, use of genetic diversity is linked to differentiation of households within and between communities. However, as the objective of the surveys is only to get a broad oversight of genetic resources between communities/locations, such information is not considered essential for the present purpose.

In preparing for genetic surveys, broad environmental classification of agricultural areas will be carried out based on existing data, remote sensing and LANDSAT-TM images of Bhutan. Based on these data, targets for surveying will be delineated and prioritized.

Field surveys are done by the staff of the genebank and supported by extension officers. The genebank staff are confronted by farmers and through which they learn about their crops and agricultural practices and better understand farmers' use, rationale and requirements of genetic diversity.

Surveys take place in the form of group interviews within communities, followed-up by visits to individual farms and farmer interviews. In Bhutan, women play a major role in selecting and maintaining seeds and tend to claim their role as primary informants.

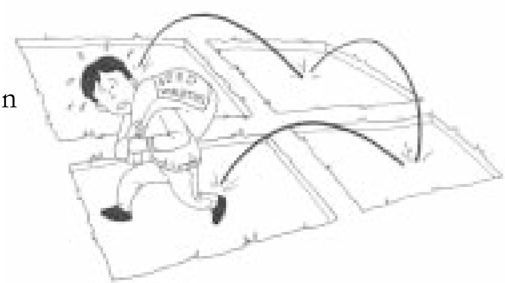
For surveys, it is possible to use a checklist in an open discussion, or follow detailed forms to be completed. For genetic resources, there might be an advantage in using a checklist. One person could interview and another one could document the information, later to be entered in survey forms. This allows a free flowing discussion, is less intimidating and may yield interesting information not always represented in survey forms. Both approaches, however, are tested in preliminary surveys, because the most appropriate form of data collection probably has a cultural bias.

## Collection

The surveys would contribute to a rational collection strategy, prioritizing crops and locations and establishing methods of sampling, collection of genetic resources because conservation and storage in the genebank are not advisable at this stage.

However, for major crops, representative landraces for particular environments/locations may be collected. The objective is not conservation but use in farmer participatory testing and gaining insight in Genotype x Environment (GxE) interactions. This collection also offers an opportunity to develop and test methods to access and document farmer knowledge on genetic resources.

Anticipating the above, some general observations on collection for conservation can be made.



Most genebanks collect small samples of targeted materials in the field and regenerate them at the genebank, at the same time collecting characterization data. This does not seem to be realistic for Bhutan. First, it lacks the facilities and staff for extensive regeneration. Second, materials collected in very diverse environments and regeneration/ multiplication at a central site may well lead to genetic drift and differences in growth habit (characterization). Hence, the more practical approach would seem to collect fairly big samples from farmers. In sampling named landraces within farming communities, there may be some advantage in sampling small samples from a number of farmers and bulk them in one sample. This, of course, is arbitrary, but takes into account that landraces tend to be variable in time and place. There is no single representative sample.

In Bhutan, minor crops in home gardens appear to be often not named under a variety name. How to collect them is a problem. A reasonable approach would be to be guided by ecological zones and bulking samples depending on how many samples can be realistically entered into the genebank.

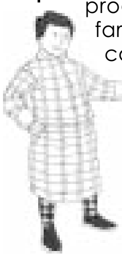
Landraces under the same name grown in clearly different environments should normally be kept separate due to possible differences in important adaptive complexes.

## Farmer Involvement and Benefits

The importance of *in situ* conservation in Bhutan is obvious as agriculture is still mainly traditional, based on a wide diversity of crops and farmer developed landraces. It is a system where genetic diversity is still employed as a means to achieve yield security through continuous adaptation and depends on maintaining ecological balances with natural biotic (insects, fungi, soil fauna and flora) and a-biotic (soil, climate) conditions. Hence, genetic diversity is maintained through use and conservation is not needed as an objective in itself. This is not to say that specific genetic entities are not lost, but that we deal with a dynamic system in which landraces are continuously changing through natural and human selection and replacement by exchange of planting materials between farmers and communities.

The rate of change depends largely on farmers' access to new planting materials considered an improvement on their own material. Rapid adoption and spread of new varieties have been observed through farmer exchange in the Green Revolution in India.

The genebank program in Bhutan aims to complement this program by what is referred to as a Participatory Variety Selection (PVS). As part of the genetic resource surveys, a limited number of landraces of major crops have been collected from various representative and contrasting environments throughout Bhutan.



The project Biodiversity Use and Conservation in Asia Program (BUCAP) addresses the farmers' concern of accessing new genetic diversity. In this project, agricultural research centers of Bhutan are producing breeding populations in rice and maize, according to farmers' criteria released to selected farmers in a number of sites/ communities for further selection. It employs farmer-participatory plant breeding, building on experiences obtained in the Community Biodiversity Development and Conservation Program (CBDC) - a cooperative program of the Netherlands genebank with SEARICE, NGOs in Africa and Latin America, the Ethiopia genebank and NORAGRIC of Norway. The project is coordinated by the National Biodiversity Center of Bhutan.

The collected landraces are replicated in farmers' fields in the collection sites/environments as demonstration plots. Using Farmer Field School approaches, farmers evaluate these sets of landraces. On requests, farmers are supplied with a small quantity of seeds of landraces/varieties they wish to further test on their own farms. The genebank monitors what is happening with the landraces. In addition, relative performance/adaptability of individual landraces in different environments gives preliminary information on the importance of GxE interaction and environmental domains between which exchange between farmers is relevant.

## Conclusion

The culture of the Bhutanese people, reflected in its national policies, gives high priority to conservation of its biodiversity and natural environment. This provides a unique situation for integrating conservation and farmer-participatory development of agricultural biodiversity.

## References:

Almekinders, C. and W. de Boef. 2000. Encouraging Diversity. I.T. Publications, London.

Morgan, David L. and R. A. Krueger. 1998. The Focus Group Kit. SAGE Publications, London.

Van de Fliert, E. and A.R. Braun. undated. Farmer Field School for Integrated Crop Management of Sweetpotato. Field Guides and Technical Manual. International Potato Center (CIP-UPWARD).

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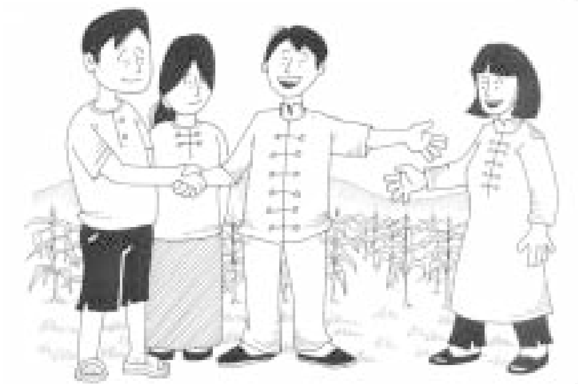
# Strengthening the Collaboration for Crop Development and Biodiversity Enhancement in China

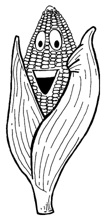
Maize is now the most important feed crop and the third most important food crop in China. It is the main staple food crop for the rural poor in the remote upland areas in the southwest, which is an agro-ecologically diverse area and the center of maize genetic diversity in China. It is believed that southwest China is one of the original areas of maize cultivation in the world. For instance, waxy maize is thought to have originated from that area.

Farmers in southwest China have cultivated and relied on maize for their survival for generations. The majority of farmers in the upland marginal areas still cultivate improved

Open Pollinated Varieties (OPVs) and landraces. Farmers still maintain a higher level of maize varietal and genetic diversity than in the rest of the country.

It is well known that the Chinese Government has followed a modern technology-oriented approach and has relied predominantly on its formal seed system. The development and distribution of modern varieties, mainly hybrids, for the three main staples, i.e., rice, wheat and maize, has been the core task and the first priority for the formal system to achieve the overall goal of national food security. Since the early 1970s, some 30% of Chinese food security is attributable to development and rigorous promotion of improved planting materials, especially hybrid wheat, rice and maize.

> **The Need for Cooperative and Complementary Relationship**
> A cooperative and complementary relationship between the formal seed system and farmers' systems, rather than the current separated and conflicting situation, is urgently needed for addressing the challenges in food security and biodiversity. It is needed, moreover, to empower farmers, who are in this case, mainly women, to become active partners in plant breeding, on-farm biodiversity management and seed marketing. This formed the central problem and the core reason for starting the current participatory plant breeding project in southwest China.



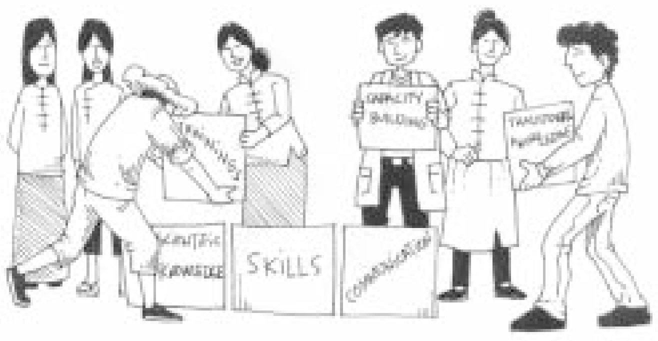
Hybrid maize is now grown on around 80% of the total maize-production area in China. Nevertheless, these hybrids are mainly used in the uniform and high-potential areas of the Northern Plain, the "corn belt" of China. Farmers in the remote and harsh areas in the uplands of the southwest are more or less marginalised by the modern technology development process.

In these marginalised areas, however, farmers' seed systems continue to play a major role in meeting farmers' heterogeneous needs in OPV seed supply, while maintaining diversity for the interests and sustainable livelihoods of all farmers. A previous impact study revealed that, in the study area, more than 80% of the seed supply is from farmers' own seed systems.

## Preparation and Networking

Other main social actors and key informants identified were (formal sector) breeders, seed companies and policymakers. The project carefully analyzed how they are influencing farmers' production and breeding efforts. This analysis revealed some major gaps in the provision of support to these efforts; gaps that the project aims to fill, in particular through building linkages among the different stakeholders. Farmers, extension staff and breeders are now working together to design, carry out and assess experiments. Together, they communicate with policymakers and seed companies about the results of their work.

In the past two years, the project has established an effective working network at both global and local level. Many stakeholders and different institutions at different levels in the two systems have been involved, and some significant direct linkages have been established in the process.




The project team realized that a local network is very crucial for a sustainable knowledge exchange between farmers and scientists and among farmers. This is a big challenge in the context of rural China, where there are no non-governmental or farmer organizations in its true sense. With this situation, the project team decided to start with two existing networks at grassroots level, i.e., women farmer groups in the informal system and existing grassroots extension stations in the formal system.

## Field Implementation

Given the specific context in China, the participatory plant breeding (PPB) field experiments were designed as pilot research using both a scientist-led and a farmer-led approach, with different research focuses in each trial for comparison. The priorities of the PPB pilot project are to look at the standards and methods of both farmers and breeders, with three objectives:

- to bring the best farmer knowledge and the best scientific knowledge together in realising the overall goal of crop improvement and biodiversity enhancement;
- to establish direct communication and feedback between the two systems and enhance local capability, equity and gender balance; and
- to compare different breeding approaches, i.e., PPB, participatory varietal selection (PVS), conventional formal and farmer traditional breeding, through trials.

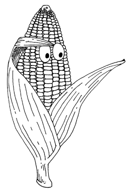
The main methods used are comparative field trials, field visits and field days, in-depth case studies and participant observation.

## Institutionalization

In the design of the project, highly relevant institutions and policymakers at national and regional levels were involved. The involvement of those institutions and individuals from a variety of disciplines at different levels in the system should directly influence the policymaking process related to all aspects of maize technology development and biodiversity management.


Secondly, the project enhances interaction, communication and collaboration among different stakeholders in the two seed systems. It will therefore provide a more complete and convincing picture to policymakers with a view to institutionalising the approach. Some concrete lobbying activities include presenting the project in policy fora; dialogue and discussion through interviews with policymakers; and joint discussions and activities of farmers, formal-sector professionals and policymakers during field visits and field days. Participatory technology development (PTD) and PPB training for the project team and collaborators was given at the beginning of the project at national and regional level. Participatory rural appraisal (PRA) training was conducted in all trial villages.

## Confronting Challenges and Future Directions



There has already been some initial impact in terms of attitudinal change and even policy consideration of certain aspects and levels of participatory plant breeding and genetic biodiversity management policy. However, gaining acceptance of the PTD concept and activities by the entire formal system and making an impact on the system is a slow and very difficult process. To make things worse, the increasing trend to a market economy and the commercialization and privatization of public institutions is making the process even slower and more difficult.

## References:

Song, Y. 1998. "New Seed" in "Old" China: Impact Study of CIMMYT Collaborative Programme on Maize Breeding in Southwest China. Published Doctoral Dissertation, Wageningen Agricultural University, Wageningen, The Netherlands.

Song, Y. & J. Janice Jiggins. 2002. Feminisation of Agriculture and Related Issues: Two Case Study in Marginal Rural Area in China. Paper Presented at the European Conference on Agricultural and Rural Development in China. (ECARDC VI), Leiden.

Zhang S, L. Yuan, et al. 2000. Research on Maize Genetic Diversity and Heterotic Patterns for Breeding. China Agricultural Science 33, Beijing, China.

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# Farmer Participation and Access to Agricultural Biodiversity:

## Responses to Plant Breeding Limitations in Cuba

After the Cuban revolution in 1959, Cuban agriculture was transformed in order to: meet the growing food requirements of the Cuban population; create export funds to obtain raw materials and empower the food industry; and eradicate poverty in the countryside.

A centralized plant breeding model was included as a component of the high-input agriculture used particularly for the country's cash crops. Wide geographical adaptation was encouraged by policymakers, with most Cuban governmental organizations providing incentives to scientists involved in releasing a variety for use over a large area.

The formal plant breeding sector has the capacity to access diversity from different parts of the world, as well as to generate and recombine traits through different methodologies such as:

- mutation breeding;
- somaclonal variation; and
- hybridization.

In principle, these methodologies were built up to satisfy the demands of homogenous agroecosystems under a high-input agriculture approach.

At the beginning of the 1990s, yields decreased exponentially for most of the major crops in Cuba. This was caused by the collapse of the major agrochemical input providers -- the socialist countries -- which were supplying more than 75% of the agrochemicals used by Cuba. When the socialist bloc collapsed, a strong budget limitation curtailed the official research network in Cuba. In the same way, the centralized national seed system suffered from serious limitations with respect to input supply.

## Participatory Plant Breeding for Strengthening Agricultural Biodiversity (PPBSAB) in Cuba

PPBS Agricultural Biodiversity is a multi-institutional and multi-disciplinary project that investigates how to contribute to these alternative practices and rebuild agricultural biodiversity in Cuba. The project aims to develop participatory seed production, improvement and distribution practices by making use of the spaces opened up by the economic crisis. It uses a variety of tools including seed fairs and participatory variety selection as a strategy for seed diversification to reduce agrochemical input consumption.

## Diversity Seed Fair

A seed fair is an approach where plant breeders of the National Research Institutes give farmers access to diversity in tomatoes, beans, maize and rice. Varieties from formal and informal seed systems are planted or sown under relatively low input conditions. Farmers, plant breeders and extension agents have the responsibility for selections in the field.

# Farmers' Experimentation

## Maize Selection Scheme

After the selection process in the diversity seed fair, farmers conduct field trials on their own farms. Farmers, in collaboration with scientists, design the experiments. Scientists explain the experimental design principles to the farmers who then make their own design according to particular farm characteristics.

The Participatory Plant Breeding (PPB) intervention is aimed specifically at fallarmyworm (*Spodoptera frugiperda*), a pest resistant to maize. This is so because the formal seed sector supplies hybrids and open pollinated varieties that demand certain amounts of agrochemical inputs for growing and for pest control. However, the farmers do not have access to such inputs in the case of maize.

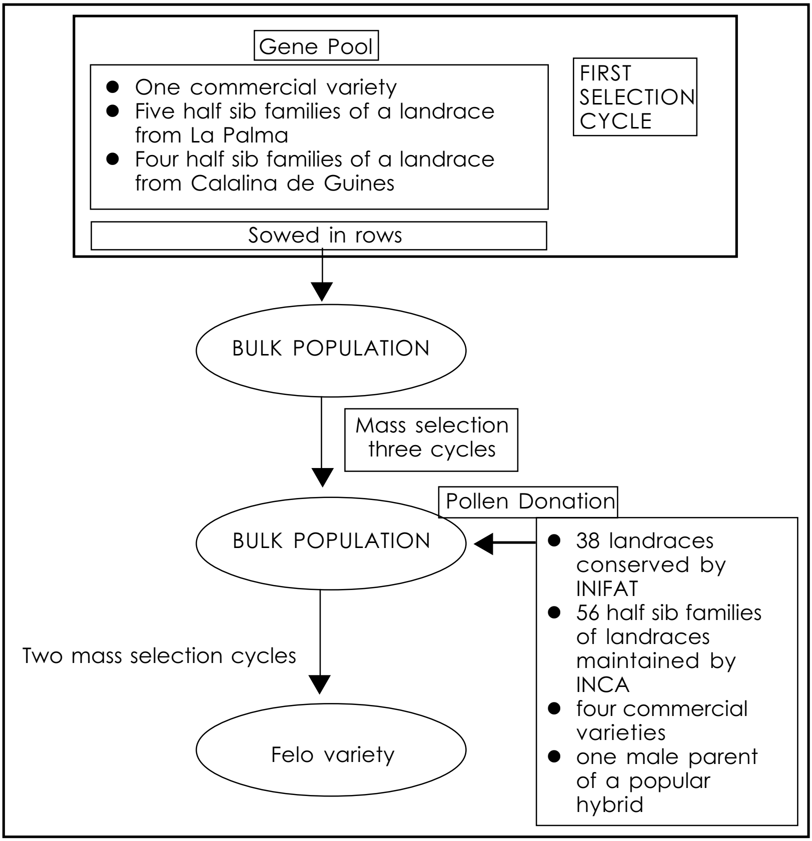
The gene pool of the maize population of one Havana farmer who had selected from the seed fair was found to be composed of:

- one commercial variety from the formal seed sector;
- five half sib families of a landrace from La Palma (neighboring province); and
- four half sib families of a landrace from Catalina de Guines (a neighboring municipality of the same province).

Afterwards, the bulk population was sown in between 38 landraces conserved by the Fundamental Research Institute (INIFAT) genebank, 56 half sib families of landraces maintained by National Institute of Agricultural Sciences, four commercial varieties and male parents of a popular hybrid.

The bulk population was named Felo (the nickname of a local farmer breeder) and two mass selection cycles were done. Currently, this population, called Felo variety, is under seed multiplication and continued selection, having recognition from all the agricultural stakeholders in the municipality.

**Figure 1: Maize Selection Scheme**



## Bean Selection

Common bean is a self-pollinating crop. The PPB project in Cuba focused on the implementation of an experimental network to compare varieties selected during the seed fair. Farmers designed their own experiments on the basis of the principles of experimental design held at the community level.

The number of varieties increased exponentially during the first two seasons. At the same time, varieties introduced with the PPB intervention had similar average yields with regards to the former varieties in La Palma (Pinar del Rio province), Batabano, and Gilberto Leon Cooperative (La Havana province).

## Impact of Seed Selection

Diversity seed fairs and farmer experimentation allowed plant breeders and other stakeholders involved with seed management a better understanding of farmers' conditions under the new circumstances in Cuba. Interestingly, farmers have discovered culinary properties and desirable bean shapes and colors. With this, a complementary decentralized seed management system filled the gaps of the project participant seed demand. Seed diversity facilitated by the PPB project allowed distribution and farmers' validation of varieties from formal and informal seed sectors.

> After the PPB intervention, farmers exchanging through a local seed network were motivated to measure yield. Thus, they have deepened their interests to learn about disease etiology, and pest and disease genetic resistance.

Prior to farmers having access to wider agricultural biodiversity, they classified their own landraces far better than any introduced materials. Now, after the seed fair and farmer experimentation, landraces from other places and varieties from breeders allowed them to consider alternatives to incorporate into their seed system.

Genes managed by the formal sector are shown to be important for strengthening local seed systems. Furthermore, farmers have historically managed many varieties according to their agronomic and culinary properties. Thus, seeds from the formal and informal sectors could be included harmoniously in the portfolio of local and national plant breeding programs.

Even though PPB in Cuba is still young, seed fairs and farmer experimentation seem to be promising alternatives to enhancing diversification in the current Cuban conditions. Nowadays, agricultural biodiversity access is opening interesting windows for participation, experimentation and socialization of science in Cuba.

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# Livestock and Aquatic Resources

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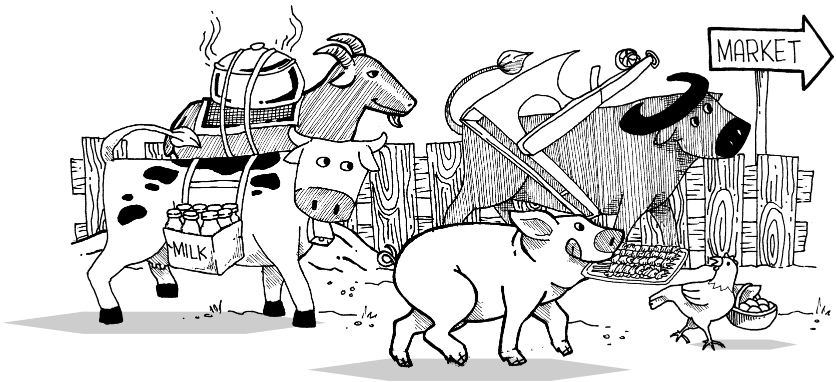
# Managing Animal Genetic Resources at the Community Level

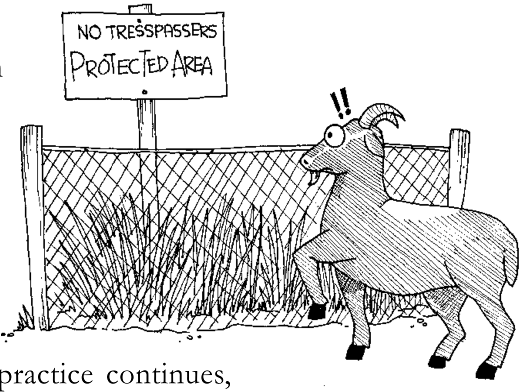



Animal genetic resources are defined as "all animal species, breeds/strains and populations used for food and agricultural production and their wild or semi-domesticated relatives". Worldwide, only 14 out of about 40 domesticated species contribute 90% of all animal products and services. They were diversified into about 6,400 breeds. While animal genetic diversity is not threatened at the species level, about one third of the breeds are classified as endangered. During the last 100 years, about 1,000 breeds have disappeared, 300 of these during the last 15 years.

## Why Do Breeds Become Extinct?

Besides replacement by exotic breeds, reasons for breeds extinction include the following:

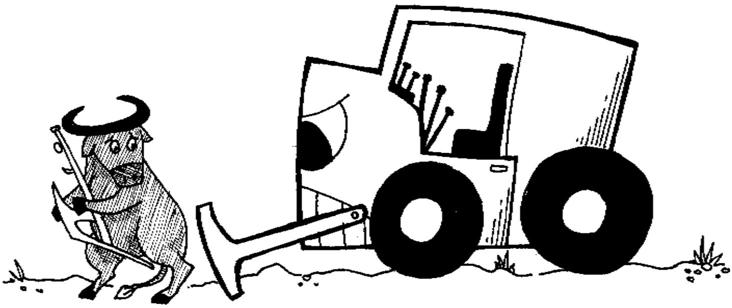
## Loss of Grazing Opportunities




One of the main reasons leading to the extinction of breeds is the expansion of crop cultivation and irrigation into marginal zones and conversion of former pastures into protected areas. In the context of nature or wildlife conservation, livestock keepers are often evicted from their traditional pastures. This practice continues, although wildlife and livestock often symbiotically co-exist and plant biodiversity may decrease with the absence of grazing livestock.

## Absence of Market Demand and Lack of Competitiveness with Improved Breeds

The change in market demand and the loss of interest in some of the by-products of local breeds are some of the contributory factors. When communities become integrated into the market economy, animal keepers switch to breeds with higher outputs of milk, meat or eggs. In India, a decrease in the demand of the draught cattle breeds, which have been superseded by tractors, is a great concern.

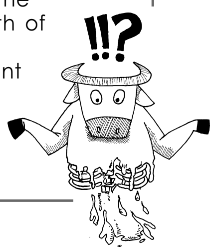


## Disappearance of Indigenous Knowledge and Institutions

If there is no more demand for the breed, related knowledge can vanish quickly within a generation. Similarly, indigenous breeding institutions disintegrate rapidly. For example, the practice of keeping a community bull has disappeared in many parts of Rajasthan where cattle breeding is no longer profitable. When the knowledge and these institutions have disappeared, it is very difficult to revive the breed and the information that goes with it.

In the Bharatpur bird sanctuary in northern India, buffaloes were evicted. This resulted in the growth of tall grass and the disappearance of nesting habitats for some of the migratory birds for which the sanctuary was famous for. As a result, buffaloes were re-admitted to the sanctuary.

In Germany, ever since stall feeding has taken over, the absence of grazing livestock has caused dense growth of undershrubs in the forest, hence, preventing the regrowth of large trees. Presently, there is a government supported program for maintaining the original forest landscape with the help of goats. Goat keepers are paid, per day and per head, for grazing their goats in the forest.




## Conflicts and Catastrophes

Wars and natural disasters can cause massive loss of livestock. Aid agencies often try to help by restocking and importing animals from developed countries. In Bosnia, this has contributed to the extinction of several indigenous breeds.

Some local livestock may produce less milk or meat, but this inadequacy in one aspect may very well be compensated, as these breeds may require less input in terms of feeding, veterinary care and housing. In remote and marginal regions, local livestock may be the only breed that is able to survive. Moreover, women - who usually are in charge of taking care of the animals - often prefer the local breeds because they require less labor and have higher resistance against diseases.

## Evaluating The Existing Local Livestock Breeds

Upgrading the productivity of local livestock breeds by cross breeding with exotic breeds is a widely used strategy in rural development. But this often leads to the extinction of local breeds which are actually more adapted to the ecosystem and fulfill a wider range of people's needs. Evaluation of local livestock, must therefore be done, before a cross breeding project be undertaken.

## Recognizing "New" or Unreported Breeds

By conducting a breed survey, the animal populations that represent distinct breeds will be covered. The question is, how does one know if the animals in an area belong to a distinct breed?

As a guide, the following questions may be asked.

- Do people have a particular term to refer to the type of animals they keep? Often, people have a local name for their breed (sometimes they may just refer to it as "local" to distinguish it from exotic breeds). Locally used terms may be different from the ones used by scientists.

- Are the people breeding their own animals, or do they buy them from outside? If the latter is the case, there is less likelihood that there is a well-defined breed in the area.

- Are there traditional breeding institutions, such as a communal system for keeping a male breeding animal? If yes, it means that people are aware of the importance of breeding, and it is therefore more likely that a specific breed exists.

- Do people have a particular concept of what a good animal should be like and do they select breeding animals accordingly?

- Do animals have a social function? For instance, are they given as dowry or bridewealth, or as short-term or long-term loans?

When Lokhit Pashu Palak Sansthan, an Indian NGO working with livestock keepers, conducted a survey of village breeding institutions and asked about the types of breeds kept, local people referred to them as either "Nari" or "Modi". Neither term is recorded among scientific breed classifications. As they probed deeper, they found out and were able to confirm that the Nari bulls were all purchased from an adjoining district, and the Nari cattle very much represent a distinct breed.

If the answers to these questions are yes, then there is a great likelihood that a well-defined breed exists in the area.

## Documentation of "New" Breeds

Proper documentation of new breeds is important if a distinct breed exists in an area. Scientific methods for documenting breeds focus on external characteristics and production. These methods often do not capture the full significance of the animals for rural livelihoods, especially their social and cultural value.

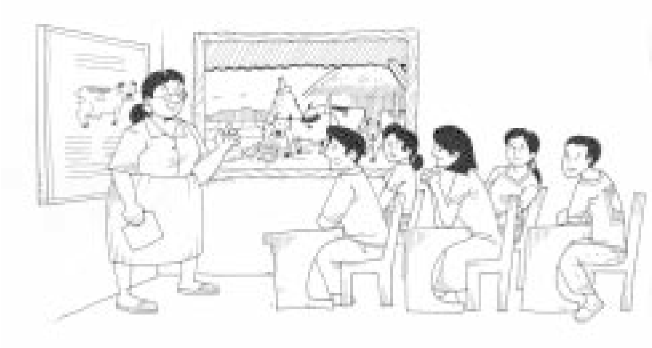
Characterization of new undocumented breeds is best done with participatory methods through informal interviews, talks with local experts and group discussions. It is important to record the local terminology used to describe the breeds and to understand local breeding goals.

## Conservation

The best way of conserving local breeds is by creating an enabling environment for the breeding communities. Some strategies are as follows:

### Increasing Community Awareness

The first step is to raise the awareness of the community about the on-going process and to identify breeders and young people who are interested in livestock keeping and the particular breed.



**Examples of traditional breeding institutions**

In Rajasthan, West India, every village has a communally owned and managed breeding bull, often also a buffalo bull. These bulls are purchased jointly, with every village household making a contribution. A village bull keeper is hired. The villagers agree on how much feed each family has to contribute to the upkeep and how much grain or money to compensate the bull keeper.

In Somalia, camel breeding families that do not have a breeding male of their own, borrow one from their relatives, hire one from others, or drive their female camels as far as 200-500 km to have them served by a prominent sire. This arrangement does not yield any financial gain to the owner of the male, but brings prestige and helps build alliances.

Among the Raika of Rajasthan too, there is an obligation of sharing a good quality male camel with anybody who asks for its breeding services.

## Creating the Right Policy Framework

As lack of access to grazing areas prevents people from keeping traditional breeds, restoration of grazing rights or opportunities is absolutely essential.

## Organization and Capacity-building for Breeders

Organizing herders and breeders into cooperatives, associations or societies is a promising tool for conservation. In Brazil, support for breeder associations proved to be one of the best ways in increasing interest in local breeds. Breeding societies can fulfill important functions specially in reviving and supporting traditional institutions.

## Creating a Market and Marketing Facilities for Products of the Breed

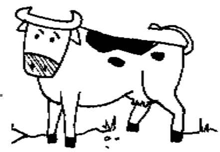
In Europe, several breeds have been revived because a specialty market for regionally typical food was developed. An example is that of the Black Majorcan pig which was threatened after the introduction of intensive production systems and foreign breeds. Then in the 1980s, 89 farmers formed a breeding association and pushed for a special label for local sausage made exclusively from the meat of this breed. By now the Spanish government has conferred a registered trademark for this product. In Italy, the famous Parmesan cheese can only be made from the milk of one particular cattle breed.

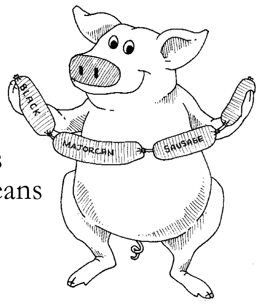
## Breed Improvement through Selection

The performance of local breeds can be improved by stronger selection for or against certain traits. Alpaca breeders in Latin America were successful in eliminating colored animals for whose fibre there was no demand. There is evidence that improvement of breeds by selection is more beneficial to farmers than by means of cross-breeding.

The LIFE (Local Livestock For Empowerment of Rural People) Network of NGOs is currently developing a method of breed characterization. This method is still being tested, but it integrates the following principles:

- Documentation of animal breeding related indigenous knowledge to put on record the intellectual contribution of the farming and pastoral communities that created the breeds.
- Use of participatory appraisal methods (rather than formal questionnaires) that contribute to raising the awareness of local communities about the genetic treasures used for husbandry.





## References:

Koehler-Rollefson, I. 1993. Pastoralists as Guardians of Biological Biodiversity. Indigenous Knowledge and Development Monitor 1(3): 14-16.

Koehler-Rollefson, I. 1997. Indigenous Practices of Animal Genetic Resource Management and their Relevance for the Conservation of Domestic Animal Diversity in Developing Countries. Journal of Animal Breeding and Genetics 11: 231-238.

Koehler-Rollefson, I. 2000. Management of Animal Genetic Diversity at Community Level. GTZ, Managing Agrobiodiversity in Rural Areas. Eschborn, Germany.

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# Freshwater Resources Conservation:
## An Action-Oriented Overview

Biodiversity in rivers and wetlands is very seriously at risk as evident from the fact that 63% of freshwater fish species in South Africa, 42% of those in Europe and 27% of those in North America have become extinct, threatened or endangered. However, in terms of protection initiatives, rivers and wetlands have been critically neglected. The limited interest in protecting the biodiversity of these systems is reflected on the Internet, which has 78,200 pages on "biodiversity conservation" but only 12 on "river biodiversity conservation".

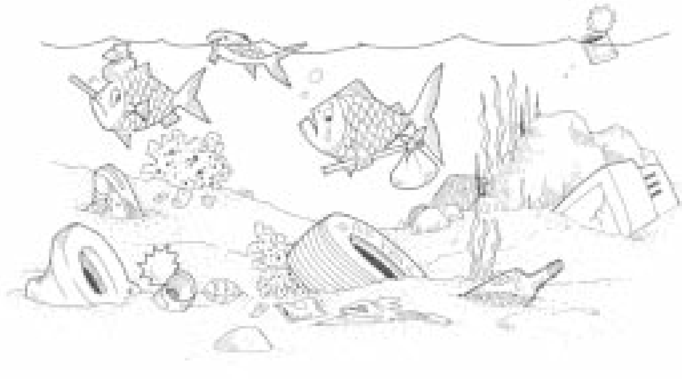
Addressing biodiversity from the perspective of practitioners is a challenge to scientists, as this broad concept has resulted in many international resolutions and vague recommendations more than pragmatic guidelines. In terms of action, two basic questions need to be considered: i) what practices should be avoided in order to prevent biodiversity degradation; and ii) what should be done to favor conservation?

## What Should NOT be Done

The major negative activities to be avoided to prevent aquatic biodiversity degradation are habitat fragmentation or degradation, pollution, overexploitation and bad fishing practices, and the introduction of alien species.

### Habitat Fragmentation or Degradation

The diversity of aquatic species results from the existence of a wide range of habitats for animals and plants. Destruction or homogenization of natural habitats -- for instance by extensive agricultural development in floodplains, chanelling of rivers or the dredging or reclamation of wetlands -- results in a loss of living space and food for species. In many cases, the animals and plants cannot survive in the modified habitats because they have evolved to use particular resources that are no longer available.



## Pollution

Regardless of the obvious effects of heavy pollutions, there is a danger of low-level pollution (for example, organic matter released by pig farms, "relatively clean" effluent from a factory) going unnoticed even though it affects sensitive and rare species, simply because it does not pose a problem for more robust species of commercial interest.

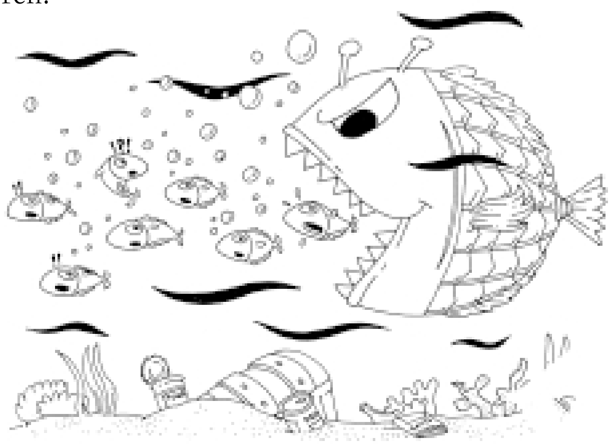
## Overexploitation and Mismanagement

Overpopulation and mismanagement are regularly mentioned but difficult to deal with, the driving factors being growing population density, poverty and increased demand for protein. Symptoms of overexploitation in fisheries are:

- big fishes -either species or individuals- become rare;
- the abundance of long-distance migrants is reduced; and
- small species of short life-span and low value become dominant.

## Introduction of Alien Species

Introduction of alien species in the natural environment (on purpose, or accidentally from aquaculture farms) is also a major danger to local biodiversity, as these species tend to be invasive and lead to the extinction of native ones. In Lake Victoria (East Africa), several dozen native species disappeared following introduction of the carnivorous Nile perch.



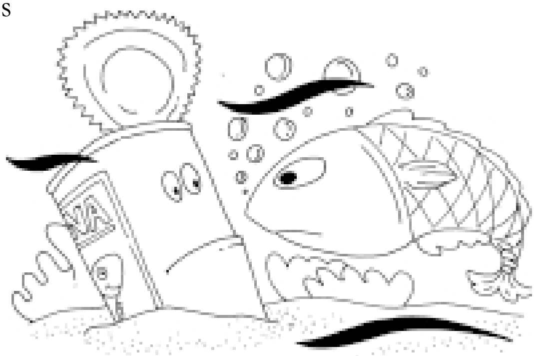
Pragmatic actions should be considered at two levels: that of the practitioner (working on natural resources and/or with human communities), and that of organizations or government agencies that can initiate projects beyond the reach of a local community. We review below possible actions at these two levels, with a focus on species, environment or people.

## What Should be Done

## Species-Oriented Action

### Identification of Indicator Species

Some particularly sensitive species maybe indicators of habitat degradation, but are not necessarily known as such by fish biologists as they are often rare. Identification of these species, on the basis of local knowledge, constitutes very helpful information that can be incorporated into environmental assessment and monitoring.



### Protection of Critical Life Stages

Some species are particularly sensitive at certain times of their life. Initiating protection measures focusing on these critical stages will help species conservation. Thus, juvenile fishes can be protected by the maintenance of shallow, herbaceous habitats along main streams, and breeders of large species will benefit from protection of their refuges during the dry season such as in the deep pools in tropical streams.

## Optimization of Socially Valued Species

Certain species are regarded as flagships or symbols in some cultures, such as salmon in Northern Europe, pirarucu in South America or mahseer in the Himalayan region. Promoting conservation based on these species will maximize impact and the chances of success.

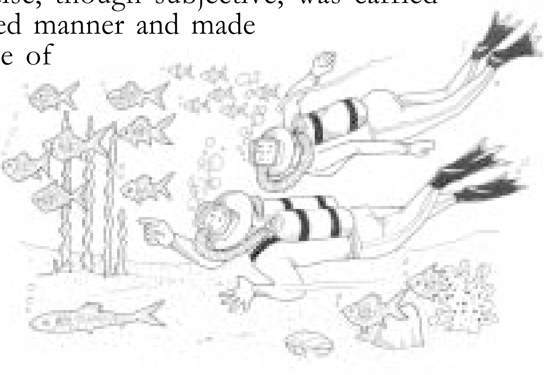
## Monitoring

Local communities can very efficiently contribute to resource monitoring and therefore to a warning system if standardized harvesting procedures (fishing and monitoring) are applied over several years. This does not require major resources, as demonstrated by the extremely valuable monitoring during seven years of the catches of ten fisherman in Khone Island (Mekong River, Lao PDR).

## Prioritization of Species

Implementation of conservation measures require categorization and prioritization of endangered species, and aquaculture as well as the ornamental fish trade requires identification of new candidate species.

Examples of these are the work carried out by the Indian National Bureau of Fish Genetic Resources (NBFGR) on the biodiversity regions of Western Ghats and Northeast India, and the initiative of the Mekong River Commission involving Lao PDR, Cambodia, Thailand and Vietnam. The prioritization exercise, though subjective, was carried out in a well defined manner and made use of the expertise of research scientists from local institutions. As an extension of these exercises, institutions located in the regions concerned are refining breeding and



culture techniques for the species identified. Keeping the focus on prioritized species, the NBFGR program also includes inventory of habitat and fishes as well as genetic characterization and gene banking. Knowledge of local persons and ornamental fish traders, though not formally documented, has contributed to the prioritization exercise.

### Inventory of Biodiversity

With realization of the value of biodiversity, local communities are interested in documenting what is available in their region. An example of a "people's inventory," including freshwater species, is one carried out in the state of Kerala, India. Such inventories are a good starting point for conservation efforts. However, they require taxonomic expertise that might not be available locally.

In these efforts, it would be advantageous to utilize national or global biodiversity databases publicly available such as *FishBase*, developed by the International Center for Living Aquatic Resources Management (ICLARM) -- The World Fish Center (www.fishbase.org). From *FishBase*, national or regional information on fish biodiversity can be obtained and initial taxonomic identification can also be carried out. *FishBase* also has a module, *FishWatcher*, where interested persons can contribute information. Modules designed for learning also contribute to raising awareness and training.

## Environment-Oriented Action

Due to the limited role of gene banks and aquaria in conservation of fish and other aquatic species, freshwater biodiversity protection **is** habitat conservation. It has also been shown that riverine fish diversity is proportional to habitat heterogeneity. Therefore, efforts aimed at habitat

conservation (river integrity, absence of dams, no channeling, natural variability) and habitat diversity (shallow banks, riffles and pools, presence of wetlands, maintenance of access to floodplains, connections between habitats) are critically important to the maintenance of freshwater biodiversity.

### Assessing the Status of a River ("Riverwatch")

Assessing a river's status can a very useful exercise generating responsibility and a sense of ownership among participants. Such an undertaking was recently proposed for the Dniester River (Ukraine and Moldova), mostly by using canoes to collect information, in collaboration with many non-government organizations (NGOs) and local authorities along the river. General assessment should focus on animal and vegetal species diversity; on the location and extent of natural habitats; on alterations to natural flows (dams, embankments, derivations); on sources of organic pollution (urbanization, livestock density), contamination (industries, chlorination) and sediments (quarries, agricultural and construction erosion, logging, dredging); and on boating practices.

### Identification of Sensitive Sites

Researchers and decision-makers do not have information about all sensitive or threatened sites. Pointing out such sites where (they are, why they are significant, why they are threatened, whether they should be monitored) and communicating with scientists and institutions with a view to targeted activities and the institution of long-term monitoring constitute an important contribution to biodiversity conservation. The Aquatic Rapid Assessment Program (AquaRAP, www.biodiversityscience.org) provides a framework for such an activity.

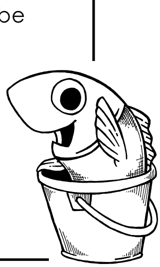
### Use of Socially Valued Sites as Conservation Sites

Some natural waterbodies are highly regarded in local cultures (e.g. wetlands by temples in Sri Lanka, ponds in Buddhist monasteries, sacred pools in Africa). Promoting conservation centred on these sites is naturally appealing to people of these cultures. Such sites can also be very useful in the conservation of genetic biodiversity: for example when the common carp stocks in the Himachel Preadesh state farm (India) became contaminated with the goldfish genome due to interbreeding, a source of uncontaminated natural carp broodstock was discovered in the Rewalsar Lake, where it had not been fished due to religious restrictions.

## Creation of Reserves

Setting up a reserve is a tempting but challenging initiative. There is still controversy among scientists as to whether multiple small protected areas should be preferred to a few large ones, or whether the emphasis should be on species-rich or species-deficient zones, taking any of those protection initiatives is undoubtedly welcome. Moreover, water bodies within protected wildlife reserves can serve as freshwater aquatic reserves. The presence, within two

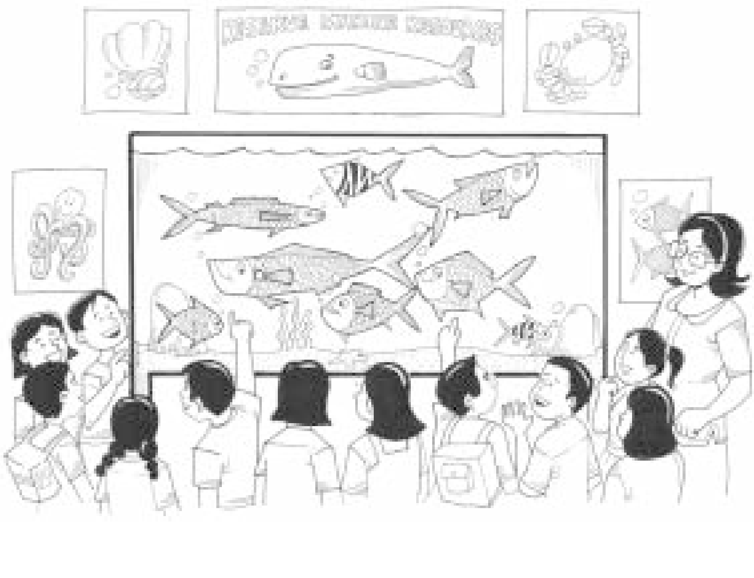
A reserve can also be a zone temporarily protected during periods of the year critical to aquatic species. At least, efforts should be made so that streams are not explicitly excluded from terrestrial protected areas, as it is the case in Yunnan (China). In all cases, initiatives centred around reserves should be undertaken in close collaboration with local communities, and expected gains - particularly in terms of enhanced catches- should not be emphasized.



wildlife reserves monitored by NBFGR in the state of Uttar Pradesh (India), of a large number of threatened species with maximum sizes exceeding those reported in the literature indicates the potential for using wildlife reserves as aquatic sanctuaries.

## Establishments of Aquariums

Aquaria are excellent means to raise awareness of the diversity and beauty of aquatic resources in the population. Even modest local aquaria exhibiting local species can play a helpful role if the peculiarities or uniqueness of displayed species are outlined to the public. Furthermore, well-managed aquaria such as the Vancouver Aquarium Marine Science Center (Canada) have breeding programs for rare species that contribute to their conservation. In existing aquaria, the promotion of conservation and the display of educational posters can be encouraged.



### Genebanks

Gene banks can hold live animals or cryopreserved gametes. Gene banks can be considered as a last line of defense against species extinction. The Dexter farm for endangered species (USA) is a successful example of a live gene bank that has contributed to delisting of threatened species by captive breeding and restocking in species-specific recovery programs. Such gene banks can contribute to recovery and utilization of genetic diversity and its use in genetic enhancement (e.g., salmon in Norway and common carp in Hungary) and conservation programs (e.g., by NBFGR, India and World Fisheries Trust, Canada).

## People-Oriented Action

The following actions focus on the social aspects of conserving aquatic biodiversity. They can consist of community-based initiatives, but also encompass advocacy of local perspectives and communication (awareness-building).

### Working with Local Communities

- **Co-management of aquatic resources:** Co-management is a complex topic that has generated much literature (see for instance www.co-management.org). Operational co-management regimes generally include socially defined groups, clear territorial limits, an ability to limit the access of outsiders and to make and enforce rules among community members, and collaborative mechanisms for monitoring and regulation.

Local participation in conservation projects should not be limited to day-to-day activities, but should also include consistent involvement in strategic issues. There are four areas in which local people can participate in projects:

1. information gathering;
2. decision-making;
3. initiating action; and
4. evaluation.

If the lessons learnt from successful projects are to benefit other sites or regions, it is important to clearly define what local people are participating in, who is participating, and how they become participants. It has been found that experience gained in rural development would act to significantly "fertilize" biodiversity conservation, which implies contributors from this field in project design and implementation. Last, securing people's involvement and local participation at a significant scale is a lengthy process, and experience having shown that at least a decade is necessary.

- **Economic incentives.** In order to be attractive, measures designed to promote sustainable use or protection of biodiversity must provide economic incentives to local communities. Such incentives can be derived from the use of previously neglected aquatic resources, but also from assistance to local communities as compensation for their conservation efforts. Hence in a national park in Madagascar, assistance in repairing irrigation canals and establishing tree nurseries was provided in return for efforts towards the conservation

of natural environments. Economic incentives can be more straightforward, when for instance the income from a tourist lodge by a river is partly paid into a community trust fund (South Africa).

- **Ecotourism** is an activity that has generated much literature; however its role has been often over-emphasized as tourists are often satisfied with what they see within quite a small area, in which case it becomes profitable at a small scale and operators have little incentive to protect the large areas that are necessary for actual species conservation.

- **Social initiatives.** Protection of biodiversity does not consist of ecological action alone. Research has revealved that loss of biodiversity is linked also to population growth, poverty and social or political disintegration, so any positive action in these fields will also act in favor of biodiversity conservation. For this reason, projects that target poverty eradication, changes in social structure or even family planning can claim a role in biodiversity conservation. Specific projects focusing on the development of alternative sources of livelihood for artisanal fishermen are also extremely helpful. They may well be effective in areas having no direct connection with fisheries resources, such as tourism, small business enterprises and household cottage industries. Successful integrated conservation projects, as for instance in Guinea Bissau, have along with fish processing and enhancements, also encompassed other social initiatives like the creation of associations, micro-credit, literacy programs, and even judicial support.

## Local Perspectives and Knowledge

Local points of view, values or experiences have often been overlooked by administrations in the decision-making process. This can result simply from a lack of information at upper levels, and it is partly up to local communities to overcome this problem by better advocacy of their own perspectives.

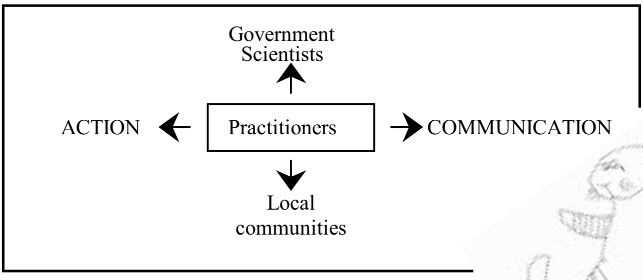
> For instance, the value of traditional low-level exploitation of the Rufiji delta's natural resources in Tanzania was recently calculated to be US$ 6.7 million a year (i.e., $192/ ha, vs. $63/ha for cultivated lands)— a significant argument when talking to national decision-makers. Valuation can also consist of outlining the importance of resources usually overlooked in the livelihood and food security of local people, such as frogs, snails and lotus in Asia. Subsistence fisheries are also often overlooked, although self-consumption can be very considerate — for instance 134kg of fish per household and per year in Alaska. In all cases it is essential that the information gathered at the local level be conveyed to scientists and national decision-makers.

- **Economic valuation:** Economic valuation has been consistently outlined as one of the most efficient contributors to biodiversity conservation. This strategy is being actively implemented by large conservation NGOs such as World Conservation Union (IUCN) and World Wildlife Fund (WWF); however field practitioners can also significantly contribute by valuing the use of natural resource in their zone. This would consist of identifying the natural resources and ecological services generated by the environment, and putting a financial value on them.

- **Using local knowledge and information:** Local knowledge and information can also play an important role in biodiversity conservation. This can consist of the collection of ecological knowledge, as is being done along the whole Mekong River whose fish diversity is huge and whose fishing communities are very experienced. It can also involve the translation of relevant documents in the national language into English in situations where a case might be better argued on the international stage and might attract the attention of foreign donors. Compilation of information found in "grey" literature is also extremely helpful, as scientists tend to focus on flagship sites and to neglect new areas that may have been covered by local studies of limited diffusion. Such information is also valuable for the identification of indicator species.

## Communication

Information is critically important in biodiversity conservation, as the scale of the degradation process necessarily requires the involvement of multiple stakeholders. Schematically, practitioners should consider themselves at a crossroad between national and local actors, and between action and communication. For efficient action, simultaneous initiatives are needed along those four directions.

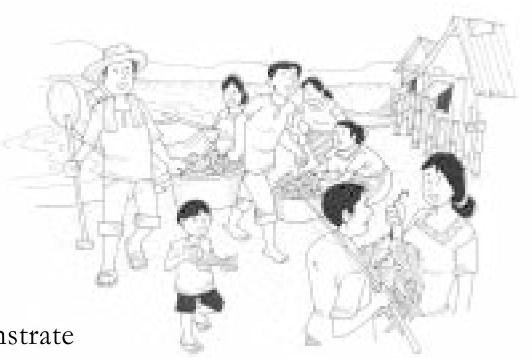



- **Diffusion of results** should be an intrinsic element of initiatives in favor of biodiversity conservation. This would benefit coordination, synergy and the sharing of lessons learnt. The impact of such communication about a given project will be maximized if it clearly states which is the approach favored (biological, involvement of communities, awareness building, etc), what is the environment considered (small stream, river, lake, wetland, coastal zone, etc; dimensions), what is the problem addressed (river discharge, pollution, damming, access to floodplains, etc), what is the target (x hectares of wetland rehabilitated, stabilised abundance of a declining species, removal of y% of an unsustainable fishery, etc); and what is the temporal scale addressed (a season, a year, a decade...). It is also noteworthy that objective "success stories" are particularly scarce despite their considerable potential value as a means of convincing decision-makers.

- **Collaboration with scientists** adds enormous value to field experiments, as scientists lend credibility, have time to report about initiatives, have access to means of diffusion and may have the ear of decision-makers.

- **Writing books and articles** on natural aquatic resources is an element of awareness building. Using the local language is an important factor in the impact that such material can have. Some donors have a policy of funding awareness-building initiatives. These can consist in educative brochures or posters, topic-oriented schoolbooks, news releases, but also in programs for broadcast (see for instance www.agfax.net) or even in karaoke songs that Asia is fond of, as developed by a project in Cambodia.

## Conclusion



In the field of biodiversity conservation, scientists consider that translating the principles into effective on-the-ground-action is still a question that remains unanswered. There is also a demand for projects that would demonstrate that significant improvements in biodiversity conservation can be attributable to, or connected with, improved local economic opportunities. There is therefore room for creativity among practitioners, keeping in mind that experimental projects should reflect the rural development experience, should ideally be funded in the long term, should decentralize decision-making to local levels, should be implemented by a mix of NGOs and government agencies, should encourage outside evaluation, and should involve collaboration with professional researchers to document, analyze and communicate their results -both successful and unsuccessful.

## References:

Heywood V.H. & R.T. Watson (eds.) 1995. Global Biodiversity Assessment. UNEP. Cambridge University Press. 1140 pp.

IIRR, IDRC, NACA and ICLARM. 2001. Utilizing Different Aquatic Resources for Livelihoods in Asia: A Resource Book. International Institute of Rural Reconstruction, International Development Research Center, Food and Agriculture Organization of the United Nations, Network of Aquaculture Centers in Asia-Pacific, International Center for Living Aquatic Resources Management. 416 pp.

Soule, M.E. 1991. Conservation: Tactics for a Constant Crisis. Science 253; 744-750.

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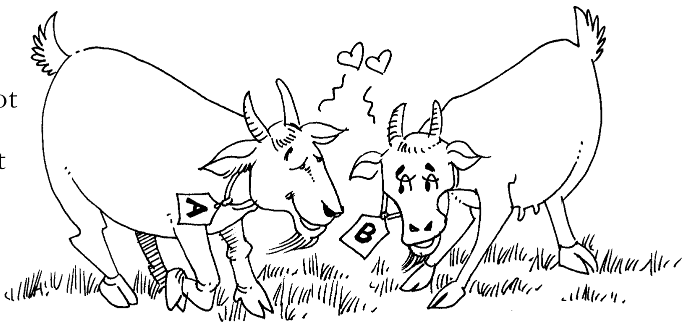
# Economic Valuation of Animal Genetic Resources: Importance and Application

Economic valuation methodologies for animal genetic resources (AnGR) play an important role in guiding resource allocation between biodiversity conservation and other socially valuable endeavors. Likewise, these can be used in various types of genetic resource conservation, research and development. Furthermore, these can assist in the design of economic incentives and institutional arrangements for farmers/genetic resource managers and breeders.

Despite its importance, AnGR valuation has, until recently, received very little attention, even though there exists a conceptual framework for the valuation of biodiversity in general.

## The Economics of AnGR Erosion

AnGR erosion can be understood in terms of the replacement, not only by substitution but also through crossbreeding and the elimination of livestock. This bias towards investment in such specialized breeds results in the under-investment of a more diverse set of breeds in a world where human investments are now necessary for the survival of the latter.




To the farmer, the loss of the local breed appears to be economically rational. The returns may simply be higher than that from activities compatible with genetic resources conservation. In particular, the latter may consist of non-market benefits that accrue to people other than the farmer. This divergence will be further compounded by the existence of distortions in the values of inputs and outputs, such that they do not reflect their economic scarcity.

When the activity of biodiversity (and genetic resources) conservation generates economic values, which are not captured in the market place, the result of this 'failure' is a distortion where the incentives are against genetic resources conservation and in favour of the economic activities that erode such resources. Such outcomes are, from an economic viewpoint, associated with market, intervention and/or global appropriation failures.

## The Need to Establish Economic Values for AnGR

Economics is about choice and the efficient allocation of scarce resources that have alternative uses. Rationally speaking, choices should be made in such a way as to maximize the "utility" or "welfare" obtained. The large number of AnGR at risk in developing countries, together with the limited financial resources available for conservation, mean that economic valuation can play an important role in ensuring an appropriate focus for conservation efforts.

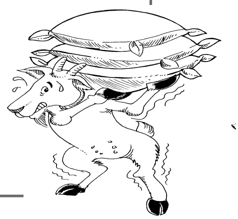

Economic arguments for conservation and sustainable use of AnGR can be an effective means of garnering the necessary public and political support, including development of appropriate policies. In this regard, important tasks include:

- assessment of the economic contribution that AnGR makes to various societies and provide economic arguments to help evaluate costs and benefits of conserving the genetic diversity;
- assessment of the impact of agricultural incentive payments, including subsidies on domestic animal diversity;

- economic analyses of alternative strategies and actions that might be taken to conserve domestic animal diversity and develop approaches for assessment priorities;
- development of economic incentives to support conservation by individual farmers or communities;
- assessment of the economic contribution of efforts to conserve wild relatives of domestic animals; and
- ensure that projects with direct or indirect implications for the livestock sector include appropriate consideration of economic issues related to AnGR.

The burden of being more specific about the value of genetic resources has come from different directions:

- resource conservationists and government planners who need to identify such values in order to justify budgets;
- Farmers' rights activists who want measures of the value in order to calculate compensation to farmers in developing countries; and
- a further source of pressure for establishing such values which gives legitimacy to much of the above is the Convention on Biodiversity (CBD) which stresses the importance of the "fair and equitable distribution of the benefits arising" from the utilization of genetic resources.



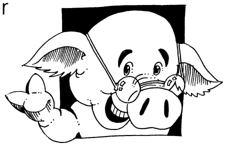
## AnGR Valuation

A range of valuation methodologies exists. These are categorized into three groups on the basis of the practical purpose for which they may be conducted. Following the identification of a given breed being at risk, these methodologies can be applied in order to justify conservation costs by:

- determining the appropriateness of AnGR conservation program costs (i.e., environmental values);
- determining the actual economic importance of the breed at risk (i.e., breed values); and/or
- permitting priority setting in AnGR breeding programs (i.e., consider trait values).

In these analytical contexts, unpriced inputs are pervasive obstacles in experimental studies. Therefore, it is of particular interest to have access to methodologies that can attribute values to the unpriced inputs of the household production functions, which are disclosed via the systematic investigation of preferences. Data availability and/or the potential for acquiring relevant data will also be an important determinant. Where such missing markets/imperfections are significant, the resulting impact of any violations of the underlying assumptions of the potential valuation methodologies must be carefully considered. Thus, appropriate measures should be taken. Such violations will mean that much of the required data will have to be collected through specially designed surveys and adequate shadow pricing of relevant inputs/outputs used where market prices do not exist or are distorted.

> In choosing a valuation technique, it is important to note that marginal and subsistence food production systems dominate the peasant economies where much of the world's surviving AnGR diversity can be found.
>
> In choosing between methodologies, the analyst will also have to be aware of how different methodologies will be of interest to different actors, which include, inter alia, farmers, breeders and policy-makers in charge of conservation.

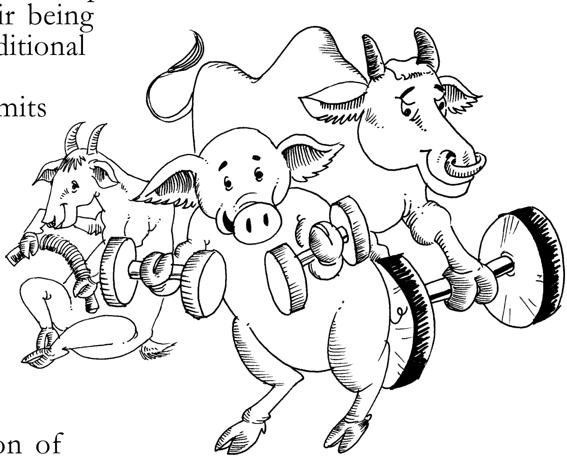


## Valuation Methodology Results

Given that the field of economic valuation of AnGR requires substantial development, the International Livestock Research Institute (ILRI), together with its partners, initiated a project entitled "Economic Valuation of Farm AnGR." Its main objective was to field test potential valuation methodologies to see which ones will work at reasonable costs. Some of the results of this on-going project and the work of ILRI's partners are presented below and show that such methodologies can be used to orient breeding strategies and conservation policy development.

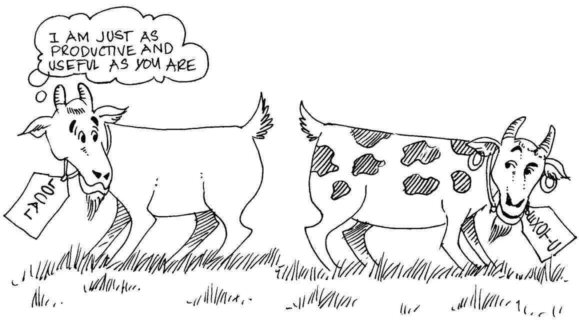
- Contingent valuation methodologies (CVM) using a choice experiment (CE) approach, show that such a multi-attribute stated-preference method can be used to value the phenotypic traits expressed in indigenous breeds of cattle (i.e., Kenya and Burkina Faso). Results indicate that CE does not only provide good estimates of trait values. These could also be used to investigate values of genetically determined traits currently not prominent in livestock populations. Furthermore, farmer preferences for specific traits and the trade-offs they are willing to make between them can be quantified.

In Burkina Faso, the most important traits for incorporation into breed improvement program goals were identified as: disease resistance; fitness for traction; and reproductive performance. Beef and milk production was less important, despite their being the focus of more traditional economic analyses. In addition, the data permits an analysis of how household characteristics determine differences in preferences. This information can be of use in designing policies that counter the present trend towards marginalization of indigenous breeds.



- An alternative CVM, using a dichotomous choice approach, was used to estimate the benefits of establishing a conservation program for the threatened Italian "Pentro" horse. A bio-economic model was developed and used to show that a large positive net present value associated with the proposed conservation activity does exist. This approach is thus a useful decision-support tool for policy-makers allocating scarce funds to a growing number of animal breeds facing extinction. It also provides an indication of how existence values (one component of total economic value) for livestock breeds may be significant. Through the use of appropriate mechanisms, they could be harnessed to provide funding for AnGR conservation.

- An aggregated productivity model approach revealed that under the subsistence mode of production in Ethiopia, the premise that crossbred goats are more productive and beneficial than the indigenous goats is wrong. The findings challenge the prevailing notion that indigenous livestock do not adequately respond to improvements in management and are always inferior (regardless of production system) to "improved" breeds.



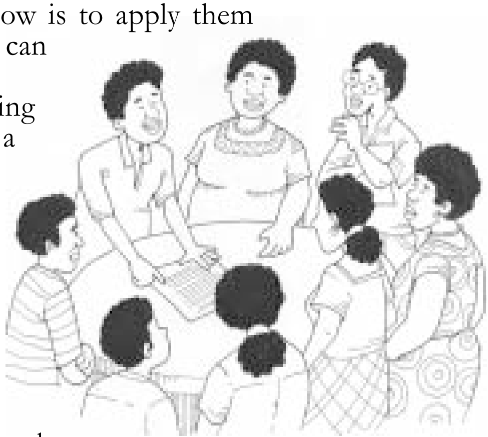

- The assumption that crossbred animals are always superior is also questioned in a cost-benefit analysis framework which suggests that the net benefits of crossbreeding programs may have been overestimated, leading to the promotion of exotic livestock breeds at the expense of indigenous livestock breeds.

Conventional economic evaluations of these programs have often not considered subsidies provided by national governments and international donors.

In addition, the mandatory changes in production systems necessary for increased productivity are often associated with higher levels of risk while replacement of indigenous breeds has socio-environmental costs due to the loss of the (usually non-market) values of the indigenous genotypes. A conceptual framework for evaluating crossbreeding programs in Sub-Saharan Africa is under development to take such costs into account.

## The Way Forward

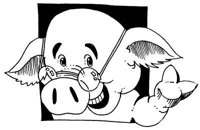
Although some methodologies have already been successfully tested, these and other valuation approaches remain to be applied under differing circumstances for different breeds/species. The challenge now is to apply them in a context where they can contribute to actual development and planning activities. This requires a combination of stakeholder awareness-raising as to their importance and capacity building to ensure that they can be applied to support the incorporation of the results into actual decision-making frameworks.



Mechanisms for translating social values into efficient incentives for farmers/genetic resource managers and breeders are also required as the current divergence of private and social costs mean that the relative costs and benefits of AnGR conservation tend to accrue unevenly at local, national and international levels. Several such mechanisms have been proposed and include, *inter alia:*

- genetic call options;
- licensing agreements;
- prospecting/royalty rights; and
- Farmers' Rights.

It is worth noting that despite the importance of the economic valuation of AnGR, it is not, however, an end in itself. Even where it is possible to identify the total economic value of AnGR, mechanisms to capture these values are necessary.



The removal of any adverse subsidies, the establishment of environmental funds and public financing, as well as market creation and support for commercialization can also provide incentives. Such mechanisms and policies may even help speed the development of improved valuation models.

## References:


Gicia, G., E. D'Ercole and D. Marino. 2003. Valuing Farm Animal Genetic Resources by Means of Contingent Valuation and a Bio-Economic Model: The Case of the Pentro Horse. Ecological Economics Special Issue on AnGR.

Rege, J.E.O., and J.P. Gibson. 2003. Animal Genetic Resources and Economic Development: Issues in Relation to Economic Valuation. Ecological Economics Special Issue on AnGR.

Scarpa, R., A. Drucker, S. Anderson, N. Ferraes-Ehuan, V. Gomez, C. Risopatron, C. and O. Rubio-Leonel. 2003. Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Kelen Creole Pig in Yucatan. Ecological Economics Special Issue on AnGR.



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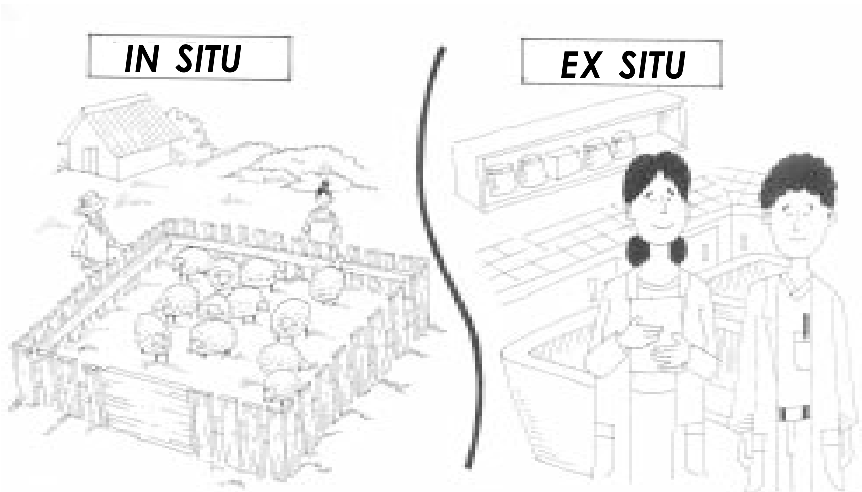
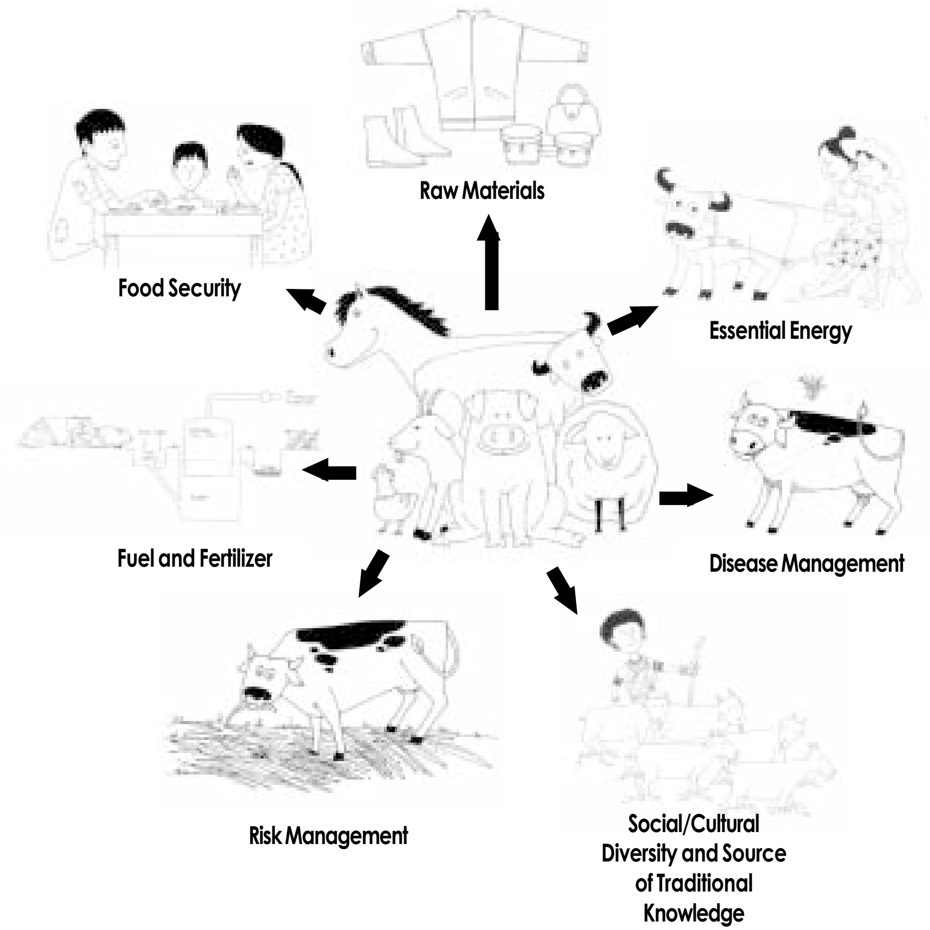
# Conservation of Animal Genetic Resources




Animal genetic resources are the building blocks for livestock development. Genetic diversity enables farmers and breeders to utilize a wide range of production environments and develop diverse products to meet the needs of local communities. The diversity also allows farmers and breeders to respond to changing environmental conditions and consumer demands.

The contribution of animal genetic diversity in agriculture, economic development and resources management is a major consideration for its conservation. At the same time, being an integral component in many social and cultural traditions, diversity contributes to individual and community identity.

## Roles and Values of Animal Genetic Resources



# Key Elements for a Successful Conservation Strategy

## Establish a Committed and a Strategic Approach to Use, Develop and Conserve Animal Genetic Resources and Mobilize Financial Resources

A conservation strategy is more than just a technical program. It must contain an awareness building component and a planning process that promote wide involvement and commitment of all stakeholders. Within countries, the building of partnerships among government agencies, local authorities, farmers, researchers, business interests and non-governmental organizations is critical to a successful conservation strategy. Farmers, who own and utilize livestock, must be involved in the process as their decisions influence the direction of animal production and the future of a given local breed. Ensuring profitability of production is the most important goal for farmers; therefore, conservation activities must consider the need of farmers to generate income.

In 1995, the **Global Strategy for Management of Farm Animal Genetic Resources** was adopted by the Food and Agriculture Organization of the United Nations (FAO-UN) with the aim to provide a comprehensive framework for the management of farm animal genetic resources. Within the Global Strategy Framework, each country was invited to establish National Focal Point for Animal Genetic Resources and to nominate a National Coordinator. In assisting countries, the FAO-UN has produced a wide range of technical guidelines. Another major initiative for animal genetic resources has resulted from a decision from the FAO Commission on Genetic Resources for Food in Agriculture, that agreed in 1999 to launch preparation of the first **Report on the State of the World's Animal Genetic Resources**. This country-driven process is intended to provide a comprehensive assessment of the state of animal genetic resources and the capacity to manage them now and in the future, and identify priorities for national, regional and international action.

In Europe, the need for conservation of animal genetic resources was recognized in the 1960s, when many countries already initiated programs to maintain their native endangered breeds. The first conservation program in France, with the Solognote sheep, was started in 1969. The following decade, in the British Islands, the Rare Breeds Survival Trust and the Traditional Livestock Foundation have initiated their activities.

In the European Union, a special premium is available within the framework of the agri-environmental program to support farmers who maintain local domestic animal breeds that are in danger of extinction. There are also situations where conservation activities are directly supported by non-government foundations such as the Rare Breeds Survival Trust in the United Kingdom.

## Employ Effective Conservation Methods

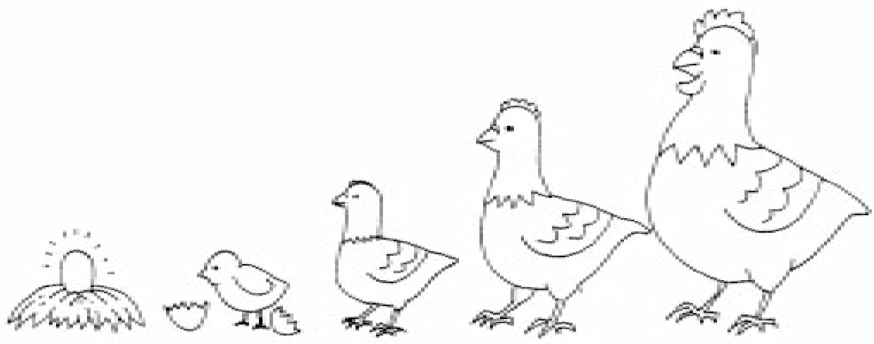
Conservation efforts can be broadly categorized as *in situ* and *ex situ*. *In situ* conservation means that animals are kept within their production system, in the area where the breed developed its characteristics. *Ex situ* conservation applies to situations where animals are kept outside their area of origin (herds kept in experimental farms, farm parks, within protected areas or in zoos) or more often, when genetic material is conserved and stored in genebanks.

Both conservation approaches have advantages and disadvantages. Until recently, there was a lot of enthusiasm regarding the potential of *ex situ* conservation as the most reliable and cost-effective conservation strategy. This view was further reinforced by the development of biotechnology. However, *in situ* conservation, particularly in cases where specific breeds are endangered, is now recognized as a more effective, primary approach and efforts in this regard are increasing.

## *In situ* Conservation

*In situ* conservation facilitates breed characterization, evolution and adaptation. Under *in situ* conditions, breeds continue to develop and adapt to changing environmental pressures enabling research to determine their genetic uniqueness.

The most cost-effective approach to *in situ* conservation is to maintain locally adapted breeds within commercial or subsistence production systems. Specific traits, often expressed in indigenous breeds, including hardiness, fitness, longevity, low feed requirements, resistance to diseases and relatively high reproduction performance can be extremely beneficial. Moreover, lower yields from locally adapted breeds can be compensated by higher lifetime production, as well as from their lower total maintenance costs.



Locally adapted breeds can also be used in crossbreeding programs especially when their prolificacy and maternal abilities are high. The ability of locally adapted breeds to perform in low-input stressful production systems provides the basis for sustainable agriculture. This is true especially in many regions of the world where there is routine exposure to environmental stressors such as disease and extreme climatic variation.

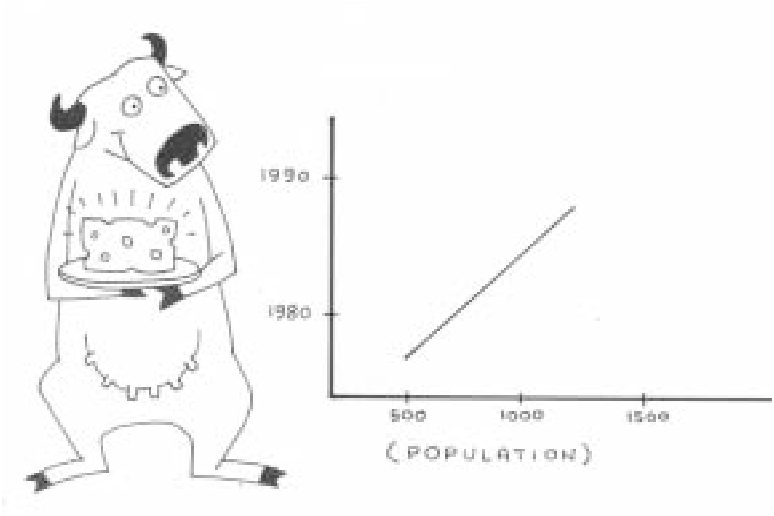
For example, trypanotolerant cattle breeds like the N' Dama, Muturu or the Keteku in Nigeria make possible dairy production in areas where other breeds cannot survive.

## *Ex situ* Conservation

*Ex situ* methods are generally regarded as an accompanying measure to *in situ* conservation. Cryoconservation provides a long-term insurance to conserve genetic diversity for future needs and demands for animal products. However, cryoconservation neither permits characterization of breeds nor provides a full range of socio-economic, ecological or cultural benefits that can be achieved through *in situ* methods. Moreover, as the genetic make up of a breed is frozen, it cannot adapt to changing environmental conditions. Another disadvantage of cryoconservation is that breed restoration may be extremely costly and time consuming. But as a complementary conservation approach, cryoconservation provides a long-term insurance system to *in situ* conservation.

Cryoconservation requires modern facilities, and skilled personnel and is expensive. In the majority of *ex situ* banks, semen and embryos are the most common genetic material. There are also programs that include the storage of oocytes, tissue and DNA. *Ex situ* establishment is most advanced for cattle and small ruminants, although other farm animal species, especially pigs, horses, rabbits, poultry and fish, are being stored through cryoconservation.

A key element of the operation of *ex situ* conservation banks is the establishment of protocols for the collection of genetic material, health and quarantine requirements, evaluation of biological value of stored material, access to stored resources and replenishment procedures.




## Production of Specialty Products

Production and successful marketing of goods and services that are highly valued by consumers can promote maintenance of minor breeds. For example, in Italy, the population of the Reggiana cattle increased from 500 in the early 1980s to approximately 1200 by 1998 because of the development of Parmigiano Reggiano cheese that is made exclusively from milk obtained from Reggiana cows. This cheese commands a high price, about 16 % higher than other brands of parmigiano cheese. This provides an economic incentive for farmers to conserve and use a breed that may otherwise be lost. This incentive-based approach has been successful in other regions.

Market identification is a type of incentive approach that has also proved successful in Mediterranean countries where local or regional sheep and goat dairy products and traditional processing are highly valued by consumers (e.g., Ossau Iraty, Roquefort, Pecorino Romano, Manchego, Serra da Estrela, Feta, etc.).

Market-based linkages have also been established for meat products that are derived from locally adapted breeds. Examples include the Mirandesa cattle in Portugal, Piemontese, Chanina, Merchigiana and Ramangola cattle in Italy and Hinlerwälder cattle in Germany. Successes were reported in Vietnam where a local breed of black chicken commands a high price. In Poland, eggs from the Greenlegged Partridge hen are marketed as low cholesterol organic products that are highly valued, commanding high prices.

## Promotion of Agro-Tourism

In Europe, increased interest in agro-tourism provides opportunities to conserve locally adapted breeds and increase economic diversification. It can also create public awareness of the roles and values of diverse breeds. In the United Kingdom, for example, there are now 22 Rare Breeds Survival Trust Approved Centres. One such farm, the Costwold Farm Park, attracts over 100,000 visitors annually.

**Consider these .....**
The first step to conservation and sustainable use of animal genetic resources is understanding its critical roles and values. Such understanding has to be developed through continuous communication with stakeholders and society, through educational programs, and widespread dissemination of information and knowledge about animal genetic resources. When it has been determined that a breed conservation initiative is required, it must be strategically planned considering local capacities and conditions, market opportunities and potential for collaboration among stakeholders.

## References:

Boyazoglu, J. 1999. Livestock Production Systems and Local Animal Genetic Resources with Special Reference to the Mediterranean Region. Invited paper, VII Congress of the Mediterranean Federation for Ruminant Health and Production, Santarem, Portugal 22-24 April, 1999.

FAO. 1998. Proceedings of the 6th World Congress on the Genetics Applied to Livestock Production, FAO/6th WCGALP Workshop on Animal Genetic Resources and Sustainable Development, Armidale, NSW, Australia, January 1998, Volume 28.

Gandini, G. and J. K. Oldenbroek. 1999. Choosing the Conservation Strategy: Genebanks and the Conservation of Farm Animal Genetic Resources, Edited by J.K. Oldenbroek ID-DLO, The Netherlands.

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# *In Situ* Conservation of Farm Animal Genetic Resources

There are two broad approaches through which farm animal genetic resources (AnGR) can be conserved: *ex situ* and *in situ*. *Ex situ* approach to conservation includes methods such as cryopreservation and live animal conservation in designated localities (e.g., government farms). *In situ* conservation encompasses entire agroecosystems, including immediately useful species (e.g., crops, forages, agroforestry species, other animal species) that form part of the system.

*In situ* conservation is defined as "the continuous husbandry of a diverse set of populations by farmers in the agroecosystems where an animal population/breed/strain has evolved."

It is the management of viable populations (by farmers) in the agroecosystems where they have developed their distinctive properties.

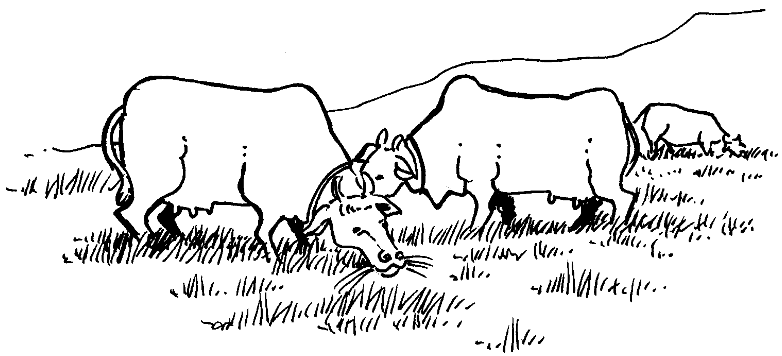
The following objectives may underpin an *in situ* conservation program:

- To conserve the processes of evolution and adaptation of animal populations to their environments.
- To conserve diversity at all levels - ecosystem, species and within species (breeds and genes).
- To integrate farmers (mixed farmers, pastoralists) into a national AnGR system.
- To conserve ecosystem services which are critical to the functioning of the earth's life-support system (i.e., maintaining soil-forming processes, reducing chemical pollution, restricting spread of animal and plant diseases, etc).
- To improve the livelihood of resource-poor farmers through economic and social development (i.e., combining *in-situ* conservation with development of local infrastructure, or increasing access by farmers to locally-relevant animal and plant (forage) germplasm).
- To develop systems to make conserved material (i.e., semen for local use) or conditions easily accessible to farmers.

## Advantages and Disadvantages of *In Situ* Conservation of AnGR

One major advantage of AnGR is that it conserves both the genetic material and the processes that give rise to the diversity. Thus, adapted indigenous breeds can be co-conserved with wild species, maximizing system output sustainably. Long-term sustainability of breeding efforts may depend on the continued availability of the genetic variation that can be maintained and further developed by the herders themselves using their own management practices. Moreover, because the technology for cryopreservation of AnGR is only well-developed for a handful of livestock species, conservation of most livestock species will continue to depend on *live animals*. In almost all cases, interventions supporting continued evolution (in response to changes in the production system) is cheaper and more effective for AnGR *in situ* conservation.

Unfortunately, *in situ* conservation also has some drawbacks. The first one is that the same factors that allow for dynamic, holistic, agroecosystem conservation, may serve to threaten the security of breeds/strains. For example, genetic erosion can still occur due to unforeseen circumstances such as war and natural disasters. Moreover, social and economic change may either foster or hinder *in situ* AnGR conservation over time. Indeed, one of the challenges of *in situ* conservation research is to evaluate how economic development is affecting farmer maintenance of diversity so as to account for this process in the implementation of conservation programs.



## Community-based Management and *In Situ* Conservation of AnGR

The role of community-based conservation has received increasing attention from the realization that most creative and productive activities of individuals or groups in society take place in communities. As local communities have vested interests in all the natural resources (including AnGR) on which their livelihoods depend, and have the most to lose in the event of loss of these resources, they are best placed to conserve them. Moreover, they have a better understanding, than any other group, of what it takes to sustainably manage their traditional resources. Community-based management of

AnGR refers to a system of AnGR and ecosystem management. AnGR keepers are responsible for the decisions on definition, priority-setting and the implementation of all aspects of its conservation and sustainable use.

Conserved animal material in *ex situ* systems is more likely to be utilized in emergency restoration but is much less likely to find use in long-term animal improvement programs.

*In situ* conservation and community-based management of AnGR are conceptually similar. However, there are subtle but significant differences. Conservation of AnGR has been defined as the sum of all actions involved in the management of AnGR, such that these resources are best used to meet *immediate* and *short term* requirements for food and agriculture, and remain available to meet possible longer term needs.

On the other hand, management of AnGR is the combined set of actions by which a sample, or the whole of an animal population is subjected to a process of genetic and/or environmental manipulation. Its aim is to sustain, utilize, restore, enhance and characterize the quality and/or quantity of the AnGR and its products (i.e., food, fibre, draught animal power, etc). From this definition, it is clear that 'management' of AnGR encompasses all activities, which ensure that the population is dynamic and is responsive to changes in the physical and socio-cultural environment.

In crop agriculture, participatory plant breeding is now generally accepted and widely applied in many developing countries. Livestock development remains primarily driven by imported technological packages (i.e., artificial insemination, exotic germplasm) and very limited involvement of communities in their implementation.

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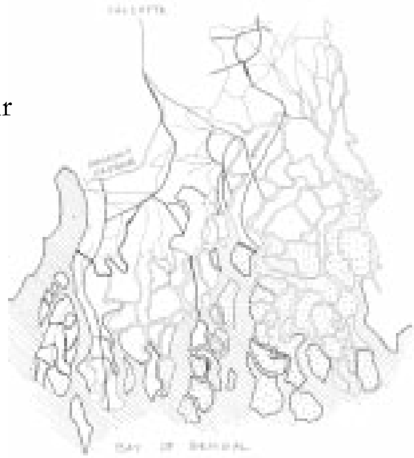
# Conserving Fish Biodiversity in Sundarban Villages of India


Sundarbans is the largest inter-tidal delta in the world and covers two countries, i.e., India and Bangladesh. This region is crisscrossed with many rivers, rivulets, creeks and canals with an agro-climate typical of a coastal region. Natural resources here are diverse and two distinct landscapes are found in the Indian Sundarbans: the **main land** where people have access to markets, schools, government offices, etc. reached by roads and rails, and 54 **islands** where the inhabitants depend on river transport to travel from one island to the other or to the main land. Such is the diversity of the natural and physical resources of the area.

Villages in the Sundarbans have lots of backyard ponds. Village families excavate a portion of their low-lying paddy field to get earth to raise the land and construct dwelling houses and for drinking water. Therefore, almost every household possesses these excavated areas, which, in the monsoon season, store rain water. These ponds (small water body) are used for fresh water aquaculture.



## Diversity of Niches

A Participatory Survey conducted in a typical Sundarban island village (Debipur under Kultali Developmental Block) indicated that five types of niches were found in the village and all were utilized for freshwater aquaculture. These niches are: small domestic ponds, big ponds (either owned by individuals or few families), rainfed canals, land-shaping ponds (mainly excavated for agricultural irrigation purpose) and low-lying inundated paddy fields (Table 1).

A wide range of fresh water species (Table 2) are found and in spite of the fact that because of the inter-tidal environment, other water bodies are saline. (Brackish water species in the village are not discussed in this paper.) Different niches in the same village host different categories of fish: marine, brackish water and fresh water.

## Diversity of Species

Matrix ranking was undertaken of the fresh water fish species using five criteria that the community identified

- taste;
- home use;
- marketability;
- better market price; and
- people's interest to grow.

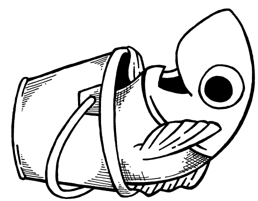
**Table 1. Preference for Fresh Water Fish Found in Madhya Gurguria Village in Sundarbans (based on matrix ranking exercise - January 2002)**

| Niche | Types of Fish | Taste | Home use | Marketability | Price obtained | Interest to grow |
|---|---|---|---|---|---|---|
| Small pond (Back yard) | Rohu* *(Labeo rohita)* | 9 | 6 | 7 | 6 | 7 |
| | Mrigal* *(Cirrhinus mrigala)* | 7 | 7 | 6 | 5 | 6 |
| | Catla* *(Catla catla)* | 5 | 5 | 5 | 5 | 5 |
| | Java punti *(Puntius javonicus)* | 8 | 8 | 4 | 4 | 9 |
| | Tilapia *(Orechromis niloticus)* | 6 | 8 | 3 | 4 | 8 |
| | Singhi* *(Heteroneustes fossilis)* | 9 | 4 | 8 | 8 | 1 |
| | Mourala* *(Amblypharyngodon mola)* | 8 | 9 | 9 | 9 | 4 |
| | Silvercarp *(Hypophthalmichthys molitrix)* | 4 | 10 | 2 | 2 | 10 |
| | Koi* *(Anabus testudineus)* | 8 | 6 | 9 | 8 | 3 |
| | Magur* *(Clarias batrachus)* | 10 | 2 | 10 | 10 | 4 |
| | Tangra* *(Mystus vittatus)* | 8 | 3 | 8 | 7 | 3 |
| Big pond | Rohu* *(Labeo rohita)* | 9 | 6 | 7 | 6 | 7 |
| | Mrigal* *(Cirrhinus mrigala)* | 7 | 7 | 6 | 5 | 6 |
| | Catla* *(Catla catla)* | 5 | 5 | 5 | 5 | 5 |
| | Java punti *(Puntius japonicus)* | 8 | 8 | 4 | 4 | 9 |
| | Tilapia *(Orechromis niloticus)* | 6 | 8 | 3 | 4 | 8 |
| | Singhi* *(Heteroneustes fossilis)* | 9 | 4 | 8 | 8 | 1 |
| | Mourala* *(Amblypharyngodon mola)* | 8 | 9 | 9 | 9 | 4 |
| | Silvercarp *(Hypophthalmichthys molitrix)* | 4 | 10 | 2 | 2 | 10 |
| | Koi* *(Anabus testudineus)* | 8 | 6 | 9 | 8 | 3 |
| | Magur* *(Clarias batrachus)* | 10 | 2 | 10 | 10 | 4 |
| | Tangraz *(Mystus vittatus)* | 8 | 3 | 8 | 7 | 3 |
| | Golda chingri* *(M. rosenbergii)* | 8 | 1 | 10 | 10 | 10 |
| | Sol* *(Channa striatus)* | 7 | 9 | 6 | 7 | 2 |
| | Lata* *(Channa punctatus)* | 6 | 10 | 1 | 1 | 1 |
| | Pabda* *(Ompok pabda)* | 10 | 6 | 9 | 9 | 8 |
| | Bata* *(Labeo bata)* | 9 | 7 | 7 | 8 | 9 |

| Niche | Types of Fish | Taste | Home use | Marketability | Price obtained | Interest to grow |
|---|---|---|---|---|---|---|
| Drainage or Irrigation canals | Rohu* *(Labeo rohita)* | 9 | 6 | 7 | 6 | 7 |
| | Mrigal* *(Cirrhinus mrigala)* | 7 | 7 | 6 | 5 | 6 |
| | Catla* *(Catla catla)* | 5 | 5 | 5 | 5 | 5 |
| | Java punti *(Puntius japonicus)* | 8 | 8 | 4 | 4 | 9 |
| | Tilapia *(Orechromis niloticus)* | 6 | 8 | 3 | 4 | 8 |
| | Singhi* *(Heteropneustes fossilis)* | 9 | 4 | 8 | 8 | 1 |
| | Mourala* *(Amblypharyngodon mola)* | 8 | 9 | 9 | 9 | 4 |
| | Silvercarp*(Hypophthalmichthys molitrix)* | 4 | 10 | 2 | 2 | 10 |
| | Koi* *(Anabus testudineus)* | 8 | 6 | 9 | 8 | 3 |
| | Magur* *(Clarias batrachus)* | 10 | 2 | 10 | 10 | 4 |
| | Tangra* *(Mystus vittatus)* | 8 | 3 | 8 | 7 | 3 |
| | Golda chingri* *(M. rosenbergii)* | 8 | 1 | 10 | 10 | 10 |
| | Sol* *(Channa striatus)* | 7 | 9 | 6 | 7 | 2 |
| | Lata* *(Channa punctatus)* | 6 | 10 | 1 | 1 | 1 |
| | Pabda* *(Ompok pabda)* | 10 | 6 | 9 | 9 | 8 |
| | Bata* *(Labeo bata)* | 9 | 7 | 7 | 8 | 9 |
| | Bhetki* *(Lates calcarifer)* | 9 | 1 | 8 | 8 | 8 |
| | Pankal* *(Mastacembelus pancalus)* | 8 | 8 | 6 | 5 | 1 |
| Land-shaping pond(On Farm) | Rohu* *(Labeo rohita)* | 9 | 6 | 7 | 6 | 7 |
| | Catla* *(Catla catla)* | 5 | 5 | 5 | 5 | 5 |
| | Mriga* *(Cirrhinus mrigala)* | 7 | 7 | 6 | 5 | 6 |
| | Java punti *(Puntius javonicus)* | 8 | 8 | 4 | 4 | 9 |
| | Silvercarp *(Hypophthalmichthys molitrix)* | 4 | 10 | 2 | 2 | 10 |
| | Golda chingri* *(M. rosenbergii)* | 8 | 1 | 10 | 10 | 10 |

| Niche | Types of Fish | Taste | Home use | Marketability | Price obtained | Interest to grow |
|---|---|---|---|---|---|---|
| Paddy field | Koi* *(Anabas testudineus)* | 8 | 6 | 9 | 8 | 3 |
| | Singhi* *(Heteropneustes fossilis)* | 9 | 4 | 8 | 8 | 1 |
| | Magur* *(Clarias batrachus)* | 10 | 2 | 10 | 10 | 4 |
| | Sol* *(Channa striatus)* | 7 | 9 | 6 | 7 | 2 |
| | Lata* *(Channa punctatus)* | 6 | 10 | 1 | 1 | 1 |
| | Mourala* *(Amblypharyngodon mola)* | 8 | 9 | 9 | 9 | 4 |

(1= low, 10=high)
(Indigenous/local fish species are marked with an *)
N.B. A total of 18 different freshwater species were found in a single village



It has been observed that about 11 species are cultured in small ponds and as many as 18 species are cultured in canals. This species composition is a combination of both exotic and Indian major carps, Indian minor carps and some of the so-called "unwanted" "trash" and "predatory" fish. Scientists have previously suggested the need to eradicate these species while introducing composite fish culture technology. The different species were either released or allowed to enter from natural sources through in-letting of the water.

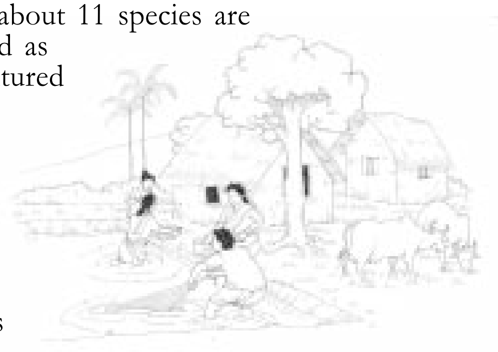


**Table 2. Freshwater Diversity in Debipur Village in Sundarbans**

| | | | |
|---|---|---|---|
| 1 | Rohu *(Labeo rohita)* | 18 | Tilapia *(Orechromis niloticus)* |
| 2 | Catla *(Catla catla)* | 19 | Cyphon *(Cyprinus carpio)* |
| 3 | Mrigal *(Cirrhinus mrigala)* | 20 | Grass carp *(Ctenopharyngdon idella)* |
| 4 | Bata *(Labeo bata)* | 21 | Nandos *(Nandus nandus)* |
| 5 | Silvercarp *(Hypophthalmich thys molitrix)* | 22 | Dheney *(Esomus dandricus)* |
| 6 | Sol *(Channa striatus)* | 23 | Bhetki *(Lates calcarifer)* |
| 7 | Singhi *(Heteropneustes fossilis)* | 24 | Techokha *(Panchax panchax)* |
| 8 | Magur *(Clarias batrachus)* | 25 | Potke chingri *(Acetes indica)* |
| 9 | Koi *(Anabus testudineus)* | 26 | Lata *(Channa punctatus)* |
| 10 | Tangra *(Mystus vittatus)* | 27 | Kholse *(Colisa fasciatus)* |
| 11 | Mourala *(Amblypharyngodon mola)* | 28 | Pankal *(Mastacembelus pancalus)* |
| 12 | Punti *(Puntius ticto)* | 29 | Kunche *(Amphipnous cuchia)* |
| 13 | GoldaChingri *(Macrobrachium rosenbergii)* | 30 | Pabda *(Ompok pabda)* |
| 14 | Dim chingri *(M. rude)* | 31 | Bogo *(Xenentodon cancila)* |
| 15 | Chanda *(Chanda nama, Chanda ranga)* | 32 | Bele *(Glossogobius giuris)* |
| 16 | Pholui *(Notopterus notopterus)* | | |
| 17 | Ban *(Mastacembelus armatus)* | | |

## "Weed" and "Predatory" Indigenous Fishes are still popular

The eradication of predatory and trash fish has resulted to the loss of many wanted and preferred species, many of which are immensely popular. For example, *Ompok pabda*, a predatory indigenous fish species (in the preference matrix) scored 9 out of 10 in marketability, home use and interest to grow.

Ease of culture without any supplementary feed, good marketability, taste, food preference have not been considered by scientists. In spite of repeated efforts to discourage predatory species like *Channa striatus*. (Sol), *Anabus testudineus* (Koi), *Mystus vittatus* (Tangra) and *Ompok pabda* (Pabda), some 'weed' fish like *Amblypharyngdon mola* (Mourala), *Colisa fasciatus*. (Kholse), are still found in fresh water fish farms.

## Changing Trends in Polyculture Systems

Changing trends are observed among smallholders of aqua bodies in carp culture. Farmers have included walking catfish - *Clarias batrachus* as the seventh species along with the recommended six species of silver carp, grass carp, common carp, and three Indian Major Carps. This polyculture technology developed by research institutes has indeed undergone refinement and modification over the years by the enterprising fish farmers. Many fish growers are currently culturing more than 10 species in the composite fish culture as against the six originally recommended.

## Nutritional Value of Small Indigenous Species

Rice and fish are major components in the diet of rural communities in Bangladesh, India and Thailand. People of these countries still prefer small fish species that grow to a maximum length of only about 25 cm. Many small species are even less than 10 cm long and are eaten whole. Analysis of these small indigenous species showed that they contain large amounts of micronutrients and minerals (Table 3). Mourala *(Amblypharyngodon mola)* is a rich source of vitamin A. Small fish are consumed whole and are a good source of calcium, substituting the milk requirement in the diet. A study from Bangladesh revealed that many deficiencies like iodine, iron, etc. have been reduced in poor communities by taking small indigenous species. This fish diversity is maintained by adopting some changes in the fresh water fish culture.

**Table 3: Nutritional Value of Fish Species in Sundarban Villages of India**

| Fish species (per 100g raw, edible parts) | Vitamin (mg) | Calcium (mg) | Iron (mg) |
|---|---|---|---|
| **Small Indigenous Species** | | | |
| Mola *(Amblypharyngodon mola)* | 1960 | 1071 | 7 |
| Dhela *(Rohtee cotio)* | 937 | 1260 | - |
| Darkina *(Esomus danricus)* | 1457 | - | - |
| Chanda *(Parambassis spp.)* | 341 | 1162 | - |
| Puti *(Puntius spp.)* | 37 | 1059 | - |
| Kaski *(Corica soborna)* | 93 | - | - |
| **Large Fish Species** | | | |
| Hilsha *(Hilsha ilisha)* | 69 | 126 | 3 |
| Silver carp adult *(Hypophthalmichthys molitrix)* | 17 | 268 | - |
| Rohu *(Labeo rohita)* | 27 | 317 | - |
| Silver carp juvenile *(H. molitrix)* | 13 | - | - |
| Tilapia *(Oreochromis niloticus)* | 19 | - | 5 |

Source: Thilsted, S.H., N. Ross and N. Hassan. 1997. The Role of Small Indigenous Fish Species in Food and Nutrition Security in Bangladesh; ICLARM Quarterly, July-December 1997.

## Conserving Fish Diversity by Restocking Small Indigenous Species

The so-called "unwanted weed fish" can be restocked in the paddy field or in a deeper portion of the paddy field where water is assured so that, at the onset of the monsoon, these species will be able to breed .

Rural youth in the Sundarbans have undertaken the nursery management technology as a livelihood enterprise. They mainly grow major carps from spawn to fry and sell them in the market. A minor carp - *Labeo bata* has also been grown in their ponds. Rural youth can be encouraged to keep a separate pond for growing of the small indigenous species. Most of them are natural breeders and can breed easily during monsoon so that even after the carp nursery season is over they can sell the fish in the local rural markets.

In southern Bengal of India, rural youths have already undertaken the breeding of *Clarias batrachus* as an enterprise. They have already standardized the practice. The seeds of the *Clarias batrachus* are collected from the paddy fields. Rural youths are also undertaking the breeding of ornamental fish as livelihood enterprise. Some of the species like *Punti* (*Puntius* spp.), *Dhela (Rohtee cotio)*, *Chanda (Chanda nama, Chanda ranga.)* have established their value as an ornamental fish.

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# Livestock Breeding:
## Strategies and Concerns


Breeding strategies contribute significantly to improving livestock production efficiency, by enhancing the productive and reproductive performance of livestock. Several national breeding programs are still focusing solely on production outputs (e.g., milk yield) but do not consider its relationship with other important traits (e.g., reproductive performance or health). The utilization of livestock by small holder or communal farmers requires that the correlation among different traits be established before breeding schemes are adopted. The decision criteria, concepts and implementation of strategies, for the conservation of locally available farm animal genetic resources, are presented.

## Major Constraints to Livestock Breeding

The small number of stud breeders makes the implementation of an effective national breeding policy virtually impossible. Another major threat to indigenous farm animals is the uncontrolled mating of disseminated crossbred stock. A characterization and performance evaluation of available indigenous populations is still missing or incomplete for all important livestock species including local strains of poultry. Other major constraints for a sustainable genetic improvement of livestock, *in-situ*, are detailed in the box.

**Major Constraints for Genetic Improvement of Farm Animal Genetic Resources**

**Sector policy and breeding program**

1. Lack of national breeding policies
2. Insufficient *in-situ* conservation plan for genetic resources
3. Lack of well-defined breeding strategies
4. Unsustainable or lack of continuity of breeding program
5. Insufficient support of relevant research and training activities
6. Insufficient number of qualified animal breeders available
7. Livestock improvement program unsustainable due to dependency on external funding or subsidies and distorted markets

**Infrastructure**

1. Lack of performance recording schemes in several countries, especially in the smallholder sector and for indigenous breeds
2. Organization of animal breeders in many countries insufficient or non-existent
3. Communication, transport and computation facilities insufficient or not available

**Breeding programs**

1. Breeding objectives often non-existent or vague
2. Ineffective sire exchange and artificial insemination program
3. Small population sizes, small herd sizes and unreliable animal identification
4. Characterized by indigenous populations
5. Genotype environment interactions often neglected

**Selection and genetic gain**

1. Long generation intervals through extended and late maturing animals
2. Low selection intensity through high mortality rates and limited performance testing, if any
3. Low accuracy of estimated breeding values due to small active breeding population
4. Inbreeding effects may cause depression of performance
5. Antagonistic relationship between genetic merit for production and adaptation

# Livestock Breeding Strategies

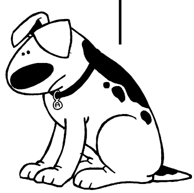
## Focus on Indigenous Populations

Selection within population or breeding for traits of medium to high heritability, such as daily gain or lean meat percentage, is a potential and sustainable strategy in developing countries. Development of local populations through adequate selection sustains local breeds and, therefore, secures conservation of genetic resources. With this scheme, breeding costs are kept low by not importing exotic livestock.

However, it is argued that this strategy progresses slowly over a given time period due to low level of output (e.g., milk, meat) of some of the indigenous livestock. Also, insufficient characterization of local populations prevents the set-up of a viable long-term selection program.

A group breeding scheme is also an efficient system to improve livestock. In the smallholder sector and where no progeny testing and artificial insemination (A.I.) scheme exists, breeders may adopt cooperative breeding schemes. A number of interested farmers record their flock, select the best females and send them to one unit forming a nucleus. The so called nucleus could be managed by a farmers' committee and is kept open for highly productive females. Selected males are used as replacement sires in the cooperating farms. The maximum rate of gain is achieved, when 5% to 10% of the total number of breeding animals is kept in the nucleus.

Efficiency, in its broad sense, is defined as the product output per unit of input involving a complex relationship between factors such as feed input, maintenance feed requirements, level of reproductive and productive performance, infrastructure and breeding costs and income per unit of sold product.



## Design a Sustainable Breeding Program

The general strategy for sustainable *in situ* conservation programs should focus on the optimization of the genetic potential according to environmental factors (e.g., the needs of the market, the ecological environment and future development). Livestock farmers should develop and identify their own breeding objectives, testing schemes and breeding stock based on their own conditions, which are determined by the production environment. Characterization of indigenous populations and comparative performance trials require sufficient and accurate data sources as the choice of the foundation stock for any breeding program is very important.

**Steps in designing sustainable breeding programs for *in situ* conservation**

**Principal thrust:**
To improve overall biological and economic efficiency of livestock production, through the provision of an optimized genetic potential, to fulfill the needs of the market or the subsistence of the farming system.

1. Identify production system(s), potential markets or market niches and economic merits of the animal population and its traits.
2. Define breeding goal and objective through a participatory approach.
3. Evaluate available populations for breeding purposes and select the best stock. Ensure identification of potential breeding animals and herds. Estimate critical effective population sizes and their 'cut-off' points, which are both species and population-specific.
4. Promote and develop adequate structures enabling the conduct of breeding systems (e.g., characterization, multiplication and selection) by the livestock owners. Ensure knowledge at farmer and professional level through applied training.
5. Develop improvement schemes based on testing and selection against the formulated breeding goal.
6. Ensure gene flow through dissemination of breeding animals using traditional stock sharing system or formal markets to all livestock production herds.

Within an agro-ecological zone, for example, the risk of extinction of a population, the presence of unique traits such as adaptive behaviour, disease tolerance or good mothering ability, and cultural and historical values of a population, the critical role of the population in crop-livestock systems, could be assessed by a representative group of stakeholders. The application of a simple scoring model for each criteria, e.g., ranging from 'very high' to 'non-existent', and its weight can be used to establish an aggregate score.

## Create a Multi-Sectoral Team of Appraisers

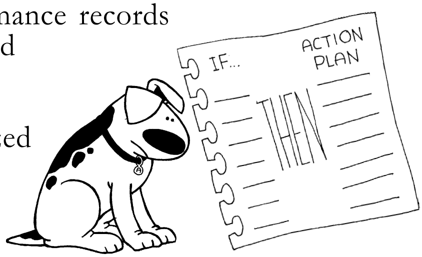
In the absence of objective data derived from long-term recording or in-depth studies, an assessment by a representative group of stakeholders might be helpful. The information gathered from the assessment would present the relative importance of populations within and between species. The exercise would allow direct farmer participation and ownership of a future breeding program.

However, the outcome of such an exercise could be distorted with the prevailing biases (e.g., donor dependencies, previous extension messages). This requires a critical review of the assumptions made and further independent analysis.

## Develop Action Plans for Policy Development

If the livestock production can no longer cope with the increasing demand, effective and efficient breeding policies should be implemented immediately. Listed below are some action plans recommended to achieve a measurable impact:

- Analyze production systems and economic merit in existing and future national, regional and overseas markets for livestock products. Assess needs of the subsistence sector to improve income generation in rural areas.
- Develop breeding policies and implement measures to avoid further uncontrolled developments resulting in extinction of indigenous populations and inefficient crossbreeding programs.
- Analyze existing performance records of indigenous, exotic and crossbred populations. Conduct comparative studies under standardized typical environmental conditions involving sufficient numbers of animals. Analyze assumed antagonistic relationships between productive and adaptive traits. Develop cost efficient and effective field performance testing schemes.




- Define and record secondary traits of importance for multipurpose livestock, such as disease resistance or utilization of locally available feed resources.
- Conserve valuable genetic resources. Establish a regional network on conservation issues as a venue to exchange ideas, experiences and problem solving strategies. Screen existing populations.
- Evaluate the genetic and economic merit of planned breeding strategies before exotic stock or advance technology is imported.
- Disseminate improved livestock to producers by applying a participatory approach, i.e., farmers must be integrated to achieve ownership of the program. Develop group breeding and open decentralized nucleus schemes.

- Review the impact of state owned and managed nucleus herds, breeding station and extension organizations. Market development and orientation as well as cost recovery should become a high priority.
- Pool national efforts and utilize existing facilities, know-how and technologies region wide, such as estimation of breeding values or testing of innovative technologies and promote professional training.
- Stakeholders, including professional animal breeders, should start a concerted action to implement *in-situ* conservation programs through appropriate breeding strategies.

## Conclusion

Decentralized, community-based group breeding activities, applying standardized data recording schemes, could be the best compromise in the less developed countries to improve livestock and to conserve genetic resources. The indigenous genetic resources of livestock offer an enormous potential, which is not yet explored. The conservation of such valuable germplasm should be regarded as mandatory for securing food for present and future generations.

## References:

Ayalew Kebede, W. 2000. Do Smallholder Farmers Benefit More From Crossbred (Somal x Anglo-Nubian) than from Indigenous Goats? Goettingen, Univ. Diss., 155 pp.

Chagunda, M.G., C.B.A. Wollny, E. Bruns, E. and L.A. Kamwanja. 1998. Evaluation of the Artificial Insemination Program for Small Scale Dairy Farms in Malawi. Arch. Tierz. 41: 45:52.

Moyo, S., J.E.O. Rege and F.J.C. Swanepoel. 1994. Evaluation of Indigenous, Exotic and Crossbred Cattle for Beef Production in a Semi-arid Environment. Proc. 5th World Congress Genet. Appl. Livest. Prod. 20: 344-347.

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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).

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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.

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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

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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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