AGROSPECIAL 5

BRINGING FARMERS BACK INTO BREEDING

EXPERIENCES WITH PARTICIPATORY PLANT BREEDING AND CHALLENGES FOR INSTITUTIONALISATION



CONNY ALMEKINDERS & JAAP HARDON (EDS)
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PREFACE

The purpose of this report is to provide an overview of Participatory Plant Breeding (PPB). It reviews the approach from both a technical and a social perspective and identifies the challenges for incorporating PPB in national plant breeding regimes, which we argue is necessary for its scaling-up and future sustainability. It draws on the concrete experiences of a number of PPB projects in Latin America, Africa and South East Asia. These are selected to provide a range of different levels of cooperation between researchers, NGOs and farmers.

PPB can complement the centralised institutional plant breeding regimes that are common to industrial countries and practiced by the international institutes of the CGIAR and government institutions in developing countries. When used in combination with increased external inputs (fertilisers, chemical control of pests and diseases, improved irrigation and practices) these breeding approaches were successful in raising yields in the more favourable production areas and are generally referred to as "the green revolution". However, they have been less successful in providing small scale farmers in marginal agricultural areas with improved varieties. PPB has emerged from the perceived need for more farmer-oriented approaches to the existing linear process of plant breeding, extension and distribution/marketing to farmers. This is partly because environmental conditions in the tropics and sub-tropics tend to be much more diverse, often even within short distances, than they are in most temperate countries. Secondly, it is recognised that farmer seed systems have a value and strength in coping with such diversity and that farmers have an inherent capability to select those materials that are most appropriate for their local requirements. This recognition led to the establishment, in the 1990s, of a number of pilot projects that involve farmers in various stages of the breeding process. These range from involving farmers in setting breeding objectives, in testing and selecting breeding materials in various stages of development in their own fields under different environmental conditions, and ultimately in providing farmers with the skills and materials to breed their own varieties.

This report reviews the experiences of a range of selected pilot projects with a view to developing more general insights into PPB: what has worked well, what did not work so well and how PPB approaches can be improved. These insights are then used as basis for identifying the major challenges likely to be involved in the scaling-up and institutionalisation of PPB. These questions need to be placed in the general context of national crop improvement programmes and particularly how they can broaden their reach so that they also include small resource-poor farmers, especially those in more marginal areas that have thus far received little benefit from such programmes. The inputs for this review include a number cases (part two of this document) combined with information from the literature and our own experiences. The case study material has been provided by individual authors, who are partners in the various projects described. Some of them also had an input into the overall conceptualisation of this document. Their cooperation is gratefully acknowledged.

Rather than trying to provide a critical evaluation of PPB, the emphasis of this report is on seeking to understand the different conditions under which various projects are implemented, how these relate to broader goals and how these influence the modes of cooperation between the various project stakeholders. At present PPB projects are generally pilot projects, utilising different approaches, with little indication about which are most effective and indeed how effectiveness can and should be assessed.

We also ran into a common problem with farmer-managed activities, that is, the scarcity of quantitative data. We expected to be able compile data regarding actual selection procedures including population sizes, intensity of selection etc. However in the PPB activities, data are not documented in the same way and with the same detail as breeders do in conventional programmes. Hence the technical analysis remains rather descriptive. For this reason we shifted our attention and looked for documentation that also pays attention to the participation aspect of the experiences.

We hope that this document will contribute to a better understanding of what PPB is all about and widens interest, particularly amongst plant breeders and policy makers, in regarding farmers as potential and enthusiastic partners in crop improvement.

Jaap Hardon and Conny Almekinders, Wageningen, June 2006

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PART A: FROM CONCEPT TO PILOT PROJECT AND BEYOND

JAAP HARDON AND CONNY ALMEKINDERS, WITH ANJA CHRISTINCK, SALLY HUMPHRIES, DIDIT PELEGRINA, BHUWON STHAPIT, RONNIE VERNOOY, BERT VISSER AND EVA WELTZIEN

1 INTRODUCTION

1.1 Setting the Scene

In the nineteen sixties and seventies a marriage of institutional plant breeding and high input agriculture appeared to offer the opportunity of alleviating the spectre of endemic food shortages in many parts of the world. This development was spearheaded by the International Agricultural Research Institutes, established and coordinated by the Consultative Group on International Agricultural Research (CGIAR). In concert with national agricultural research and plant breeding programmes, significant increases in the productivity of major food crops (notably rice, wheat, corn and a number of food legumes) were realised in many developing countries. This achievement should not be underestimated. However, improved technology was no panacea. Replacing local varieties by 'modern' varieties that were more responsive to inputs and the provision of quality seed generally worked well in more fertile agricultural areas. But, for the very environmentally diverse and stress prone marginal areas, blanket recommendations and a one-size-fits-all technology was not an appropriate strategy. To cope with this problem, plant breeders in different parts of the world started to involve farmers in target environments in setting breeding objectives and subsequent selection and testing of breeding materials (both on-station and/or on-farm). The objectives were to better satisfy farmers' needs (driven by their diverse ecological environments and household requirements) and improve local adaptation (Ceccarelli *et al*.; 2001; Sperling et al, 2001, Witcombe *et al*. 2002; Weltzien *et al*., 2003).

At the same time a number of NGOs including CET-CLADES (Latin America) and SEARICE (SE-Asia) argued for a re-validation of traditional agricultural systems and practices, to widen the scope of development beyond the high potential areas, and to increase sustainability and cost-effectiveness. They stressed that farmer seed systems were (and are) still the main sources of seed, including modern varieties. In many countries these farmer seed systems provide a more reliable, robust and time-tested seed supply system than institutional seed systems.. This re-validation also emphasised the role of genetic diversity within farmers' fields, especially, but not only, in the more marginal areas This diversity constitutes an important resource for adaptation to local conditions of spatial and temporal environmental stress and for meeting the culinary qualities and specific purposes desired by households. The role of farmers actively managing and continuing to develop diversity through their seed systems was emphasised. This contributed to greater recognition of farmer seed systems as an essential component within the national seed supply that should be strengthened in concert with, rather than replaced by, national public and/or private seed production and distribution. These views led to increasing levels of farmer participation in crop improvement programmes. An important contribution in the development of such approaches was provided by the Keystone International Dialogue Series on Plant Genetic Resources (see box 1).

Hence Participatory Plant Breeding (PPB) is an approach that evolved from a number of different origins, with differing perspectives that came together at a timely moment. As broadly defined by Vernooy (2003) PPB refers to approaches that involve close collaboration between researchers and farmers, and potentially other stakeholders, to bring about plant genetic improvements within crops. The aim, most simply stated, is to ensure that the research undertaken is relevant to farmers' needs. An early vision of what PPB could look like and how it could contribute to farmers' well-being was subject of a workshop in Wageningen, the Netherlands, jointly organised by some of the partners in the Keystone Dialogue series; the International Development Research Centre (IDRC, Ottawa), the International Plant Genetic Resources Institute (IPGRI, Rome), the Food and Agriculture Organisation (FAO, Rome) and the Centre for Genetic Resources, the Netherlands (CGN, Wageningen) - (Hardon, 1995).

There is now a wide variety of projects in different parts of the world that fall under the broad heading of PPB. The CGIAR System-wide Programme on Participatory Research and Gender Analysis has made a major contribution to the recognition and adoption of PPB within the CG institutes, national breeding programmes and NGOs. In 1989 this Programme had already identified 80 PPB projects within and outside the CGIAR System. Since then many others have been initiated. Later, with donor support, they launched a Small Grant Programme to stimulate PPB research.

Influential initiatives have included those with barley in Syria and other Mediterranean countries (Ceccarelli and collaborators), with rice in Nepal and India (Witcombe, LIBIRD and Indian partners), with millet in Rajastan, India (Weltzien and collaborators), Preduza (Andean Region breeders with support from WUR, Netherlands), the Honduran and Cuban experiences gained through the Meso-American Programme, and the Chinese maize experience led by the CCAP and GMRI. These Programmes have given rise to published experiences in refereed journals mainly by those involved in the formal aspects of research. By contrast NGO-managed projects, experiences and views, such as those of SEARICE, CIPRES and FIPAH in SE Asia, Nicaragua and Honduras, respectively (see this document) are largely only available in the grey literature of project reports and often only in local languages. While some of the achievements of these NGO-managed projects, have been formally published (see references this document), many of their acquired experiences and knowledge are only available in project reports and local languages. These experiences are therefore less accessible to institutional plant breeders. This partly explains the relatively low level of adoption of more farmer-managed approaches by formal plant breeders. However, it is also fair to say that many plant breeders were, and often remain, sceptical of PPB as a breeding approach. They tend to view more farmer participation in crop improvement as socio-politically attractive but at the cost of the scientific rigour that they consider essential to get "real" progress.

Box 1.1.The Keystone Dialogue, the CBD and the CBDC project

The Keystone International Dialogue Series on Plant Genetic Resources provided an input into the 1992 UNCED Conference in Rio de Janeiro and the drafting of the Convention on Biological Diversity (CBD). The objective was to balance concern about natural biological diversity, highlighted in the early the drafts of the CBD, with additional attention to the importance of the conservation and use of Plant Genetic Resources for Food and Agriculture (PGRFA). Those involved in the Dialogue (who represented a wide range of interests, including industry, NGOs, government institutions and the FAO) considered the latter aspect to be somewhat neglected. In the course of the Dialogue, the need to consider *in situ* conservation of PGRFA was directly linked to on-farm use of genetic diversity. The view was that farmers could only be expected to play a role in conservation if this would give them access to better planting materials. This led to a revaluation of the age-old practice of farmers working in farmer seed systems and developing landraces adapted to a wide range of variable environments. This system dominates in environments not covered by formal plant breeding and represents a major source of PGRFA presently available. In order to benefit farmers in those regions from progress in research and also contribute to *in situ* conservation objectives, it was suggested that institutional plant breeding should also adopt and encompass the concept of farmer Participatory Plant Breeding (Hardon, 1995). This concept formed the basis of the subsequent Community Biological Diversity Development and Conservation Programme (CBDC), the basic objective of which was to explicitly acknowledge and build upon the inherent ability of farmers to select and develop planting materials suitable to their conditions and requirements in a way that was complementary to formal plant breeding. It was argued that involving farmers would increase the effectiveness of plant breeding and broaden farmers' access, especially in more marginal environments, to research that had hitherto neglected their requirements. The CBDC Programme provided a rationale for a variety of projects, already existing and established over the following years, which directly involved farmers in crop improvements. These Programmes followed on from existing on-farm testing of experimental new varieties (Participatory Variety Selection - PVS) and increasingly involved farmers in the whole process of plant breeding (Participatory Plant Breeding - PPB).

1.2 Conventional Plant Breeding compared to PPB

The dividing line between modern agriculture that depends on a commercial/institutional seed industry and traditional agriculture that relies on farmer seed systems is diffuse and sometimes difficult to define. This is also true of the boundaries between centralised institutional plant breeding and PPB. Essentially plant breeding involves obtaining improved planting materials from genetically variable populations in

the most efficient way. This largely depends on the ability of breeders, be they formal plant breeders or farmers, to recognise differences among the traits of plants that may have economic value. Improvement entails not just higher productivity but also developing varieties that better satisfy user/consumer requirements and provide higher yield security through resistance to diseases and better adaptation to the vagaries of local environments (drought, cold, heat, wind etc.).

NGOs involved in this sector have often stressed the inherent skills and judgement of farmers to select superior plants and, in some instances, have seemed to under-value established genetics and breeding technology. They sometimes see plant breeding as an art as opposed to plant breeding as both an art and as science. Such views were held by some of the partners in some of the first CBDC projects. However, NGOs now more widely accept that farmers can benefit from formal plant breeding by learning about effective population sizes, intensity of selection in various generations of breeding, mass selection and line selection, differences between self-pollinating and largely cross-pollinating crops and the consequences of these issues for the most appropriate breeding procedures. Hence the *participatory* in PPB refers to forms of co-operation between formal plant breeders and farmers in plant breeding in a manner that is appropriate to local conditions and the needs of farmers and their -seed systems. Whether PPB includes on-farm or local testing of finished varieties with participation of farmers - referred to as Participatory Variety selection (PVS) - is a matter of definition (see box 3). PVS is usually also used to identify farmer preferences and take these as a guide for subsequent breeding and, as such, can be viewed as a form of PPB.

There are a number of reasons why small-scale resource poor farmers and their farmer seed systems (FSS) are the main target of PPB.

Technology arguments. To develop better adapted varieties for the marginal complex environments and, in also some cases, for highly productive environments.

- Plant breeders have become increasingly aware that their initial primary concern with yields was not always sufficient to guarantee broad adoption by farmers. It has became apparent that breeding objectives need to incorporate other criteria, such as local consumption preferences. This has led to farmer-participatory evaluation aimed at establishing what additional characteristics were required, such as taste, colour /appearance and other household requirements, e.g. ease of cooking and of storage.
- When plant breeding started to address a larger diversity of environments, Genotype by Environment (GXE) interactions also needed increased attention (Ceccarelli 1989, Hildebrand 1990, Simmonds 1991). This led to a range of options for testing breeding materials under local conditions during the breeding programme and (differing levels of) farmers' involvement in selection processes.
- There was also recognition of the need to complement formal breeding by focusing on those crops and environments not covered by institutional research. This includes many minor crops which are highly important in some localities.

Empowerment and equity arguments.

- Farmers need to be *empowered* in order to safeguard their interests and agrobiodiversity. Trade liberalisation favours bulk production for international markets and threatens to further marginalise the economic position of small resource-poor farmers. NGOs have been particularly active in highlighting concerns about farmers' loss of control over their seed systems.. This led to an awareness of the need to empower farmers, promote self-reliance and strengthen their role as partners in breeding rather than as mere recipients of new varieties and seeds. This view was supported by frequent inadequacies of centralised seed production systems in delivering seed to the right places at the right times.
- *Equity arguments* are based on the fact that small-scale farmers in marginal areas are amongst the poorest in the world and have so far received little benefit from agricultural research and development and that greater efforts were needed to develop technologies that were better adapted to improving their livelihoods.

  A final important element related to equity is concern over the question of the ownership of genetic resources and, in particular, of farmer varieties. The challenges that this question poses to PPB are addressed in the last chapter of this first section.

Food policy arguments

- It is estimated that a two- to three fold increase in production is required to meet global food demand in the next 30 to 50 years. It is by no means clear how this will be achieved .One obvious contribution to this target is to more fully exploit the potentials of marginal areas and a whole range of minor crops. This has the particular benefit of increasing food production in areas where food is much needed.

Environmental arguments:

- Farmer seed systems are a major source of the remaining agrobiodiversity that exists *in situ*. This agrobiodiversity is a major source of genetic diversity with direct relevance to local adaptation and meeting divers farmer/consumer requirements. Ensuring that farmers' retain control over, and access to, such genetic resources requires *in situ* conservation systems.

2 METHODOLOGIES

The plant breeding methodology is well established. It involves setting breeding objectives, generating the required genetic diversity through hybridisation, recombining the first generations, followed by various forms of selection in subsequent generations to increase the frequency desired characteristics and to fix these, leading to a new variety that is reasonable uniform and stable. Hence, the question in PPB is not so much what to do, but how to involve new partners in the breeding process. Technically this is determined by the relative comparative advantages of plant breeders and farmers and the role of other brokers, often NGOs, who act as facilitators. However, in practice, the roles that various partners are willing and able to play are not always straightforward. As yet, there is no consensus among plant breeders about the advantages of farmers' active participation in the various stages of breeding and on-farm selection or the extent to which farmers should be affording responsibility and ownership of the end product. It may seem logical to have farmers set their own breeding objectives and this often accords with the agenda of facilitating NGOs who also seek to empower farmers. This approach may at times however conflict with what may seem to be the most technically effective approach. Finally, farmers may be guided by an interest in specific activities for which they may not necessarily have a comparative advantage. This creates a range of arrangements in which the various actors organise themselves for carrying out PPB. Since the procedures and methods used relate to the form that cooperation between breeders and farmers takes, we distinguish between the social and technological components of PPB. Broadly speaking, the technical component relates to the actual breeding procedures, while the social component refers mostly to the way the actors interact.

2.1 The technical component

Public and private plant breeding generally stress broad adaptability to maximise the range of environments in which their varieties can be adopted. Potential new varieties are commonly tested in multi-locational experiments prior to their release. In the final selection of varieties for release, including, when appropriate, application for protection of Plant Breeders' Rights (PBR) and satisfying the rules and regulations for market distribution, the varieties that are usually most favoured are those that do well over a range of sites/environments. Hence, varieties that exhibit high local specificity tend to be excluded. From the economic point of view this is understandable.

However, plant breeders are increasingly faced with GxE interactions outside the range that can be adequately covered by broad adaptability. Hence, local specificity becomes more of an issue when addressing the needs of more diverse marginal environments. The problems are exacerbated by the conditions of low-input farmers in such regions, who often lack the means to correct the vagaries of the environment through use of external inputs such as irrigation and agrochemicals. This has led to various forms of "decentralised" selection (see box 2).

Box 1.2 Decentralisation and participation

This approach was pioneered by Ceccarelli et al. (2001) in the ICARDA barley breeding Programme which addressed diverse environments in the Middle East and North Africa. He refers, to such cases as *decentralised* breeding. On the basis of the level of farmer involvement in selection, he differentiates between:

- Selection by farmers in their own fields (decentralised participatory selection)
- Selection on the research station by farmers (centralised participatory selection)
- Selection by breeders in farmers' fields (decentralised non-participatory selection)
- Selection by breeders in the research station (centralised non-participatory selection).

Despite these differences there is a common factor in that all these approaches lead to final products of a breeding programme, namely the finished varieties that are named by the breeding institution (thus claiming a form of ownership) and that satisfy standards (such as distinctness, uniformity and stability) necessary to gain entry to the institutional seed supply system.

The advantages of involving farmers in on-farm trials in the breeding process and in setting breeding objectives to suit their requirements are generally recognised. Witcombe et al. (2006) argued that PPB merely refers to increasing levels of "client-orientation" in plant breeding and suggests that the division between 'participatory' and 'non-participatory' breeding is artificial. They suggest the term 'Client-Oriented Breeding' (COB), and argues that this should be based on a rigorous examination of why and when farmers should be involved in the plant breeding process" (Witcombe *et al.,* 2005). In their opinion better adapted varieties can, from a purely technical point of view, be developed without necessarily involving farmers selecting material on their own farms during segregation generations. This view is supported by Morris and Bellon (2004) who suggest that the most efficient way to involve farmers in the breeding process could be to limit their involvement to goal setting and testing final varieties. Weltzien *et al.* (2003) draw similar conclusions from reviewing a number of cases, pointing towards the possibly unnecessary complexity introduced by farmer participation.

On the other hand, there are important arguments for involving farmers in the intervening phases of selection. Farmers are considered to be in a better position to observe and evaluate complex trait combinations that are relevant in their own farm conditions – often resulting in other characteristics being taken into consideration which plant breeders would not have used. In support of this, Sperling *et al.* (1993) reported cases where, in later generations, farmer selections out-yielded those made by breeders. Gyawali *et al.* (2002) and Joshi *et al.* (2002) found that farmers preferred the selections made by other farmers not because of higher yields, but because they combined comparable yield with earlier maturity. Kornegay *et al.* (1996) pointed out that farmer selection sometimes had the advantage of combining reasonable yield with better quality, resulting in higher market prices. Similar experiences, in which farmers combine high yields with preferred consumption traits are reported by Bertuso et al. (1995), as well as by authors of case studies presented in this document. For farmers these other traits (more than) compensate for possibly lower yields. For the same reasons, landraces are often preferred over higher yielding modern varieties, notably in rice in many Asian countries (personal observation).

A related theme is the growing concern, often expressed by NGOs, about the effects of institutionally bred, genetically uniform, modern varieties on farmer seed systems, as this was leading to genetic erosion and creating dependency and loss of ownership of farmers over their planting materials. They stressed the importance of farmer seed systems as a reliable, robust and major source of seeds especially for poor farmers and highlighted the need to protect farmers' ownership and control over the genetic resources which they have nurtured, and on which they depend. With some justification, they view farmers as self reliant and competent in selecting and managing genetic diversity. Their basic is objective to empower farmers and farmer seed systems. Initially, this position led to a confrontational attitude towards formal plant breeding, national seed supply systems and *ex situ* conservation.

It is worth examining the different perspectives that these positions entail. The first stresses maximum efficiency in breeding and the supply of new varieties through institutional seed systems, the latter attempts to combine effective plant breeding with increasing the role of farmers in the breeding process, safeguarding their ownership and diffusing the products through farmer seed systems.

It is interesting to observe that in the evolution of, what is variously referred to as PPB, PCI, De-centralised Breeding or Client-Oriented Breeding, there has been an increase in understanding between these two, somewhat polarised positions. Many plant breeders, through working with farmers, have become aware of the advantages of involving farmers in the breeding process. At the same time, NGOs confronted with the complexities of plant breeding and the value of modern varieties as a source for high production potential recognised the benefits that plant breeders and formal institutions could render in a supportive role. This coming together is not only apparent between projects, but even in developments within projects. However, for this to occur within programmes it is essential that plant breeders and farmers share common interests and goals and that the breeding programmes last sufficiently long for such for changes in the process to occur.

2.1.1 Participatory Variety Selection (PVS)

Participatory Variety Selection (PVS) is the first step in increasing the role of farmers in the crop improvement process. There is little doubt about the advantages of involving farmers in testing potential new varieties either on-station or on-farm. This process also provides breeders with information about the specific requirements of farmers, thereby helping to set breeding objectives. PVS involves testing and selecting new varieties developed by the institutional system within farmers' fields and at local research stations in various environments and allowing farmers to compare these varieties with local farmer varieties. A variant of this practice was already commonly adopted in commercial plant breeding to demonstrate the performance of a new variety to potential markets. This form of testing new varieties is also widely practiced by the international institutes of the CGIAR, largely in cooperation with National Agricultural Research Systems (NARS). However, in comparison with such, essentially promotional, activities PVS generally tests a larger number of varieties. Farmer varieties are included not only as controls, but also as possible alternatives, and these may also include farmer varieties from other localities. The main objective is to provide farmers with a wider and unbiased range of options to independently choose from. This re-establishes the prerogative of farmers to make their own choices, one that was undervalued in the early years of the "Green Revolution" in many countries. Its general empowering effect should not be underestimated.

2.1.2 Participatory Plant Breeding (PPB)

The concept of PPB (in its narrow meaning) is a logical extension of PVS, though less straightforward. In conventional plant breeding, parents are selected and crossed to produce the F1. Usually over the next 2-3 generations the main objective is the recombination of the characteristics of both parents and only mild (negative mass) selection is practiced. From a breeding point of view the involvement of farmers at this stage seems to offer few advantages. In addition, and especially in F1 hybrids, there is only a small number of seeds, which have a high value. Planting these seeds in farmers' fields is therefore felt to be risky, as conditions are less controlled and seeds may more easily be lost. Major selection for local adaptation (soils, prevailing diseases, drought, temperature etc.) and farmers' requirements (taste, appearance, storage ability etc.) usually starts in the third and more often the fourth generation. It is at this stage that PPB starts to offer real advantages. This however relies on the assumption that research establishments are capable and willing of producing appropriate breeding populations for the target environments. This has not always proved to be the case. Hence, at present, many farmers interested in PPB face the problem of how to obtain suitable breeding populations.

Starting/breeding populations

An important technical issue raised by PPB is how to develop starting materials.
The most common approaches taken in PPB are:

- Improvement of local landraces through forms of mass selection in cross pollinating crops and combined with line selection in self pollinating crops
- Crossing favoured local landraces with modern high yielding varieties, either by research or by farmers themselves.

Farmers are well placed to take responsibility for the improvement (rehabilitation) of local landraces and this is generally considered a fairly straightforward activity. Selection of seed for next season's planting is also a form of PPB. It is most effective in cross-pollinating crops and can be readily adopted by individual farmers. This is not so very different from the selection of plants in later generations of breeding. In self pollinating crops, like rice, local landraces are improved by occasionally practicing line

selection. This more usually occurs as a collaborative activity within communities with farmers sharing the results.

In both cross and self pollinating crops attention has to be given to achieving the appropriate selection intensity. This requires proper seed production practices, involving pre- and/or post harvest selection prior to harvesting the seed for the next planting season.

Hybridisation
Development of breeding populations generally involves identifying suitable parents for hybridisation followed by inter-crossing these materials. The most common practice is to cross (selected) plants from favoured local landraces with modern high yielding varieties particularly (if available) those that already demonstrate a reasonable degree of local adaptation. If not available, research institutes can be consulted as they have access to a wider range of potential parent materials. The objective is to maintain the preferred characteristics of the local material, combining these with the higher yield potential of the modern variety. Farmers can be trained in crossing techniques, although the ease of crossing differs between crop species. In maize it can be realised easily by inter-planting both parent materials and detasseling. In self-pollinating species it requires emasculation of maternal parents and hand pollination with the pollen of the paternal parent. The actual crossing generally offers few problems. The number of hybrid seeds harvested is generally small and they need to be carefully harvested and stored. Crossing is a laborious activity which research stations are arguably better placed to take care of. On the other hand, individual farmers, with proper training, are often interested in crossing as this increases their sense of ownership.

An important aspect in which farmer managed PPB tends to differ from institutional breeding and institutional controlled PPB is the number of crosses made and the number of breeding populations tested. Farmer managed PPB usually starts with crossing one or only a few preferred local varieties with an available improved High Yielding Variety (HYV). The objective is to combine the established preferred characteristics of the local variety with higher yield potential of the HYVs. Hence only a limited number of crosses and cross-combinations are made. In institutional breeding the number of crosses between different materials is much larger (often exceeding 50), both within specific parental materials and in combinations between different parental materials

Recombination
Often starting from a limited number of seeds, recombination in the first generations requires secure growing conditions. Thus research stations can again offer better facilities than small farmers. Farmers may start selection too early in *already narrow genetic diversity* and thereby narrow the range of genetic variation available in later generations. This problem can be addressed by sufficiently detailed training.

Selection
The effectiveness of selection in more advanced generations is determined by the ability of farmers to recognise those plants within a population that most closely suit their requirements. Their ability to do so is obvious. Important factors of continued success are the selection intensity and ensuring that all the preferred characteristics are maintained in the next generation. This requires some initial guidance and training. However, it does not necessarily require strict adherence to the protocols and experimental lay-out that are commonly employed in institutional breeding. It is also true that success in institutional breeding is largely dependent on the ability of an individual breeder to recognise good plants within a segregating population rather than just relying on statistical analysis.

2.2 The social component

Farmer participation can be enhanced in different ways and this largely depends on the respective roles of the various partners involved. Following the typology set out by Biggs (1989) of approaches to improving user perspectives in research, cooperation in PPB between plant breeders and farmers may range from *consultative* to *contractual* to *collaborative* and finally to *collegial*. Different forms are:

- Breeders can consult farmers in order to set more realistic goals and choose more appropriate parents
- Farmers can be consulted by evaluating material grown on (local) research stations

- Farmers can collaborate with plant breeders by growing and selecting (in/between) breeding materials for various stages of the breeding process in their own fields

In this process, plant breeders essentially still retain full control of decisions and materials and orchestrating the programme, with an essentially *consultative involvement* from farmers.
This level of engagement can be augmented by additional forms of collaboration, which involve farmers more actively: such as supplying farmers with segregating breeding materials from appropriate parents in various stages of development for further on-farm variety development (collegial). Finally, farmers may be in full control, managing all phases of the breeding process, with plant breeders merely acting as trainers and advisers. This can result in for example the following types of situation:

- Farmers are trained to make crosses, often involving high yielding modern varieties and preferred local materials and, with some guidance from plant breeders, can develop new varieties.
- With some training in selection and seed production farmers can rehabilitate and maintain their local varieties through selection.

The above represents a sliding scale in the process of breeding that is controlled by plant breeders to increasing involvement of farmers. Increasing farmer involvement assumes that they will exert more influence on the materials to be selected and advanced to a next generation and where (and how) the evaluation takes place.

PPB can be practiced by individual farmers. However in general, and in the cases presented here, it is initiated by either national research or by NGOs acting as facilitators and trainers in specific projects. It tends to require community action, if only because it usually involves farmers with small holdings. The organisation of these communities and of the programmes can vary considerably..

Projects initiated by plant breeding institutions, often start in response to low adoption rates of the new varieties and mostly use farmers in a consultative function. Hence they are primarily concerned with identifying communities and farmers in specific environments that will test breeding materials under the guidance of plant breeders. This process also increases plant breeders' understanding of farmers' requirements.

By contrast, projects initiated by NGOs often have an explicit aim of empowering farmers. Hence they tend to start from forms of community development. In Central America this often takes place by identifying groups of farmers and providing some form of group organisation (e.g. Local Agricultural Research Committees - CIALS). These groups act as counterparts for supporting institutions. In South East Asia the Farmer Field School methodology, developed initially for Integrated Pest Management (IPM), is widely used (Ngo Tien Dung and SEARICE, 2003). It has been adapted by the CBDC, BUCAP and PEDIGREA partners to the management of genetic resources and involves intensive group training of farmers supported by staff of the institutions. Training in technical aspects continues throughout the whole planting season. This approach has proven to be highly effective in Asia and has been rapidly taken up by farmer communities. It increases the confidence of farmers and is changing their relationship with research and extension services from one that is top-down to one that is more participatory.

3 SYNOPSIS OF THE PPB CASES

This document is based on projects in Latin America, Africa and Asia, intended to represent a cross-section of ongoing projects for a range of crops. Of special interest is the nature and evolution of participatory processes between partner organisations and how these have impacted on the breeding methodologies adopted.
In attempting to analyse the experiences of the various PPB cases, a number of factors, both relating to the social and technical components were taken into consideration

1. The initiating or leading actor/institution: that may be breeders (national or international), NGOs or farmers. Farmer-led initiatives are relatively rare and are not represented in this study.

2. Stage of involvement/type of breeding & seed activities: these can be PVS, PPB with research institutes supplying breeding populations or PPB with breeding populations produced by, or with, farmers.

3. Approach to participation: this can take the form of collaboration with breeders within their programme, or collaboration between breeders and farmers as equal partners.

4. Environmental conditions: these may be favourable, marginal and not previously targeted by breeders, or extremely marginal agro-ecological pockets, which are either geographically isolated and/or have different growing conditions. Different socio-economic environments also play an influential role.

5. Type of crop: these can be major food crops- dealt with by formal breeding activities; or minor crops for which there have been little or no formal breeding activities. This review only addresses 'major food crops' and vegetables. This is not intentional, but has been determined by the availability of case material, which drew on projects supported by the Norwegian Development Fund and those with which the reviewers are familiar.

3.1 Case studies

This section provides a synopsis of the case studies presented in more detail in the second part of this document. The sequence of presentation of the cases is based on the judgement made by the authors of this chapter regarding the *point of departure* of the projects. While all projects are focused on PPB and have an objective of developing improved varieties that better fit farmers' needs and priorities, it possible to differentiate between the projects according to the emphasis that they give to variety improvement and empowering farmers. The first group of cases appear more geared towards varietal improvement and designing breeding activities, whereas the second group gives more prominence to supporting farmers' capacities to manage their own genetic resources as a concrete form of empowerment. We discuss the relevance of this grouping in the next chapter.

3.1.1 Mali

The case study from Mali was set-up by researchers and breeders aiming to create a breeding programme that could more effectively develop varieties that are attractive to farmers. It involved setting breeding objectives based on farmers' priorities and developing materials for decentralised PVS on community lands. It was initiated by plant breeders of the CGIAR institute ICRISAT and has its origin in an economic impact assessment of its Sorghum and Pearl Millet Breeding Programmes. This revealed that farmers' adoption of newly-bred varieties, particularly those from others than the local *guinea* landraces, was very low. When farmers did adopt new varieties, they were mostly purified *guinea* - race sorghum landraces selected from local materials. These offered little yield advantage but did mature slightly earlier. Most farmers produce their own seed and practice seed selection prior to harvest. Seed exchange between farmers and communities is limited and there is no seed marketing system in the project areas.

Through widespread variety evaluation trials it became clear that farmers gave priority to higher yielding varieties. Breeders from ICRISAT and the national research institute IER breeders subsequently developed some materials from interracial crosses between *guinea* and *caudatum* parental material. Farmers were involved in selecting material for on-farm PVS testing trials from the ICRISAT sub-

stations, including material from poly-crosses involving local materials, and identified their own local controls. Materials from the national research programme (IER), selected by the national plant breeders were also included in the testing. On-farm PVS trials were designed by researchers who also supplied a basal dose of N and P fertiliser. These trials were managed by farmers and recording was done by farmers with the assistance by students and extension workers. This led to 4-5 promising varieties being selected for larger-scale on-farm test trials. These trials were implemented in some 60 locations and involved also NGO-collaboration. The yield advantage of the new varieties over local controls was modest (10-20%) and farmers interest in increasing the range of varieties employed seemed to relate to a variety of criteria. At one seed fair some 700 Kg of seed of new varieties was sold to a total of 300 farmers. Consideration is being given to further expanding the accessibility of new varieties, as well as expanding this approach to neighbouring countries.

The most apparent advantage of the approach is that it gives farmers access to a wider range of genetically different advanced materials tested under local conditions. Farmers outside the project areas also showed great interest. Wider distribution remains a problem due to the absence of a developed seed market. This, together with a traditionally limited pattern farmer-to-farmer seed exchange (within and between communities) has hampered the distribution of the selected materials.

3.1.2 Nicaragua

In Nicaragua the NGO CIPRES initiated the PPB bean pilot project, organising a group of interested farmers for this purpose. The project attracted a breeder from INTA who provided technical expertise. At the outset there was no master plan. The pilot project was largely a "suck it and see" affair using materials that the breeder had available at that time and intended to give them experience before starting 'seriously' with seeds from crossed local varieties they had identified. It was an adventure which all three parties, the farmers, CIPRES and the breeder, jointly developed and planned as they went forward. As a pilot project it went through several stages: it started with a range of materials and as it progressed it progressively focused on the development of 1 or 2 varieties that could be promoted and diffused to other communities. There was also a sister project, with the same group of 50 farmers, focusing on maize. Although clearly delineated, these projects were embedded in a larger community-based programme run by CIPRES, which involved rotating funds, food security and marketing activities. The PPB activities have also led to new sets of bean materials, maize and sorghum being introduced for testing and selection.

3.1.3 Honduras

The case from Honduras is based on farmers organised in Committé's de Investitación Agrícola Local (CIALs). These local farmer committees are mostly involved in coordinating and experimenting with various agricultural technologies, among which the testing and selection of local and improved varieties and this included the evaluation and selection of materials provided by EAP Zamorano. Most CIALs operate in areas and conditions that are not addressed by formal research in Honduras, such as the mountainous region of Yorito, which has many extremely poor small-scale farmers. EAP Zamarano is effectively the only operational research institution in Honduras and focuses on the more favourable environments but does consider the CIALs network as a complementary organisation. EAP Zamarano provides CIALs with early generation and advanced generation breeding populations of maize and beans. CIALs' testing and selection among numerous communities results in a large number of materials being identified as being the most promising for each community and locality. The materials are exchanged throughout the CIAL network, evaluated, and if liked they are maintained. Registration of the local varieties with the municipalities suffices CIALs' ownership and identity, although recently farmers have started to aspire formal registration. The CIALs are supported by a series of NGOs, including FIPAH which plays a central role. The case illustrates a situation that lies somewhere between the technical and empowering approaches, with a relative wealth of materials being generated, evaluated and selected. The farmers are quite independently organised, although they are still reliant on external finances to provide the resources needed for experimentation and to organising national CIAL meetings.

3.1.4 Nepal

The Nepal case on maize also started with PVS of 32 advanced breeding lines supplied by CIMMYT and 3 composite varieties from the National Maize Research Programme (NMRP), with added controls of local varieties. Technical support was supplied by a multidisciplinary team from the NGO LI-BIRD and

the Nepal Agricultural Research Council (NARC), with farmers' input being coordinated by a Farmer Research Committee (FRC).The scope of farmer participation was widened during the course of the project.

The project revealed farmers tended to select tall plants that were prone to lodging, this because of post harvest selection of large cobs. Farmers also appeared unaware of the occurrence of spontaneous crossing between local and introduced varieties in their fields, resulting in heterogeneous populations. This led, after the first year, to mass selection in such populations and in their local varieties and farmers learning how to make controlled crosses. Hence the objectives of the project expanded from PVS to include on-farm selection, hybridisation and PPB.

3.1.5 China

The example from China started with women in 2 villages where improved maize varieties did not perform well. It very soon expanded to include 4 more villages in the South-Western part of China. Various actors subsequently became involved in the evaluation of maize materials, including 3 key national research organisations, extension agents and local farmers who organised themselves in groups. Given the context of agricultural research in China the importance of this should not be underestimated. The prominent role of women is also relevant here: agriculture in marginal areas is becoming feminised, as men move out to look for other income opportunities. Equally the initiative was led by a female social scientist. This, as well as the field methods for selection and crossing represents a novel way of working in agricultural research in China. A total of 70 local and improved maize varieties of different origins have been incorporated in a large combination of trials, in which the materials were evaluated, improved through selection and base-populations developed. These efforts led to quite a number of varieties being identified as promising by the farmers, who subsequently multiplied them and distributed them to others. These chosen materials were again a combination of local and improved varieties, including old CIMMYT varieties derived from the Mexican landrace Tuxpeño. This case then represents a combination of PVS and PPB, although in maize it could be claimed that any type of selection of seed from any material for next season is a form of PPB (selection from within a genetically heterogeneous population). This case tends to blur the distinction we made earlier between PPB and PVS as well as the line between formal and informal actors, (e.g. breeders and farmers).

3.1.6 Bhutan

The Bhutanese case has its origin in a severe rice blast epidemic at high altitudes (1800 - 2700 M.) in 1995. This led to a long-term breeding programme for resistance, involving crosses between modern varieties and local landraces and screening in various rice growing regions. When the NGO SEARICE initiated the PBB-oriented BUCAP project in 2001, a link with the Blast Resistance Breeding Programme was established. SEARICE emphasised the empowerment of farmers as a necessary condition for PPB and adopted a Farmer Field School (FFS) approach. Farmers readily understood the advantages of this approach. It promoted self-reliance in decision making and re-vitalised their confidence in managing their genetic resources.

At the start, farmers became actively involved in screening advanced breeding lines for blast resistance and local adaptation. Plant breeders initially saw this PVS as the main objective of the project. BUCAP, however, emphasised PPB and through Farmer Field Schools farmers learned how to select in local landraces to improve uniformity and productivity, referred to as "rehabilitation". BUCAP also introduced PBB for maize in the eastern region of the country and achieved immediate significant improvements. Individual farmers subsequently learned about, and started to make their own crosses. From a top-down relationship with research and extension, the increased confidence of farmers led to a relationship that was more one of partnership. Gradually plant breeders and extension workers started to appreciate the advantages of PPB, especially in the more extreme high altitude environments. Some farmers even challenged plant breeders to start selection in similar advanced breeding populations and to compare on-farm and on-station results after a few generations of selection. Farmers are now learning from plant breeders about the most appropriate breeding methods, when to practice bulk selection and when to start pedigree selection etc. These positive experiences with FFS have led to proposals to include this methodology in the training of extension workers.

3.1.7 Laos

A similar development is apparent in the case of BUCAP Laos, where farmers and extension staff were already familiar with FFS through projects on Integrated Pest Management (IPM). The importance of empowerment through FFS is highlighted by the fact that BUCAP's implementation was not handled by the plant breeding programme of the National Agricultural Research Centre (NARC), but by the Plant Protection Centre (PPC) managing the IPM project.

The main emphasis was on glutinous rice in rain-fed lowland and upland production systems. Sites were selected to cover a range of conditions for water availability (during both dry and wet seasons), and production for markets and household use. In the north of the country the focus of selection was on short plants, and in the South it was on tall plants. Yield, disease resistance and cooking and eating quality were important selection criteria in both areas. Early results suggested increased adoption of improved varieties, especially during the rainy season, and that these are now replacing local landraces. In the more marginal areas, landraces continue to predominate and yield improvements are realised through landrace selection (rehabilitation). Farmers have now learned how to make crosses, but the results so far are limited due to a lack of knowledge about how to manage segregating populations. While plant breeders at the NARC have an interest in the project, they primarily act in an advisory capacity and at request of PPC. However, a more active and integrated role is under consideration.

3.1.8 Vietnam

The BUCAP Vietnam Programme is an example of a PPB approach, where farmers have most of the control over the process. It is also probably the largest PPB Programme in progress at the present time. The information is based on a review carried out in 2005 at the request of the major donor (Norwegian Development Fund) by one of the authors (J.J. Hardon) and information from two farmers responding to a questionnaire on the breeding procedures followed.

As in Laos, the BUCAP project in Vietnam was linked to the extensive and successful IPM project in rice which employed a FFS approach. It was again implemented by the Plant Protection Department of the Ministry of Agriculture. Between 2000 and 2002 PPB projects were started in 5 provinces in North and Central Vietnam, spanning mountain regions in the North, The Red River Delta near Hanoi, the central region and the central coastal region. Its successes led to the programme being expanded to include five other provinces, including the Mekong River Delta in the South. It is being implemented in a wide range of environments, including both rain-fed and irrigated rice production. By 2003 it involved 48 villages and a total of 2519 farmers (1169 women and 1350 men). The size and range of project activities is illustrated below.

Number of field studies	538
Of which:	
• PVS	147
• Population/Line selection	150
• PPB	68
• Comparison/multiplication varieties	47
• Associated studies on Rice Intensification (SRI)	20

In 2003, farmers were reported to have selected 185 varieties from 347 tested. In the first five provinces 750 tons of seed of selected varieties were produced (215 for the spring season and 535 tons for the summer-autumn season) from initial breeding populations provided by institutional breeding institutes. An example of early success was two varieties (MD1, MD2) developed in Mo Da village and two varieties (TX1, TX2) in Tam Xuan villagePVS increased farmers' access to a wider range of varieties and contributed to more variety diversity in farmers' fields. Early adoption of mainly IRRI/National Research bred varieties raised national rice production significantly. However the government more recently became concerned about low export prices for its rice due to poor consumption quality. This contributed to acceptance of the BUCAP Programme at local and national government levels which viewed PVS as an effective means for increasing the diversity and quality of rice production. The high level of organisation of farmers in communes and their familiarity with FFS were important contributing factors that facilitated the establishment of projects. From PVS and PPB using breeding populations from research institutes, individual farmers in most projects started making their own crosses, mainly between local landraces and high yielding modern varieties. Remarkable results were obtained in rehabilitation of

local varieties through mass selection and yield increases of more than 20% have been reported. Government plant breeders provide advice on breeding methods and training in crossing but, working through communes, the farmers maintain a high level of autonomy. Identifying and accessing suitable parental materials for crosses in the various environments is still a problem that requires addressing. While communes are well placed to organise seed production of selected varieties for larger scale distribution and marketing, the questions of how to organise this so as to satisfy existing national rules and regulations, including those for naming varieties, still poses some problems. Extension services obtain revenues from producing and marketing nationally approved varieties and may not favour competition from communes. Despite these problems, the ability of farmers and communes to play a meaningful role in breeding, selecting and producing seed is now well established. What is now needed is for such activities to be integrated in public national policies governing breeding and seed production at a national scale.

3.1.9 PEDIGREA

The final case study presented is the PEDIGREA Programme, which has national projects in Indonesia, the Philippines and Cambodia. As in other programmes in Asia, the FFS approach is central, with an emphasis being placed on local community development and empowerment. PEDIGREA systematically aims at farmer-led approaches in PPB, in which farmers, rather than scientists, decide upon breeding objectives and breeding materials. Relationships with public research and extension are not institutionalised, but good contacts have been developed in Indonesia and the Philippines. In Cambodia good contacts have been established with extension services, but public plant breeders seem critical of PPB. Aside from the involvement of a number of local/national NGOs, support is also provided by a number of overseas agencies, including the Dutch Genebank (CGN), the Netherlands Agricultural Economics Research Institute (LEI) and the International Plant Genetic Resources Institute (IPGRI) office in Kuala Lumpur. The programme differs from the other cases in the sense that it has adopted a farming system (rather than a crop-specific) approach. While rice-based cropping systems predominate in the project sites, PPB is also extended to other crops, such as vegetables and fruits and even livestock (e.g. pigs and chickens). In Indonesia (Indramayu) and the Philippines (Mindanao), both modern improved varieties of rice and farmer varieties are grown, mainly for home consumption with some surplus for the market. In both project areas fruit and vegetable growing provides an important source of farm incomes, with some farmers specialising in this. In the Cambodian project rice production depends on rain and the flooding of the Mekong River. Farmer varieties of rice predominate and vegetable production is important in the dry season. Chickens, pigs and fish provide the main sources of animal protein.

One distinctive feature of PEDIGREA is that it also includes market development and seeks to strengthen farmers' marketing skills and their ability to deal with traders.

As in the other Asian examples, the FFS methodology has proven to be highly effective in training large numbers of farmers (1437 to date) spread across some 30 communities. Training involves developing skills in PVS, PPB and marketing. As in all cases, PVS has helped farmers to select appropriate varieties in rice, and in this case also in some vegetables. Rehabilitation of local varieties played an important role, but many farmers have also showed an interest in crossing, both between local varieties and with modern varieties and this has led to a large number of on-farm selection programmes being developed, especially in Indonesia. The most frequent bottlenecks encountered are the scarcity of land and of good storage facilities for experimental seeds. Problems are also apparent in the size of breeding populations and the methodologies and conditions used within selection. Farmers, so far, appear to largely make their own choices based on FFS training. These problems have been identified and steps are now being taken to address them. Clearly it is a programme that is evolving, yet it has retained a high level of interest from farmers.

3.2 Reflection on the cases

Of all the case studies in this review the one from Mali is probably most representative of PBB efforts made by breeders from the formal sector, notably the CG institutions. Technically the case uses moderately advanced materials, although farmers were involved in earlier phases through consultation which allowed the breeders to define breeding goals and select parental materials. Farmers also participated in the overall planning through meetings at which the breeders share the results of

evaluations. In these meetings the goals and plans for next year are discussed agreed upon after a dialogue between involved breeders and farmers.

The Malian case bears many similarities to Ceccarelli's barley programme (Ceccarelli, 2001) which was , also highly decentralised. Programmes structured in such a way better meet farmer and local requirements. The programme also identified the reasons for the low adoption of new sorghum varieties. It included local varieties as parents and through on-farm testing, with guidance from researchers, led to 4-5 promising new varieties being identified within a relatively short time. The yield advantage over local landraces (10-20%) was referred to as "modest", but should be qualified by taking into account the harshness of the environment, the limited use of fertilisers and the increased earliness of the selected varieties. In addition to the earlier maturation of the new varieties, they also contributed to more genetic variation in farmers' fields. Adoption, however, while greater than before was still slow. This mostly seemed to be mainly due to failing seed markets and limited farmer-to-farmer exchange in the local farmer seed system.

As with the Malian example, the Chinese project with maize also followed on from a study that showed low adoption of improved varieties. The pilot project brought together a range of formal institutions and farmer groups. This resulted in evaluation trials being set up, farmers being trained and a number of well adapted varieties being developed.

Projects led by the NGOs LiBird and CIPRES (in Nepal and Nicaragua respectively) also aimed to generate varieties that better responded to needs of farmers than those that had been developed through formal breeding. For LiBIRD, an NGO with highly qualified researchers, the first priority was to address farmers' needs for improved varieties. CIPRES also gave priority to increasing production and increasing the food security of farmers, although here there was also an associated policy-advocacy philosophy. Both programmes closely followed conventional breeding procedures, with strong technical input from institutional and NGO staff. Starting materials were advanced breeding lines supplied by breeding institutions and during the course of the project additional advanced breeding materials were supplied . Farmer breeders were organised in groups, where they received training and guidance. As the farmers gained in confidence, they changed from recipients of guidance to experimenters and partners finding solutions and adapting testing procedures to fit their situation. In Nepal some farmers even started their own crossing programmes through inter-planting parent varieties and detasseling.

There are evident differences in how farmers are organised to undertake the breeding procedures. Distinct organisational structures exist in the Nepalese, Honduran and Nicaraguan cases. In Nepal and Honduras the projects are coordinated and supported by local Farmer Research Committees (FRCs) resulting in shared community selection programmes. In the Honduran case, farmers in a number of communities, organised in the Latin equivalent of FRCs, have started to experiment at the local level with support of an NGO. These local groups are organised in a national CIAL network. Plant breeders from the national institute (EAP Zamorano) provide breeding materials and their position is probably best described as a provider of resources to the various CIALs. The development of varieties and the diffusion of seeds seem be complementary to EAP Zamorano's programmes, addressing different environments and farmers. Hence, this case combines the development of locally adapted varieties with promoting empowerment.

In Nicaragua emphasis has been on group activities that are coordinated by the NGO (CIPRES). The actual experimentation has been carried out by just 5 selected farmers, creating 5 parallel individual selection processes. Other farmers in the community have participated through field days and guided visits to the trial sites. At the end of the process only 2 farmers' work resulted in a selected variety. It was recognised that better use could have been made of the efforts of the other three farmers, and consideration is being given to pool promising lines from all the farmers involved for selection in an earlier stage.

As in Mali, the project in Nicaragua obtained immediate breeding results within a relative short period of time. Two selected new bean varieties were to be registered for entering into the national seed supply system. In Nepal, PVS led to the identification of a maize composite (Rangpur) that performed well. Improvement of a preferred local landrace (Thulo Pinyalo) was also realised and led to open on-farm hybridisation with the Rangpur composite and follow-up selection in order to combine desirable traits. Within two years selection from open pollination between 5 composite varieties obtained from national

research led to a promising new population named Resunga. In Honduras the Mazucalito variety was the first concrete product from the project activities, with others now coming out of the pipeline.

The projects in all these four countries (Mali, Nepal, Honduras and Nicaragua) clearly illustrate the advantages to institutional breeding of involving farmers in the breeding process. While the objectives were still relatively conventional: the development of a limited number of well-defined improved varieties, the projects have created more varieties, and of greater diversity, than would have been the case in centralised non-participatory breeding programmes.

At the other end of the range, a number of NGOs such as SEARICE and the partners in PEDIGREA were not primarily concerned by the goal of broadening the scope of public plant breeding. They were more interested with empowering farmers and strengthening farmer seed systems, and choose FFS as their 'modus operandi'. Their programmes emphasised the value of local landraces, both as a source of adaptation and as genetic resource that should be conserved and which farmers should claim ownership of. Perhaps the main difference between PPB as promoted by NGOs and PPB/decentralised breeding employed by research institutions is in the former farmers are the main actors and are the owners of the varieties and follow their own judgements about which varieties satisfy their requirements. Such varieties generally enter farmer seed systems independently of national seed regulations, often through open exchange. Distinctiveness, genetic uniformity and stability (DUS), the criteria required for formal registration, are generally not an objective for farmers breeding activities. These varieties are treated as local farmer varieties, and it is accepted this continued processes of local adaptation through on-going seed selection (prior or post harvest) is an important way of maintaining genetic variation. The objective is not to breed a limited set of varieties, which is reflected in the large number of farmers involved and the high number of crosses being made. National research and extension are involved but in a supportive, rather than in a controlling function. The degree of involvement varies between countries, it is relatively structured in the BUCAP projects (Bhutan, Laos and Vietnam), but seemingly more informal in the PEDIGREA projects (Indonesia, Cambodia and Philippines).

Table 1.1. Characterisation of cases

Case (country)	Initiating actor	Crop	Breeding	Approach/Methods	Conditions
China	National Research Organisations	Maize	PPB (later generations) and PVS. Enhancing performance through mass selection Large number of varieties identified and distributed, some varieties formally released.	Farmers (women) organised the project	Marginal, formal varieties not adapted.
Mali	ICRISAT (CG)	Sorghum	Farmers involved in identifying breeding objectives through decentralised variety evaluation. Decentralized PVS and large scale on farm evaluation. Support for seed distribution. Identification of relatively few well adapted sorghum varieties.	Strong breeders' influence in the set-up and selection of early generation materials. Farmer groups organised by NGOs. Farmer associations strongly influence the planning & course of the programme; sharing financial resources. Project aims to influence overall organisational set-up of breeding activities	Marginal environment (unpredictable onset of rains). Formal varieties not adapted; weak formal seed systems; little seed exchange taking place though informal seed systems.
Nepal	LiBird (NGO)	Maize	PPB (late generations) Relatively large scale but a limited number of varieties developed	Strong breeders' influence (LIBIRD), farmers organised by the project	Mountainous, marginal. No adapted improved maize seeds available
Nicaragua	CIPRES (NGO)	Beans	PPB (first), later more PVS. Generation of relative few varieties for intende formal release.	Strong NGO and breeder influence in the beginning and selection of early generation materials. Farmer groups organised by NGOs, but later they exert more influence over the direction of the programme.	Formal varieties lacked disease resistance and market quality.
Honduras	FIPAH/ CIALs (NGO and farmers)	Beans	PPB and PVS (crossing initially for learning purposes). Generation of high number varieties for exchange in the informal system.	CIALs: farmer experimentation is the main driver; NGO supports the work of farmers, providing capacity building as required.	Marginal high altitude, not addressed by formal system
Bhutan & others (BUCAP)	BUCAP partners (NGO and NARS)	Rice	PPB, including crossing. Generation of a wealth of genetic material.	FFS organised by the project: farmers carry out most of the work as part of a learning process.	Formal varieties not optimally adapted to farmers' socio economic conditions.
Indonesia & others (PEDIGREA)	PEDIGREA partners (Dutch and CG ARC, NGOs)	Rice, Cucurbitas	PPB, including crossing. Generation of a wealth of genetic material	FFS organised by the project: farmers carry out most of the work as part of the learning process.	Formal varieties not optimally adapted to farmers' socio economic conditions.

4 ANALYSIS AND DISCUSSION OF ISSUES EMERGING FROM CASES

This chapter reviews and discusses experiences with PPB projects. It draws largely on the case studies discussed above (and set out in more detail in part two of this report) together with some published experiences from other PPB projects.

4.1 Participation in Breeding

The involvement of farmer communities in various aspects of crop improvement is a central aspect of PPB. The way in which the different partners are organised and involved in the breeding process can be seen as the social component of technology development. In other words, the analysis of participation in breeding can be seen as the analysis of the social organisation around technology development. We refer here to social organisation and technology in a wide sense: social organisation refers to the individual actors and institutions, how they relate to each other and to the technology. The technology is seen as a combination of the genetic resources used, how they are combined, and where and how they are selected, multiplied and diffused by the various actors and institutions. When reference is made to "communities", they are defined as groups of farmers that share a limited geographic space, with more or less common physical and economic conditions.

4.1.1 PVS

The value of farmers' participation in variety selection (PVS) is generally accepted and has been practiced for a long time by both private and public plant breeders as part of their evaluation and validation trials. Materials are tested under local conditions and often compared with local controls. Thus, while PVS does not represent a revolutionary departure from earlier practices, it has played an important role in sensitising plant breeders to the requirements and preferences of farmers and the potential of local varieties in breeding. Equally important, breeders now increasingly recognise farmers' capacity to 'identify' good material and take farmers' selection criteria more seriously. Through PVS a larger number of materials have been tested in farmers' fields and farmers have been exposed to a broader range of materials either on-station or in evaluation trials in their own communities. Because PVS trials are geared to exposing farmers to 'more diversity', they usually include advanced breeding materials, improved and selected farmer varieties from different localities. Selected local varieties are thus not just treated as 'yield-controls', but also as potential alternatives to institutionally bred varieties. This has raised the profile of local varieties. It shows an increased recognition of the value of local varieties and of the fact that yield potential is not the only characteristic that should be considered. In addition, it has shown itself to be an effective way to identify materials that can be used as parental materials in crosses.

However, less specific attention has been paid to the ways in which the farmers are involved in PVS. In many PVS activities, farmers participate through sharing their opinions about which variety does best and why. Yet the decision about which, and how many, materials enter into the next cycle are still often taken by the breeder. For understandable reasons breeders prefer PVS trials to satisfy common experimental standards that allow reliable comparison of results. This, however, is difficult to achieve in farmer experimentation. Individual farmers' plots can be treated as replications, but materials and practices may differ between farmers' plots and from season to season. This may not be a problem for breeder and farmer identification of the best performing materials to be planted next season (as practiced in the Mali case, Eva Weltzien, pers. comm.) but does complicate the statistical processing of results. Nonetheless researchers have developed adapted statistical designs and procedures to overcome this constraint (Bellon & Reeves, 2002, Eva Weltzien, pers. comm.).

It is known that farmers involved in evaluating materials in PVS trials often want to take home favoured seeds from the tested materials after harvest to try them in their own fields. This is in line with the practice of farmer seed systems. However breeders normally feel uncomfortable about not being in control of release and materials diffusing over the area without them having been properly tested and registered, and this can give rise to conflicts of perception and interest.

The transformation of consultative PVS into an approach that is truly collaborative can therefore take some time. Documentation does not always explicitly identify where a particular PVS experience is positioned in the range between consultative to collaborative practices, and how relationships change over time.

The effectiveness of PVS is beyond any doubt: better performing varieties preferred by farmers are identified in situations where farmers have largely relied on local materials and have not adopted improved introductions. However, from the cases presented in this document and other experiences it is not possible to conclude what form of farmer participation and organisation is most effective. Such forms can range from large groups and voting (use of ballot boxes or otherwise) to identify which materials should be used in next season's evaluation plots, or small groups and/or individuals identifying seeds to take home for planting on their own fields, or variations between these different types. One evident difficulty here is differentiating between levels of effectiveness.

4.1.2 PPB

Views about, and experiences with, PPB are even less straightforward. The cases analysed show that PPB is not a single defined methodology, but covers a variety of approaches and methods involving different types of partnerships, and different levels of input and control by plant breeders and farmers respectively. In addition, it is a process that changes over time, as the partners gain experience and trust. In most situations, new materials are regularly brought in, processes change, participating farmers drop out while new farmers enrol, etc. As with PVS, it is not always clear how farmers participate in decisions on the materials being selected and the planning of next seasons' evaluation and selection.

It is obvious that involving farmers in plant breeding increases the complexity of the task. It reduces plant breeders' control over the process, the lay-out of trials, standardisation of measurements and consequently the statistical reliability of results. Plant breeders look for identifiable end-products (varieties) and tend to resent leakage of breeding materials into farmers' fields before formal release. All this happens in PPB. Hence, it is not surprising that plant breeders feel they need good reasons to embark on a path that is in conflict with well established and successful formal plant breeding methodology. However, such reasons do exist: the failure of modern varieties to satisfy farmers' requirements, extreme environments that for economic reasons do not justify special breeding programmes, local crops that are not covered for the same reasons etc.

Although PPB can often potentially benefit farmers it is necessary to balance the costs and benefits. This is sometimes problematic: while the costs are evident and can be estimated, the benefits are often difficult to quantify in hard economic terms, as the technical outcomes of the process are not always possible to foresee and also because they do include other environmental, social and political factors which may be so not readily costed.

4.1.3 Participation in the crossing phase

Making crosses and developing breeding populations is extremely time-consuming. In addition, the choice of parents for hybridisation and efficient exploitation of breeding populations in subsequent generations requires an understanding of some basic principles of plant breeding as well as access to materials. Lack of such understanding may lead to time being wasted and disappointing results. This may explain why, many NGO-initiated projects gradually increase the involvement of research and plant breeders. This does however not negate the empowering effect that acquiring the ability to successfully cross has for farmers. Farmers from Pueblo Nuevo, Nicaragua visited farmers in Yorito, Honduras and saw that they were making crosses, and were very keen to master this part of the breeding process. They stated that they may not want to practice it on a large scale, but that it would allow them to generate new diversity if the supply of improved materials from institutional sources were to dry up.. Such a rationale also exists in BUCAP's promotion of PPB.

Data received from Vietnam suggests that in one village (Thong Kong) farmers made a variety of crosses between 4 preferred local varieties in three combinations as well as crossing 3 of these with an improved High Yielding Variety (HYV). In another village a farmer (in Nong Kai province) reported to have crossed only his preferred local variety with one HYV. A problem here is, that often hybridisation seem to be based on on a single cross between a plant from the local variety and a single plant from the HYV. Certainly, considering genetic variation within the local variety, more plants in the local variety should

be used as parents. This also applies to the HYV which may be genetically more uniform but not absolutely so. Hence important genetic variation may be lost in subsequent selection.

From a purely technical perspective it may be advantageous to start a PPB Programme by farmers and breeders jointly identifying and evaluating parents for crossing. This actually occurs in quite a number of the presented projects. Research stations can then proceed by making the crosses as they have better facilities for hybridisation and can multiply such populations for 3 or 4 generations. This may help to broaden the range of breeding populations available to farmers and thus the change of success of selection by farmers. This is an issue that needs to be considered in PPB projects. Limited genetic diversity in breeding populations may well be an important bottleneck in many PPB projects. The number of breeding populations should be limited for farmers to be able to handle them. There would also seem to be an advantage for such breeding populations to be in an advanced stage of recombination. At this stage, mass selection or pedigree/line or whatever method of selection is considered the most appropriate strategy for particular characteristics for farmers and adaptation starts to become effective. It is at this stage that farmers start to have a comparative advantage.

4.2 Impact on variety development

Most of the cases presented here have led to the development of superior materials in a relatively short space of time. These materials have also, generally been quite rapidly distributed through farmer seed systems, unencumbered by the need for formal registration procedures or problems with timing, inadequate supplies and distribution that are sometimes encountered by the formal seed production system. Shortening the period between hybridisation and the use of improved materials in farmers' fields is, in itself, a worthwhile achievement. It highlights the ability of farmers to select planting materials that best satisfy their requirements and to decide which materials, and in what stage are suitable for use. Farmers do not look for the high level of genetic uniformity obligatory for registered varieties. Rather, they are more concerned with performance in the field, which is not necessarily related to genetic uniformity.. PPB seems most advantageous in situations not covered by formal plant breeding (environments, crops, local preferences). It still is an open question whether PPB offers advantages to institutional breeding of major crops in favourable high production environments that are already covered by national plant breeding schemes. One case in this report, The BUCAP Vietnam projects suggests that they may do so. Here PPB is practiced in some of the major irrigated rice production areas, where high yielding modern (IRRI based) varieties which have been introduced and are widely used have a relatively poor consumption quality and fetch a low price on the world market. PPB is showing its advantage in that it leads to closer attention being paid to quality aspects and local preferences. It is arguable that in time national breeding will come around to addressing these requirements.

It may be too early to draw reliable conclusions about the impact of PPB on overall crop improvement. So far there are clear indications that PPB is successful in environments and with crops that are not (or are inadequately) supported by formal plant breeding. As with PVS, PPB has increased awareness among breeders of the way in which local farmer varieties often better meeting local consumption preferences and are better suited to, often extreme, environmental conditions. For many farmers these features are as, if not more, important than yield potential.. In high-production environments in Vietnam, PPB has been reported to increase the diversity of varieties within farmers' fields. While PPB appears to stress local adaptation, it does not necessarily result in narrow local specificity. PPB-bred varieties of rice from Nepal did well in comparative trials in the hills of Bangladesh (Witcombe *et al.,* in prep.), while another PPB–bred variety, Macuzalito, is doing well in trials in different parts of Honduras (FIPAH monthly reports). In Nicaragua, a first evaluation has indicated that the farmers who participated in the PPB pilot project have been able to improve their houses (painting, small extensions), have a more varied diet with more meat (previously they had to buy beans at the end of the season for their own consumption) and have been better able to buy more school gear for their children.

Other observations indicate that PPB has an empowering effect on farmers. While this social impact is undisputable, there is a need to monitor the technical impact of PPB more systematically in order to establish its complementary role in crop improvement.

4.3 Roles of various actors

4.3.1 Farmers

The organisation of farmer groups differs substantially between the cases. In the Nepalese case, the farmers are organised into Farmer Research Committees – the equivalent of the Committees de Investigación Agrícola in the Honduran case. In the South-East Asian cases, FFS is a strong feature and in the case of Vietnam they are embedded in Farmer Communes. In the cases of Nicaragua 'invited' farmers later organised themselves more formally into cooperatives. In Mali the participating farmers were already organised through an NGO programme and a farmers' association. In China, farmers are experimenting with a number of organisational forms adapted to the local social and political situation. In all of the cases there was an initiating outside organisation (NGO) promoting group-organisation in one form or another.

Despite these differences, the majority of the cases showed a similar trend of participation developing and changing over time. Initially PPB projects tend to be top-down, even when they are implemented by NGOs. This is not surprising. Farmers have to learn the principles of PPB and how to cooperate in this context. Farmers may be familiar with seed selection but, for most, developing breeding populations and generating diversity through crossing and selection in segregating material is new and this requires training and guidance over time.

Once involved, farmers tend to rapidly understand and appreciate the knowledge obtained through the PPB training. They are, by nature, experimenters and have an interest in exploring and testing new planting materials. Within groups individual farmers often take a more prominent role by offering their land for experimentation The empowering elements of PPB may lead to rather ambitious attempts of individual farmers to make their own crossings, develop their own breeding materials and ultimately new (farmer) varieties. Examples of such varieties being developed can be found in the Vietnamese and Philippine cases.

An important aspect of the empowerment of farmers through PPB and training is that it tends to change their relationship with research and extension services from recipients of top-down knowledge towards a more equal partnership. This seems to make farmers more valuable partners for the breeders: they understand more quickly and are more articulate in their views and opinions. The CIAT breeding programme to develop drought resistant varieties prefers to do trial evaluations for bean and sorghum in the fields of farmers in Northern Nicaragua who were involved in the PPB, as they know that these farmers take care and know what they are doing.

Farmers' interest and reasons for in engaging in PPB may differ, often depending on their social and economic position. For farmers in mainstream production areas, higher yields and other economic and agronomic benefits are often the main motives. By contrast farmers from remoter areas and particularly from ethnic minorities mention the maintenance of cultural practices and their traditional environment as major motives (Visser, pers. comm.).

4.3.2 Plant breeders

The role of plant breeders within projects also varies. Often they were initially wary or hostile of PPB, seeing themselves as the experts, with extensive training in centralised plant breeding. When faced with diverse environments, they tend to select a limited number of varieties with broad adaptability, rather than selecting on the grounds of local specificity. However, they do recognise the importance of learning about farmer preferences so that they can include these criteria in their selection criteria. Yet, they measure their achievement by the development of identified single varieties that are widely adopted. Initially, plant breeders have often shown difficulty in accepting the rather different concepts and objectives of PPB in which they play only a supporting role and receive only little identifiable credit. Experiences show that these attitudes rapidly change once the breeders are engaged in PPB. Closer interaction with farmers often proves rewarding. Plant breeders who become involved in PBB usually start to recognise and value the complementary knowledge of farmers in selection and the value of locally adapted materials. Farmers frequently use evaluation criteria that would not have occurred to breeders. At the same time, as farmers' understanding about selection procedures grows, they increasingly value the expertise and support plant breeders can offer. Thus the two groups come to recognise that they share a common interest. A more significant problem is that plant breeders' managers

or colleagues do not always share appreciation of PPB. It will take time, and especially results, for recognition of PPB's value to become more widespread within the plant breeding community.

4.3.3 NGOs and other 'brokering' parties

The concept of PPB largely has its origin in the NGO community. NGOs are involved in all the cases reviewed in this study and, with the exception of the Malian and Chines case they are the main authors of the project proposals, the implementers and facilitators. Generally the projects have broader objectives, such as the empowerment of farmers and farmer communities and PPB is one component of a broader programme. Thus NGOs aim to meet a variety of goals; first and foremost, they see themselves as representing the interests of farmers *vis-a-vis* national agencies (extension, plant breeding, higher authorities etc.). Through maintaining close contacts with farmer communities they help to facilitate group activities, training and when able, they provide (modest) financial means to help solve problems (transportation, repair of irrigation pumps, inputs such as fertilisers, crop protection chemicals, seed storage facilities and others), advise on legal issues etc. Hence, they often serve as a trusted broker. Their role may not always be very visible, but can be the driving force to keep the projects going and maintain support at government levels.

Social scientists.and other researchers. One cannot discuss the Honduran and China case without considering the role of social scientists. The leading resarchers in Mali, although professional breeders, have important broad experience that allow them to go beyond the breeding issues. The involved researchers are CG – University affiliated and NAR researchers. The importance of the input from social sciences is easily overlooked and merits further analysis.

Extension service. Generally extension services quickly adapt to PPB projects and provide active support. In Asia, familiarity with FFS methods through IPM Programmes meant that extension services quickly recognised their value in testing planting materials. As a result they are generally supportive of PPB. This has helped in changing rather top-down modes of extension to more participatory approaches.

Farmer organisations. The cases also show that well-established farmer groups (like the CIALs in Honduras) or farmer representations (like the Farmer Associations, in Mali) are also able to play a 'brokering' role with local communities. The apparent need to for the presence of a brokering party shows the importance of the coordination and support function. This challenges earlier views of PPB, which was thought of as a two party activity involving farmers and breeders (see for example the conceptualisation of breeder- and farmer-led activities in Sperling et al, 2001). The experiences from the cases presented here stress that PPB is not solely a collaborative activity between farmers and breeders, but that brokering and supporting coordinators play a key role.

4.4 Empowerment through PPB

4.4.1 Empowerment of farmers

In all the cases, PVS and PPB have proved to be effective in developing farmers' capacity in various aspects of breeding and selection as well as in raising the confidence of farmers to make their own choices.

On the basis of the case studies it seems that PPB in its various forms has the most obvious appeal to small and, largely self-sufficient, farmers who sell part of their harvest in local markets. It tends to be more rapidly adopted in more marginal, stress prone environments where institutionally bred modern varieties often do not perform well or do not satisfy local preferences. Farmers in such areas readily understand the value of selection. In many ways it is a revitalisation and revalorisation of practices they are, or have been, familiar with. The success of farmer-selection is very evident when considering the results with local landraces. Reports by farmers in the BUCAP projects in Vietnam and Laos (pers. com) suggest yield improvements of over 20%. This is an important outcome, and one of relevance to the objectives of both national and international plant breeding institutions. There are also evident

opportunities for PPB in crops that are not dealt with by institutional plant breeding, though here there are fewer reported examples of successes.

An important aspect of most PVS and PPB projects is that they stimulate self-reliance among farmers and give them more confidence in their relationships with national research institutes. From anonymous beneficiaries (if indeed they ever were) farmers become active participants in identifying appropriate planting materials and in crop improvement. Ownership of varieties through formal registration or alternatives such as municipality records greatly adds to this. In many cases PPB has also provided an entry point for experimentation on a wider range of issues. PPB which utilises FFS and other forms of farmer-organisation also increases social cohesion within communities instigated through joint activities and meetings. It often strengthens the position of women, when they play an important role in seed production. It also promotes communal awareness of the value of local genetic diversity. While it is difficult to quantify such advantages in economic terms, they are nevertheless real.

Last but not least, the availability and access to better performing varieties, introduced into the informal system is also an element of empowerment, enabling farmers to increase their productivity.

4.4.2 Empowerment of breeders

The empowering effect of PPB on breeders may be overlooked but is also significant. Breeders from national agricultural research programmes have, through their involvement in PPB pilot projects, realised the direct impact that they can have on farmers' livelihood. In multiple interviews carried out with breeders by one of the authors, it became evident that one common important effect of involvement in PPB was an increase in breeder's motivation. While working with farmers inevitably implies longer hours and irregular working times this was in most cases counter-balanced by increased job satisfaction and recognition by farmers and collaborating NGOs of their professional expertise

4.4.3 Impact on empowerment of NGOs

Programmes implemented as part of the CBDC in earlier years, which BUCAP and PEDIGREA are successors to, often had an element of 'rebellion' against the top-down breeding approaches of the formal public and private breeding institutions. Yet, it has been realised that a confrontational political approach is not acceptable to national authorities. In addition, the advantages of gaining technical support from plant breeding institutions and extension services and access to breeding materials have become obvious. It is not unfair to claim that NGOs, having now learnt the difficulty of doing PPB with farmers have come to have a greater appreciation of plant breeders' expertise and improved materials.

4.5 Costs and benefits

The World Bank recently criticised FFS on the basis of costs and benefits (Quizon et al., 2001). While the need to try and quantify the costs of PPB is not questioned, there is an unresolved question about *how* costs and, more problematically, the benefits should be quantified. PPB initiatives have generated adapted cultivars where other approaches have failed or yielded less adapted materials. PPB initiatives have also proved their worth in bringing developed varieties into the hands of farmers, thereby generating social and economic benefits. So far, only a limited number of attempts have been made to analyse the costs and benefits of PPB (see for an example, Lilja et al, 2002, Ashby & Lilja, 2004). The generation of the data for such quantification poses a major challenge. IDRC is currently supporting cost benefit studies in ICARDA/Syria, INCA/Cuba, and with CCAP-GMRI in China. See further 5.3.

4.6 Lessons from comparing experiences

One of the aims underlying this review was to seek lessons about PPB, through a comparative analysis of different case studies. We assumed that, after 10 years of pilot projects, it would be possible to generate some general formulation about which processes of breeding and selection had shown themselves to be the most effective. This, however, proved very difficult. All the case studies have been successful in

generating varieties that are more attractive to farmers than the ones they were using before. Present results mainly came from supplying farmers with advanced breeding materials (generations F3-F4). Hence is not yet possible to compare this with results obtained from crosses made by farmers who are managing subsequent generations on-farm. To make such direct comparisons, a more experimental approach may be required in which the final results of parallel selection programmes by farmers and plant breeders starting from the same breeding populations are compared.

Farmers tend to be divided about the kind of materials that they want to use when starting PPB. The majority of participating farmers appears to prefer more advanced breeding populations developed by research, which also meet their (multiple) requirements and whose parentage includes local varieties. It seems clear that successful PPB usually involves active support from national plant breeding institutions. Yet, pilot projects aside, this often depends on individual plant breeders taking a personal interest, and squeezing such work into their usually already heavy workload. There is a need to change the attitude of management and policy makers from one of treating PPB as a tolerated incidental activity, to one of acceptance of the real opportunities that PPB offers to farmers. This requires that PPB becomes accepted as a complementary strategy within national crop improvement and is integrated within institutional programmes. This will only occur when the results of PPB are more widely publicised, become part of the training of plant breeders and generally gain recognition and respectability in the plant breeding profession.

Documentation is one major bottleneck. Several PBB projects are facilitated by NGOs. They tend to be action-oriented within individual projects, emphasising participatory processes. The data collected on the breeding itself usually do not satisfy requirements for publication in refereed technical journals. NGO personnel generally lack the technical skills and motivation to submit papers to learned journals. There a few exceptions to this, but mostly from projects initiated and controlled by plant breeders (such as the Malian case). Under farmer-controlled conditions it is difficult to improve and standardise data collection. Hence the achievements and potential of PPB are, as yet, not widely available to the plant breeding profession. This should seriously concern the PPB community. A specialised journal or recognition of the relevance of PPB by an existing journal could help address this problem. At the same time project initiators should consider increasing the attention that they pay to documentation within projects in order to be able to provide sufficiently rigorous material. The complexity of documenting the often vary dynamic processes should however not be underestimated.

This problem also affected our attempt to classify the various cases. As the available technical data on the breeding process were generally inadequate, our focus shifted to the approaches towards participation, i.e. what we called the social methodology. Yet this is also difficult to evaluate. The inputs received from the authors of the case studies made it evident that *participation* has a multi-faceted nature and can include many nuances. It includes personal relationships that grow over time involving mutual understanding and trust. It involves the way the partners deal with financial issues and other power-related elements. These nuances are difficult to capture in short texts, such as the ones we solicited from the authors. As result, detailed characterisation and differentiation is not possible. Given this complexity, we feel it is not fruitful to try to 'quantify' the notion of *participatory* in discussing PPB, other than the breeding stage at which farmers become involved in the process.

When looking at various examples (both in this report and others), we are however tempted to distinguish two groups of projects, based on their point of departure. We also see a logical link between the perspective and the type of actor taking the lead within the initiative. In one group of projects the actors set off with an emphasis on developing improved varieties. This can be considered as 'taking a more *technical perspective'*, i.e. basing design and decisions mostly on technical arguments. In these situations plant breeding institutions do take a leading role and may widen the scope of their programmes to include more diverse environments not covered by centralised institutional breeding programmes. The second group places the PPB more in a '*perspective of empowerment of farmers'*. These projects are mostly instigated by NGOs. An important motivation behind the empowerment of farmers is to strengthen their self-reliance and safeguard their ownership over their genetic resources. These projects place great emphasis on the role of farmer seed systems in providing a reliable source of seeds and in promoting (the maintenance of) genetic diversity. A further objective is the maintenance (or promotion) of genetic diversity in farmers' fields, which plays a key role in sustainable cropping systems.

Despite different departure points, there seems to be a growing realisation that these two objectives are intrinsically linked. Without improved varieties as 'tangible' results of the process, the impact of

empowerment would be much lower. Without empowerment, farmers' participation as partners in the breeding process is less effective. Thus over time the two perspectives tend to converge, regardless of the point of departure. As such attempts to position the cases within this report into one of the two groups, on the basis of a snapshot in time (the case studies in this document) appears arbitrary. Moreover, such a classification would require a more profound and nuanced understanding of the relationships between the various parties and how they develop over time.

While some valuable advances in developing a common and accepted set of technical procedures (i.e. a PPB technical manual) have been made (Christinck et al., 2005; Smolders, 2006a & 2006b), it remains debatable whether it is possible to develop a globally applicable methodology. In our opinion there need to be flexibility in deciding upon issues such as plot sizes, number of materials to be used etc. Above all such decisions need to be adapted to the specific conditions of target communities. Taking such decisions requires a considerable level of expertise and judgement. Thus such flexibility does not imply that PPB is a 'sloppy type of breeding'. However, it may be possible to generalise experiences on (i) the phase of the breeding process in which the farmers' involvement is most effective, (ii) the number of farmers involved and the manner of their involvement, (iii) the process of farmer selection and (iv) existing farmer seed production practices. Decisions on all these issues will be depend at least to some extent on the balance between the main objectives of a project: that of rapidly developing new appropriate varieties, and of empowering farmers and strengthening farmer seed systems.

One important lesson that clearly emerges from the case studies and that we feel needs to be highlighted is the important role of the 'brokering actor', be they an NGO-technician, a co-ordinator in a breeding programme or a farmer association. Experiences with PPB show that considerable effort is needed to coordinate meetings, field days, implementation of evaluation trials and last, but not least, provide some overall guidance.

Although at first sight the relative paucity of concrete lessons that can be gleaned from this review of ten years of pilot projects leaves to be desired, the review emphasises and illustrates the richness and diversity of PPB and draws us to the conclusion that there is no one single most effective way of going about it.

5 BEYOND THE PILOT PROJECT: CHALLENGES FOR INSTITUTIONALISATION

5.1 Institutionalising farmers' involvement in plant breeding

At present we can see a large number of projects practicing various forms of PPB, all of them being quite successful so far (case studies in this publication, Ashby & Lilja, 2004). There is however no general message about the possible role of PBB within national crop improvement regimes. This leads us to question the future direction of PPB. Sustaining and institutionalising PPB (i.e. mainstreaming, and scaling-up) where it offers real advantages would seem to require recognition that it can play a valid complementary role within national seed programmes and policies. This step requires an enabling institutional and policy environment as well as available and organised technical support. One way of seeing if this support and environment do exist, is to ask what happens after pilot projects finish? Will breeders and farmers still meet and jointly decide on what to evaluate and how? Will materials from new crosses still find their way to interested farmers? And, will this way of working become the normal way of 'doing breeding' where it appears opportune? For these conditions to be met, PPB must be recognised as an approach that effectively combines the development of improved varieties and development objectives aiming at alleviating rural poverty and improving local food production. At present reports on progress towards institutionalisation (mostly personal communications) send mixed messages, but do identify a number of challenges that need to be addressed in order to create a truly enabling environment.

Publishing the results of the achievements of PPB is necessary in order to influence policy makers and managers of agricultural research of PPB's value. In addition PPB methods need to be included as part of curricula in training plant breeders. For PPB methods to be included in such curricula there is a need for well documented case studies and the translation of these cases into solid methodologies. This document aims at contributing to this process. One of the most substantial findings of such a comparison is that there is no-one single methodology that can be recommended. Rather it is obvious that PPB can be implemented in many ways, according to the context, which will vary according to the crop, ecological and social conditions. This suggests that it is unlikely that a single and solid methodology' applicable to all situations can be developed. Moreover, there is the danger that such a methodology could too easily become a straightjacket or blueprint that and this would probably be counterproductive. However, general and accessible guidelines are useful: some such contributions have already been published (e.g. Christinck et al, 2005) and others are in preparation. It is important that such publications are available and accessible (also in terms of their content) not only to breeders and scientists but also to technicians and farmers. The International Future Harvest Institutes of the CGIAR, as the largest international publicly funded agricultural research system, with the stated objective of helping to alleviate rural poverty could and should play a central role in assisting in developing the methodology for, and promoting PPB. While some within NGO circles may find such involvement controversial, it is one way of bridging the present gap that exists. It may also help to convince donors (and NGOs) that the CGIAR is capable of looking beyond the cutting edge of science.

Having said this, it should be noted that farmer breeding, selection and maintenance continues to take place, as it always has, independent of PPB efforts. However, PPB interventions, may have improved farmers efforts in this respect, as has been the case, for example, in Vietnam where farmers involved in the Vietnam-CBDC Programme have been able to maintain the genetic integrity of a much preferred farmers' variety that is sold in the urban market of Ho Chi Minh City (Tin et al, 2006).

5.2 Policies, seed rules and regulations

One major problem with PPB is that the varieties that it produces often fail to comply with national crop improvement and seed regulations. This is at least in part because these rules and regulations are often copied from industrial countries, heavily biased towards commercial plant breeding practices and products.

These rules and regulations generally address the requirements of a centralised public, and especially the commercial, seed industry. This includes making provision for the legal ownership of varieties (Plant Breeders' Rights) and setting standards for quality and uniformity of the seeds marketed (Seed Regulation). The former of these concerns (PBR) aims at increasing private investment in plant breeding, whereas the latter is a form of user protection, intended to control the quality of seeds that are produced for profit. Little account is taken of the fact that many of the seeds that farmers use are obtained from "informal" farmer seed system and are produced on-farm. This system is not formally controlled or regulated, yet it forms the core of the national seed supply in most developing countries. It is reliable and generally the physical quality of seeds (viability, vigour etc.) produced is comparable with the quality achieved by centralised seed production systems. For PPB and farmer seed systems to play a role, the varieties resulting from on-farm improvement of local landraces or on-farm breeding should be regulated, if at all, by *sui generis* rules and regulations. In farmer seed systems knowledge about the seed producer and his (and often her) reputation is often taken as a proxy of quality. This can pose a problem in some projects and countries (and has become evident in the projects in Vietnam and Nicaragua). Farmers and communities involved in PPB and with an interest in naming and claiming a form of ownership over the products of their breeding and improvement, and faced with demands from other farmers and communities are often uncertain about the options for wider distribution and marketing. Their material generally has not gone through the formal procedures of testing for compliance with Distinctiveness, Uniformity and Stability (DUS) standards, nor is this demanded by their (potential) customers. In many cases that we are familiar with the uniformity of the materials is reasonably comparable to those produced by the formal sector. It should not be forgotten that uniformity is important for farmers, as otherwise they would have problems in maintaining the variety. Equally quality is often not a problem, when compared with the quality of the seed that is nationally distributed through either public or private channels. A final problem is Distinctiveness, which is equally problematic for breeders! A bean breeder from INTA, Nicaragua, mentioned that many promising bean materials do not make it into the public domain because they are not 'recognisably distinct' from existing available ones. For farmers the cost of applying for such recognition usually is too high.

The experiences from the case studies indicate that aiming for recognition and diffusion via national seeds system implies a tendency to working towards developing and promoting relatively few varieties, even within the context of PPB projects. In Honduras, farmers have engaged in ways of recognising and registering seeds that do not rely upon the national regulatory framework. The CIALs register favoured varieties with the municipality and have the seeds blessed by a priest. This provides the basis for the exchange of seeds, from one community to another, through the CIAL network. The production and diffusion of a relatively large number of varieties does not pose a real problem in the Honduran situtation. It does not conflict with formal sector interests, as the formal sector recognises that it does not develop bean varieties that are adapted for mountainous conditions. It is important to note however that recently the Honduran farmers have expressed the wish to see their materials also approved and released by the formal system (S. Humphries, pers. comm.). Recognition by the formal sector is apparently a strong incentive for the farmers.

Free exchange of seeds between farmers, often through barter, is common in most farmer seed systems. However when new varieties are bred through PPB, there is often an incentive to try and sell the material to recover some of the investment made. It is realised farmers will subsequently freely multiply such varieties for their own use, but within the cultural and farming traditions of the marginal areas this is not seen as a problem. In Vietnam some communes are thinking of establishing seed production cooperatives and in Nicaragua, farmers also hope to be able to sell seed of the PPB varieties. Apart from representing a potentially important additional source of income, they consider the sale as recognition by the buyer of the input made by the farmers made in developing and maintaining the varieties. They have complied with all the requirements for registering the varieties, but they do not meet the condition of being recognised as a breeding institution and can therefore not lay legal claim to being the creators of the two varieties they have bred. This illustrates the incompatibility of legislation with the actual practices of farmer seed systems, which in some cases reduces farmer-to-farmer exchange to an almost illegal activity.

In a broader context there is a more general issue here of Farmers' Rights, and the necessity of systems that allow farmers to operate within their own established practices and traditions of open exchange and to seek benefit from their work in an appropriate manner.

5.3 The sustainability of PPB

Costs and benefits
Costs and benefits have an important bearing on the continuity of PPB activities, especially when the funding of projects comes up for review. For farmers with small land holdings, who are and often share-cropping, PPB implies a high cost in time and in land. Yet the benefits so far have been promising. Good varieties have been developed from PVS, as well as through PPB using more advanced breeding populations derived from research. These successes can be readily be explained by the fact that previous breeding activities did not target the needs and conditions of small scale farmers. Thus, *in situ* selection by farmers quickly resulted in varieties that were better adapted to their needs and conditions. In addition, the breeding process on-farm can be as fast as on station, and in some cases even faster. Pilot projects also tend to be well funded and results immediately enter farmers' fields. However, the question remains about the sustainability of PPB once external funding stops? To answer this data on costs and benefits are essential.

In calculating the costs and benefits of PPB, it is important to be aware that different forms of PPB have different levels of cost effectiveness, and that a range of approaches might need to be evaluated. Quantified cost estimates can be made of implementation and management costs of projects, of training farmers, of the levels of support provided by implementing agencies, and the cost of support by research and extension. On the farmers side it is perhaps harder to estimate the costs involved. They may involve a loss of yield on the land set aside for experimentation, as well as the costs of farmers' time. This can be difficult to calculate as it will depend on the opportunity costs involved (i.e. what other economically beneficial activities they would have otherwise been engaged in). Quantifying benefits however is more problematic. When projects successfully produce better planting materials, these benefits are long term. These benefits can be calculated economically, yet much depends upon the discount rate (i.e. discounting future benefits against present day costs by an annual rate of interest. Other factors, such as the beneficial affects of empowerment and improving social interaction and cohesion within communities are far less amenable to economic valuation, and thus are often not included in any economic calculation.

Participation of the breeders
Sustaining forms of PVS and PPB requires a regular supply of breeding populations. Thus, the continued support and cooperation of research institutions seems crucial for making crosses between appropriate parental materials in order to develop breeding populations for target environments. But research institutions, often faced with budgetary constraints or even cut-backs in funding, may not be willing or able to continue to support breeding aimed at less favourable, diverse environments and small, low-input and often less productive (in terms of yield) agricultural production. In several instances support from the breeder has come to a halt simply because of the lack of resources for transportation to visit project sites. The increasing trend of privatisation within plant breeding and agricultural research in general poses an additional problem for such continued support as private industry has little interest in promoting PPB.

Participation of farmers and NGOs
FFSs in Asia and CIALS in Central America, have been able to encourage farmers to participate in PPB by offering them some financial and technical assistance. The examples of Vietnam, China and Honduras show that PPB can be a vehicle for communities to increase their levels of organisation and collaboration. In Vietnam, some farmer communes are even considering entering the national seed market. Farmers in Nicaragua have organised themselves into a cooperative with the same aim. But it remains to be seen whether they will be able to generate sufficient funds through seed sales to become self-sufficient and sustainable. The current levels of development of these projects do not allow us to arrive at any conclusions on these issues. The continuing role of NGOs as a brokering agent may even be more problematic since they depend entirely on resources from external donors, which are always finite, and their contribution to the process is difficult to measure in tangible terms.

5.4 Conclusion

All in all, the experiences of the projects reviewed in this paper and elsewhere indicate that PPB can be successful and does offer realistic options that can benefit farmers thus far neglected in crop improvement programmes. However, the sustainability of PPB is a serious problem that must be faced.

There is no doubt about the value and potential benefits of closer involvement of farmers in crop improvement in general and particularly in relation to complex and harsh environments and 'minor crops'. However, in our view, the sustainability of PPB depends on the practices becoming integrated with national plant breeding institutions and an integral component of national agricultural and social development policies and programmes. This requires formal recognition that farmer seed systems are an important component of national seed supply. The actual costs of PPB Programmes would seem to be relatively low compared to their impact, although reliable cost estimates are not yet available and may find difficulty in expressing all the benefits involved. Organisations involved in and supportive of PPB projects should seriously consider these issues. Concerted and coordinated activity is needed by the stakeholders in PPB in order to promote awareness among national politicians, policy makers, ministries of agriculture and economic development, research managers and national and international donor agencies. To achieve this, stakeholders in PPB need to join forces and emphasise their common interests (rather than the differences in approaches) and form a united platform. This is a challenge that must be faced in through a shared realisation of mutual inter-dependence and common interest, a concept well understood by farmers but somewhat less so by other stakeholders in PPB.

6 REFERENCES CONSULTED

Almekinders, C., J. Molina Centeno, R. Herrera Torrez, S. L. Merlo Olivera; J.M. Gonzalez Suárez, J. García Carrasco, 2006. Experiencias y aprendizajes del desarollo de variedades de frijol de manera participativa en el norte de Nicaragua. Agronomía Mesoamericana 17(3): xx-xx.

Almekinders, C.J.M., and A. Elings, 2001. Collaboration of farmers and breeders: participatory crop improvement in perspective. In: A. Elings, C.J.M. Almekinders and P. Stam (eds), Breeding for low-input conditions, and consequences for Participatory Plant Breeding. Euphytica 122 (3): 425-438 (Special Issue).

Almekinders, C. and N. P. Louwaars, 2002.The importance of the farmers' seed system in a functional national seed sector. Journal of New Seeds 4 (1/2): p. 15-33.

Almekinders, C., M. Crespo, C. Coco and G. Plata (Compiladores), 2004. Fítomejoramiento Participativo y Producción de Semilla: Logros y Retos. Documentación de Taller Abril 26-28, 2004 Cochabamba, Proinpa/Preduza. www.preduza.org

Almekinders, C., R. Estrada and A. Gallegos (Compiladores), 2004. Fítomejoramiento Participativo y Producción de Semilla: Logros y Retos. Documentación de Curso-Taller Abril 20-23, 2004 Cuzco, INIA/Preduza. www.preduza.org

Ashby J; and N. Lilja, 2004. Participatory Research: Does it Work? Evidence from Participatory Plant Breeding 4th International Crop Science Congress "New Directions for a Diverse Planet," 26 September to 1 October 2004, Brisbane, Queensland, Australia. http://www.cropscience.org.au/icsc2004/symposia/4/1/1589_ashbyj.htm

Bellon, M. R., and J. Reeves. (eds), 2002. Quantitative Analysis of data from participatory methods in plant breeding. Mexico, DF, CIMMYT.

Bertuso AR, van Treuren R, van Eeuwijk FA, and Visser L. 2005. Charactrisation of red rice (Oryza sativa) varieties developed under on-farm dynamic management. FAO/IPGRI Plant Gen Res Newsletter 142: 68 - 72

Ceccarelli S and Grando S, 2005. Decentralized-Participatory Plant Breeding: A Case from Syria pg. 193-199.In: Gonsalves, J.,Becker, T., Braun, A., Campilan, D., De Chavez, H., Fajber, E., Kapiriri, M., Rivaca-Caminade, J. and Vernooy, R., 2005. Participatory Research and Development for Sustainable Agriculture and natural Resource Management. Volume 1.

Ceccarelli, S., 1989. Wide adaptation: how wide? Euphytica 40: 197-205.

Ceccarelli, S., S. Grando, E. Bailey, A. Amri, M. El-Felah, F. Nassif, S. Rezgui and A. Yahyaoui, 2001. Farmer participation in barley breeding in Syria, Morocco and Tunesia. In: A. Elings, C.J.M. Almekinders and P. Stam (eds), Breeding for low-input conditions, and consequences for Participatory Plant Breeding. Euphytica 122 (3): 521-536 (Special Issue).

Christinck, A., E. Weltzien, V. Hoffman (eds), 2005. Setting breeding objectives and developing seed systems with farmers. Margraf Publishers, Germany/CTA, The Netherlands.

Danial, D.L., C.J.M. Almekinders and G. Thiele, 2006. Farmers' participation and breeding for durable disease resistance in the Andean region. Euphytica (in press).

Gabriel, J., Herbas, J., Salazar, M., Ruiz, J., Lopéz, J., Villarroel, J and Cossio, D. 2004. Participatory Plant Breeding: A New Challenge in the Generation and Appropriation of Potato Varieties by Farmers in Bolivia. Working Document No. 22. PRGA Programme. Cali, Colombia. 22 p.

Gyawali, S., Joshi, K. D. and Witcombe, J. R. 2002 Participatory plant breeding in low-altitude production systems in Nepal. In: Breeding Rainfed Rice for Drought-prone Environments: Integrating Conventional and Participatory Plant Breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programmeme/IRRI Conference, 12-15 March 2002, IRRI, Los Baños, Laguna, Philippines, 8-11. (Eds J. R. Witcombe, L. B. Parr and G. N. Atlin). Bangor and Manila: Department for International Development (DFID) Plant Sciences Research Programmeme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI).

Hardon, J. 1995. Participatory plant breeding. The outcome of a workshop on participatory plant breeding, 26-29 July 1995. Issues in Genetic Resources No. 3, October 1995. IPGRI, Rome.

Hardon-Baars, A.J. 1997. Users Perspectives. Literature review on the development of a concept. UPWARD Working Paper series No. 4.

Humphries, S., O. Gallardo, J. Jimenez, F. Sierra with members of the Association of CIALs of Yorito, Sulaco and Victoria. 2005. Linking Small Farmers to the Formal Research Sector: Lessons from a Participatory Bean Breeding Programmeme in Honduras. AgREN Network Paper No. 142, ODI, UK. January 2005. http://www.odi.org.uk/agren/papers/agrenpaper_142.pdf

Joshi, K. D. and Witcombe, J. R. 2002 Participatory varietal selection in rice in Nepal - a comparison of two methods by farmer's selection and varietal adoption. Euphytica 127:445-458.

Joshi, K.D., A.M. Musa, C.Johansen, S.Gyawali, D.Harris Client-oriented breeding (COB) produces widely adapted rice varieties (in press).

Kornegay, J., J. A. Beltran and J. Ashby, 1996. Farmer selections within segregating populations of common bean in Colombia. In: P. Eyzaguirre and M. Iwanaga, Participatory plant breeding. Proceedings of a workshop on participatory plant breeding, 26-29 July 1995. Wageningen, The Netherlands, p. 151-159.

Lilja, N., A. Aw-Hassan, H. Salahieh, J. Ashby, S. Ceccarelli and S. Grando, 2002. Benefits and Costs of decentralized Participatory Barley Breeding at ICARDA, Syria PRGA/ICARDA Presentation from: The Quality of Science in Participatory Plant Breeding. A workshop hosted by the PRGA and the System-wide Genetic Resources Programme (convened at IPGRI). September 30-October 4, 2002, IPGRI, Rome, Italy.

Morris, M. and M.R. Bellon, 2004. Participatory plant breeding research: Opportunities and challenges for the international crop improvement system. Euphytica 136 (1): 21-35

Ngo Tien Dung and SEARICE, 2003. Applying the Farmer Field Schools. Approach to Genetic Resources Conservation. In: CIP-UPWARD, Conservation and Sustainable Use of Agricultural Biodiversity: A Sourcebook. CIP-UPWARD, Los Baños Laguna, p 337-343.

Prain, G., C.P. Bagalon, 1998. Conservation and change: farmer management of agricultural biodiversity in the context of development. UPWARD, Los Baños, Philippines.

Quizon, J., G. Feder and R. Murgai, 2001. Fiscal Sustainability of Agricultural Extension: The Case of the Farmer Field School approach. Journal of International and Agricultural Education 9(1): 65-76

Salazar, René, Niels Louwaars and Bert Visser, in press. Protecting Farmers' New Varieties: New Approaches to Rights on Collective Innovations in Plant Genetic Resources. Washington DC, IFPRI. CAPRi Working Paper # 45, 33 p. http://www.capri.cgiar.org/pdf/capriwp45.pdf

SEARICE,m 2003. Strengthening farmers' agricultural diversity management systems. In: CIP-UPWARD, Conservation and Sustainable Use of Agricultural Biodiversity: A Sourcebook. CIP-UPWARD, Los Baños Laguana, p 599-607.

Smolders H and Caballeda E (eds.). 2006. Field Guide for Participatory Plant Breeding in Farmer Field Schools (136 pp.). PEDIGREA publication. Centre for Genetic Resources, the Netherlands. Wageningen. http://documents.plant.wur.nl/cgn/literature/reports/Fieldguide.pdf

Smolders, H. 2006 (ed.). 2006. Enhancing Farmers' Role in Crop Development (60 pp). PEDIGREA publication. Centre for Genetic Resources, the Netherlands. Wageningen. http://documents.plant.wur.nl/cgn/literature/reports/EnhancingFarmersRoleinCropDevelopment.pdf

Sperling, L., J.A. Ashby, M.E. Smith, E. Weltzien and S. McGuire, 2001. A framework for analyzing participatory plant breeding approaches and results. In: A. Elings, C.J.M. Almekinders and P. Stam (eds), Breeding for low-input conditions, and consequences for Participatory Plant Breeding. Euphytica 122 (3): 439-450 (Special Issue).

Sperling, L., M. Loevinsohn and B. Ntabomvura, 1993. Rethinking farmers' role in plant breeding: local bean experts and on-station selection in Rwanda. Experimental Agriculture 29: 509-519.

Tin H.Q., N.N. De, R. van Treuren R. and L. Visser, 2006. Analysis of spatial and temporal variation of the farmers' rice variety Tai Nguyen under changing cropping systems in the Mekong Delta, Vietnam. FAO/IPGRI. Plant Gen Res Newsletter. In press.

Simmonds, N.W. 1979. Principles of crop improvement. London: Longman Group Ltd.

Vernooy, R., 2003. Seeds that give: participatory Plant breeding. IDRC, Canada (www.idrc.ca/seeds).

Witcombe, J.R., Parr, L.B., and Atlin G.N. (eds), 2002. Breeding rain-fed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Science Research Programme/IRRI Conference, 12-15 March 2002, 104 p.

Witcombe, J.R., K.D. Joshi, S. Gyawali, A.M. Musa, C. Johansen, D.S. Virk, B.R. Stapit, 2005. Participatory Plant Breeding is better described as highly client-oriented plant breeding. I. Four indications of client-orientation in plant breeding. Exp. Agr., vol. 41, p. 299-319.

Witcombe, J.R., S. Gyawali, S. Sunwar, B.R. Stapit, K.D. Joshi, 2006. Participatory Plant Breeding is better described as highly client-oriented plant breeding. II. Optional farmer collaboration in the segregating generations. Exp. Agr. Vol 42, p. 79-90.

Weltzien, E., M.E. Smith, L.S. Meitzner, and L. Sperling, 1993. Technical and institutional issues in participatory plant breeding – from perspectives of formal plant breeding. A global analysis of issues, results, and current experience. PPB Monograph no. 1. PRGA Programme, Cali, Colombia.

Most relevant web site for PPB: www.prgaprogramme.org

PART B: CASE EXPERIENCES

7 FARMERS DEVELOPING THEIR OWN ADAPTED BEAN VARIETY WITH COLLABORATION OF A BREEDER AND NGO-STAFF: AN EXPERIENCE FROM PUEBLO NUEVO, NICARAGUA.

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7.1 Introduction: setting the scene

7.1.1 Origin of the initiative

In the mid 1990s the Netherlands Centre for Genetic Resources (CGN), supported by the Ministry of International Co-operation explored possibilities to initiate projects linking *in situ* conservation of agrobiodiversity with on-farm PPB, together with local organisations in Meso America. The Nicaragua NGO CIPRES was identified as a potential partner. CIPRES had been involved in on-farm seed-related projects for a number of years and expressed an interest and suggested approaching farmers in the vicinity of Pueblo Nuevo where CIPRES has an office.

In 1998 the technicians of CIPRES arranged a meeting in which they asked farmers about their interest in working on a project aimed at developing new, locally adapted, varieties of bean and maize. Around 60 farmers attended the meeting and 50 of them agreed to participate in the initiative. CIPRES then approached a breeder of INTA (Instituto Nicaraguense de Tecnología Agraria) for technical support and signed a Memorandum of Understanding with INTA. A project proposal was developed and accepted for funding by the Norwegian Development Fund. The Norwegian Funding stipulated that the project should have a direct impact on the farmers' well being.



Fig 7.1. Pueblo Nuevo and Condega, the 2 project sites lie in the Northern part of Nicaragua, about 50 km from Estilí (1 h drive)

The project in Nicaragua forms part of a regional umbrella PPB programme, covering PPB projects in Costa Rica, Nicaragua, Honduras, Guatemala, Mexico and Cuba. Each of the projects follows its own logic and has independent funding, but they all deal with beans and/or maize. The regional programme co-ordinates and facilitates the exchange of experiences at the farmer and breeder level.

7.1.2 Problem addressed and local conditions

Beans. The farmers' interest was in developing new bean varieties resistant to Golden Mosaic Virus (GMV). Tomato and tobacco production in the region had led to an increase in the white fly population, the vector of the GMV. None of the local bean varieties had GMV resistance and, as a consequence bean production in the low-lying areas had become almost impossible. Only the modern variety DOR 54 showed some resistance, but this variety was not much liked by the farmers: it was dark coloured and it did not fetch a good price as the Nicaraguan market prefers light-red coloured beans. While farmers did grow small patches of this bean for home consumption, its culinary characteristics were not considered very good.

Maize. Drought has become a major problem for maize production as a result of changing climate in the region. Improved varieties are not well adapted to small scale farming conditions. They lack sufficient drought resistance, require fertilizer to attain good yields, the seed is expensive and the grain does not make tasty tortillas.

7.2 Local production and seed system

7.2.1 Production system

Farmers in Pueblo Nuevo and Condega are typical of small resource-poor farmers in the northern part of Nicaragua. They grow maize and beans, for home consumption and income generation. The regional conditions allow two bean plantings per year (primera and postrera, June-August and September-November, respectively) and one maize planting (June-December). Beans are more important as a cash crop than maize, but market prices are low and variable. Farmers grow a mixture of local maize and bean varieties and older modern varieties. Seed is mainly saved from the last harvest. Farmers were previously involved in a special project of CIPRES to produce quality bean seed, sold as *"semilla artesenal*". Hence, there already is some prior experience of improved seed production and awareness of the importance of quality seed.

Other important crops in the locality are tobacco, tomato and cattle are raised. Tomato production has, become practically impossible due to high white fly pressure. This can be addressed by the application of chemicals, but farmers lack the resources for this (due to the high price of the chemicals, relatively low return on tomatoes, high risk of drought and high fuel prices for pumping irrigation water)[1].

7.2.2 Role of women

Women support their husbands in the field with weeding and sowing. They do not have a particular or prominent role in seed production and selection, but are in charge of stored grain (which in many cases includes the seeds). Women from better-off families normally participate less in agricultural activities.

7.2.3 Seed system

The Instituto Nacional de Tecnología Agropecuaria (INTA) is the main actor in agricultural research and development in Nicaragua. Like other NARS in the region, its operations are seriously restricted by lack of funds. The tendency is to support development of improved high input agricultural technology, partly at least due to pressure from international funding organisations, such as the World Bank. There is hardly any formal seed production in the country. Vegetable seeds are imported. Some commercial maize seed is available, but the quality produced nationally is usually not very consistent and the price is quite high. In addition, the varieties are often not well adapted and market prices for maize are low. Most farmers therefore rely largely if not completely on farmer-saved seed.

[1] At the time of printing this document, tomato production has again become important in the area: white fly pressure decreased and new chemicals are available.

7.2.4 Other important socio-economic and agro-ecological conditions

The climate in the region appears to have been changing over the last twenty years. Rainy seasons are becoming shorter and more irregular and drought periods increasingly affect agricultural production. The water-table is falling and wells are drying up. A number of years ago, Hurricane Mitch seriously affected the region and some farmers in Pueblo Nuevo had parts of their land washed away by the river.

7.3 Organisational and institutional structures

CIPRES has its head-office in Managua, which is responsible for liaising with the donor-agency. They have an office in the small village of Pueblo Nuevo where most of the population depends on agricultural production (beans and maize, tobacco and cattle). CIPRES has three local staff carrying out a range of projects, addressing rural household food security and productivity. They are technicians but do not have specialised knowledge of plant breeding or seed production. One of the technicians dedicates 50% of his time to the PPB project. This involves planning and organising meetings and field days, co-ordinating contact with the breeder, supporting the implementation of field trials and managing a rotating fund which is part of the PPB project. When evaluating the project, farmers recognised the important role of the technician in providing guidance. He regularly visits the farmer-breeders, informing and advising them on the planting, consults regularly with the breeder, organises irrigation when necessary (i.e. mobilising the financial means and purchasing fuel for the pumps) and generally assists in solving problems, which often include non-project related affairs.

The participating farmers are all small low-income resource-poor farmers, even by the standards of Pueblo Nuevo. Their farm sizes range from 0.5-4 ha. Twelve of the farmers are member of a cooperative. The other farmers are not organised and mostly derive their income from commercialising small volumes of beans and maize. Some of the farmers were previously involved in a seed production and marketing initiative supported by CIPRES.

The INTA breeder is responsible for the management and evaluation of bean and maize materials in the district of Estili. He has his office on the INTA experimental station, approximately one hour's drive from Pueblo Nuevo. After considerable lobbying from the CIPRES-coordinator in Managua, INTA agreed to his participation in the CIPRES managed project. He would be able to use INTA's vehicle when fuel was provided by the project. Involvement in the PPB project was in addition to his normal responsibilities, which effectively means that his involvement was outside his official working time. Throughout the project, the breeder explained genetic and selection issues, made suggestions and provided farmers with advice. Thus, he helped them to discuss options and take decisions about the organisation and methodology for evaluation and selection. Equally importantly, he also provided genetic materials.

7.4 Methodologies adopted in PPB and farmer participatory (breeding) practices

7.4.1 Materials used

When the Norwegian Development Fund agreed to support the PPB project, there was an immediate need for appropriate breeding materials. The plan was to identify and cross a preferred local bean variety with improved GMV-resistant material and for the farmers to carry-out selection in subsequent generations. . However, this would take at least a number of years. Hence the group agreed to start with more advanced material that the breeder had available at that time, in order to learn and be more prepared when the desired crossed material became available. They started out with 15 families derived from three crosses that involved Tío Canela, a recently released variety in Honduras (see table 1). The crosses had been made at CIAT, Colombia and had some genes that were resistant to GMV, and others for tolerance to low soil fertility and drought. Some of these breeding populations were in the F3 (third year) generation, others were F4, thus they were still in the process of segregation.

7.4.2 Farmer-breeders and the group.

The group of farmers, in discussion with the breeder, decided that five farmers would implement selection trials. This would allow the other farmers to visit and follow the process. Not all the farmers had sufficient land or interest to implement a trial and there were not enough seeds to implement more trials. If any of these farmers was unwilling or unable to continue the trial, another farmer from the same group could take over the material and continue. The farmers were selected to represent different micro-climates in the two villages. All five farmers received 520 seeds of the same 15 breeding populations from the same three crosses and sowed these in the first planting season of 2000. Based on discussions held with the breeder, CIPRES technician and the other farmers they followed similar selection procedures in the following seasons. Field days and evaluation-planning meetings were organised in which the other farmers could see the evaluation trials, mark the materials they considered the most interesting and discuss progress. Although the five farmer-breeders gave consideration to the criteria suggested by the other farmers and valued their interest, they took the final decisions about which plants or plots to select and provide seeds for next season's planting. Usually they selected more plants/plots at harvest than the breeder recommended, but eliminated some after comparing grain seed characteristics (e.g. colour, bean shape and size).

7.4.3 Selection criteria

The principal selection criteria were resistance to Golden Mosaic Virus and yield. A focus on yield as a selection criterion meant that the material was expected to be adapted to local production conditions: low soil fertility (zero or low fertilisation) and drought tolerance (only irrigated when the crop is at risk of being lost). Apart from the application of some fertilizers, the management practices of the trials were left to the farmers' own discretion.

7.4.4 Selection scheme

The five participating farmer-breeders followed more or less similar selection procedures.

2000 *Primera*: each of the 5 participating farmers planted app. 520 seeds (4 rows of 5 m) of 15 progenies/families. The lay-out of the experiments was suggested by the INTA breeder, and the CIPRES technician helped with the planting. The farmers selected up to 20 plants of each of the progenies, giving up to 300 lines for the next planting.
Postrera: 300 progeny F4-F5 lines (rows of 30 metres) → selection of app. 80 lines.

2001 *Primera*: 80 selected progeny F5-F6 lines were planted → 30 best lines were selected
Postrera: 30 selected F6-F7 progeny lines planted → app. 7 best progeny lines selected
Irrigated trial after postrera: 7 F7-F8 selected progeny lines planted by 1 farmer→ 5 lines selected for evaluation in the fields of 4 other farmers

2002 *Primera*: 5 F8-F9 selected progeny lines planted → the 2 best lines were selected. Hence at this point, each farmers contributed one single line derived from heir individual selection from the common starting material of 15 families provided by INTA in 2000.
Postrera: 26 trials with the best selection of each of the 5 farmers being planted on farms in and around the 2 communities. In addition the best improved bean variety INTA-Masatepa was planted as a control variety.
The five farmer selections and the control were evaluated for yield and for consumption quality by the farmers and their wives.

2003 *Primera:* 22 more trials were planted with the 5 selections, with INTA Masatepa as the control. This completed the evaluation data of a total of 48 evaluation trials. The results of the 48 comparative trials were statistically analysed and the 2 best selections identified.
Postrera: The two selections were named as varieties (JM 127 and Santa Elena) and multiplied for further distribution.

2004 October: informal release of the varieties

7.5 Results

Table 7.1. Yield (kg/ha) of the five best bean families selected by the five farmer-breeders in evaluation plots on the farms of those same five farmer-breeders (no repetitions)

	Origin of the material (farmer-breeder)					
Farm where planted and evaluated	Juan García	Jose M. González	Pedro Gómez	Santos L. Merlo	Jairo Videa	Test variety (&)
García (Santa Rosa)	2005	1551	(#) 2717	2069	2127	1875
Gómez (La Lima)	969	839	(#) 1948	1098	1164	1551
González (Paso Hondo)	969	(#) 2522	2134	2134	2263	1616
Merlo (El Rosario)	1035	1016	1180	(#) 1722	1275	1057
Videa (Río Abajo)	2328	1616	1357	1482	(#) 2522	2269

(#) The best yielding material on the farm of each of the five farmer-breeders
(&) In the farm of Santos Luis Merlo the variety DOR 364 was used as a local control, whereas on all other farms it was the INTA-Masatepe variety.

Table 7.2. Average yield (kg/ha) of the 5 best bean families selected by 5 farmer-breeders in evaluations planted in Pueblo Nuevo (26) and Condega planted in the 'postrera' of 2002 and 'primera' of 2003, respectively (&).

	Origin of the material (farmer-breeder)					
	Juan García	Jose M. González	Pedro Gómez	Santos L. Merlo	Jairo Videa	INTA Masatepe
Average of 14 evaluations in favourable environments (#), 2003	610	675	601	549	619	660
Average of 12 evaluations in unfavourable environments (#), 2003	457	470	406	353	334	437
Average of 22 evaluations, 2004	538	514	--	--	--	526

the overall average environmental index was 618 kg/ha
(&) Data adapted from Molina et al. (2003a; 2003b).

7.6 Reflection on experiences

7.6.1 Participation

Initially, the breeder's role was largely one of suggesting how the trials were planted and how to carry out selection, selection intensity etc. But, as the process advanced, the farmer-breeders learned about the nature of genetic segregation and evaluation. This transformed the role of the breeder from one of a teaching/advisory role to one of a true partner. Increasingly, the farmers found their own adaptations and suggested their own solutions to problems that arose. One example of a farmers' adaptation is planting in very long and narrow evaluation plots so that each plot would cover both the better and the worse part of his parcel of land. This eliminated the need for repetitions and, because of the farmer's knowledge of his soil he could accurately interpret the performance of the various varieties. Another farmer decided to heavily irrigate the bean crop after a period of extreme drought, to the despair of the CIPRES technical staff. His argument was that bean plants often do not withstand the heavy rain showers that tend to follow periods of drought. He considered this as a selection criterion, knowing he

had highly drought resistant material in his field. This section criterion would never have occurred to the breeder.

The breeder recognised that the increased influence of the farmers in the process made them more valuable partners. It allowed him to leave more of the selection and evaluation work to the farmers and they provided him with information on variety performance and selection criteria that he was less familiar with. Farmers feel that the collaboration with the breeder developed into a real partnership. Previously they had always been treated as 'recipients' of INTA varieties, but now they were able to discuss with a breeder, ask for specific materials and even develop varieties according their own preferences. They feel that this learning has brought tremendous benefits and changed their outlook on farming. One farmer said that they have become a kind of scientists in their own right. The attention and recognition they got through this project has been very important. The farmers feel they are neglected by politicians, even though they are important food producers for their country and urban populations. It is therefore no exageration to say that the project has boosted their knowledge and confidence. Somewhat later a new breeder was appointed to the INTA-Estili station and this required a renewed phase of confidence building. But this process went much faster than the first time as the farmers were much more knowledgeable and aware of the importance of good collaboration.



Fig 7.2. One of the farmer-breeders with his father, looking at the F6 and selecting before the next planting.

7.6.2 Genetic selection and diversity

The 2 varieties selected originated from the same breeding population resulting from the cross [F1 (VAX 3 x Catrachita) x Tio Canela 75]. Nevertheless, in the eyes of farmers, the characteristics of the two varieties were quite distinct. One was selected by a farmer living at a higher altitude where the climate is slightly cooler and more humid, the other by a farmer living near the river where the climate is hotter and dryer and where GMV pressure is higher. Personal preferences for particular plant types, seed colour and form also resulted in a variation of the characteristics. Although farmers immediately recognise the differences between the final five varieties from which the two were selected for further multiplication, genetic analysis using a PCR-based RAPD did not show significant differences (Widengård, 2003).

Each of the two selected bean varieties is genetically reasonable homogeneous, comparable to any other commercial bean variety. In the area around Pueblo Nuevo however, many of the other bean progenies are grown, because throughout the process the five farmer-breeders gave away samples and small bags of seed to family and friends. These materials are still being grown and may even be diffusing further. The farmer-breeders developed a close attachment with their own selections and are reluctant to do away with their own creations. The project has stimulated interest in growing (more) diversity, including in other crops (e.g. sorghum). Thus, while genetic analysis through PCR-based

RAPD methods did not identify variation between the varieties, they are certainly not genetically identical and there is more genetic variation around in the area than before. A further important contribution to the genetic diversity within farmers fields around Pueblo Nuevo and Condega stems from this project in that it has led to a continuous flow of breeding materials being brought into the area by the breeders to give to the farmers for further evaluation.

Other findings and lessons:

- Some farmers prefer to work with advanced materials in a form of PVS – to avoid the labour intensive work involved with segregating families. However, there are also farmers who clearly express a preference for receiving segregating materials, as this provides more opportunity to find the type of plant they prefer. This seems to provide an opportunity for a division of roles in a PPB process.

- The five parallel individual selection processes carried out by individual farmers leads to some interesting observations. It broadened the number of lines that were tested under varied conditions. However, at the end, only the work of two farmers resulted in a selected variety and this may have given the other three farmers the idea that their substantial efforts were wasted. As an alternative, after each generation the most promising lines of each farmer could be shared by all five farmers in next years' trials and so on. The advantage of this is that similar materials are tested in a range of (micro) environments covering the complete local environment and resulting in varieties adapted to the overall environment of the community.

- Farmers and the breeder consider that evaluation of culinary qualities may have to take place at an earlier stage of the breeding process. In this project the culinary qualities of the varieties were only compared at the end of the process. Farmers recognised that the JM-12-7 had good culinary characteristics, a soup made from it can be kept standing for 1-2 nights in an un-refrigerated kitchen. This important characteristic could have easily been absent in the best performing ones and suggests the need for early testing of material for such characteristics. However this is not easy, because the volumes of seed are small and insufficient for evaluation at an earlier stage.

7.7 Institutionalisation

The project started with some materials that happened to be available at the start of the project. Other new bean breeding populations have since been supplied by INTA. These included crosses of a number of local bean varieties that farmers themselves identified. Six local bean varieties were taken to EAP Zamorano where they were crossed with improved materials and and led to 300 F3 progeny lines planted at the INTA's experimental station near Managua in 2001. Of these, 80 progenies were selected and provided to farmers in Pueblo Nuevo. One of the 5 farmer-breeders has been taking care of these, selecting the 2 best performing progeny lines in 2004, to be compared with a control. The farmers have also received other advanced bean lines from the regional bean breeding programme and directly from a CIAT programme, (both via INTA). This shows that the breeders now find the farmers interesting partners to work with. On one occasion, the regional breeder has taken selected material from the farmers plot in order to use it again in his breeding programme, recogninising the good quality of the material.

So far, there is no clear vision as to how farmers' participation in INTA's breeding programme can become institutionalised. CIPRES and the INTA-breeder in Pueblo Nuevo/Condega have embarked on another initiative in sorghum and rice that involves CIAT-CIRAD in co-operation with INTA. This programme has a different form but links have been made between the two programmes and exchanges of experiences at the level of the farmers and breeders is taking place, facilitated by the regional PPB programme.

7.8 Management of products of PPB

Farmers in Pueblo Nuevo, with support from CIPRES, have formed a co-operative: COSENUP. This was considerd necessary to create a legal entity that could register the variety with the Ministry of Agriculture and Forestry in Nicaragua. The legal status together with the description of the variety and the data of the 48 validation trials (collected in co-operation of the INTA-breeder) and the availability of 40 quintals of seed in stock for commercialisation have been sufficient to register the variety. One of the two varieties had a partially red pod during the pre-mature period, which made it 'distinct' from other varieties. Without this chance characteristic, registration might have been more complicated. The variety was launched in October 2004, with the organisation of a big event in the village, facilitated by CIPRES and with the support of INTA. Newspapers reported on the event and the local TV station filmed and broadcasted it. Promotional leaflets were produced and distributed by CIPRES, and INTA and the varieties were displayed and promoted at an agricultural show in Estilí. Here (as well at other events) baskets with seed were put on display and people were encouraged to take a handful of seed. Not surprisingly, these baskets emptied quickly.

Under Nicaraguan seed law it is necessary to register varieties in order to be able to commercialise the seed . In addition, farmers were keen to prevent others from claiming ownership of the varieties by registering them and claim plant breeder rights. One seed middleman and producer already expressed an interest in buying volumes of the seed, presumably to multiply and commercialise. The co-operative now aims to organise seed production and distribution themselves. Initial transactions with a Nicaraguan NGO have already provided interesting financial returns on seed production. If all continues according to plan this project may well be the beginning of a farmer co-operative seed enterprise that benefits local farmers and strengthens the national seed system in a way similar to how the seed industry developed in industrial countries.

7.9 Outlook

Engagement in the development of new varieties and sustaining quality seed production are two major current challenges for the farmer co-operative. These challenges are at the centre of the second phase of the project. They now need to explore opportunities for linking with other initiatives and engaging in other crops. Maize is an obvious choice of crop. Five farmers have crossed their preferred maize variety (female) with three other maize varieties (males) through inter-planting and open pollination. Two of the male parents are local varieties that they have collected from a more northerly area where drought stress is more severe. The third one is an improved male maize variety that has shown fairly good performance in Pueblo Nuevo. The development of maize breeding materials is turning out to be more complicated than initially thought (problems with synchronisation of the flowering for crossing, one planting season per year and slow progress in mass selection) but has progressed quite well after a cycle of selfing and sib-selection. There is also a strong interest to start with sorghum and other activities based on experiences of another PPB project in the region are about to start.

7.10 References and details of the project

Almekinders, C., J. Molina Centeno, R. Herrera Torrez, S. L. Merlo Olivera; J.M. Gonzalez Suárez, J. García Carrasco, 2006. Experiencias y aprendizajes del desarollo de variedades de frijol de manera participativa en el norte de Nicaragua. Agronomía Mesoamericana 17(3): 327-336.

Almekinders, C., J. Molina, N. Alfaro & R. Herrera, 2002. Fítomejoramiento participativo en Nicaragua ya es un éxito para los involucrados. Cientificos y Agricultores Logrando Variedades Mejores. Memoria de la Asamblea Annual del Comité Mesoaméricano, Managua, Nicaragua, 28-30 de Mayo de 2001. Fondo de Desarrollo De Noruega/CIPRES, Managua. p 87-93. www.programa-fpma.org.ni (accessed February 6, 2006).

Almekinders, C.J.M., & A. Elings, 2001. Collaboration of farmers and breeders: participatory crop improvement in perspective. In: A. Elings, C.J.M. Almekinders & P. Stam (eds), Breeding for

low-input conditions, and consequences for Participatory Plant Breeding. Euphytica 122 (3): 425-438 (Special Issue).
Molina J.C., 2003a. Validación de cinco líneas mejoradas de frijol rojo en 26 localidades de los municipios de Condega y Pueblo Nuevo. Informe INTA-Estelí, Nicaragua.
Molina, J.C., 2003b. Validación de dos líneas mejoradas de frijol rojo en 41 localidades de los municipios de Condega y Pueblo Nuevo. Informe INTA-Estelí, Nicaragua.
Widengård, M., 2003. Intellectual Property Rights in common bean breding. Opportunities and constraints for local and participatory breding in Nicaragua. MSc thesis, Swedish Univeirty of Agricultural Sciences/Upsalal University

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8 WORKING WITH FARMER RESEARCH COMMITTEES IN PARTICIPATORY BEAN BREEDING IN HONDURAS

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8.1 Introduction: setting the scene

8.1.1 Origin of the initiative

The participatory bean breeding initiative in Yorito, Honduras, grew out of a programme of collaboration between la Fundación para la Investigación Participativa con Agricultores de Honduras, or FIPAH (previously known as IPCA), a Honduran non-governmental research and development organisation, local agricultural research committees known by the Spanish acronym, CIALs, and plant breeders at the Pan-American Agricultural School (Escuela Agrícola Panamericana, EAP), Zamorano.

The CIAL programme in Honduras developed from a pilot project set up by the International Centre for Tropical Agriculture (Centro Internacional de Agricultura Tropical, CIAT) in 1993. Following training in 1996 by CIAT in participatory research methods, FIPAH agronomists facilitated the establishment of CIALs in three locations in Honduras, including one in the department of Yoro in the north eastern part of the country. Today there are 24 CIALs for adults and nine CIALs for youth located in the municipalities of Yorito, Sulaco and Victoria in Yoro. Throughout this period, the CIALs that are



[2] The CIAL project in Yorito, Yoro (and also in Jesus de Otoro, Intibuca and Vallecillo, Francisco Morazan) is supported by USC-Canada and the Government of Canada through the Canadian International Development Agency (CIDA).

supported by FIPAH have received financial assistance from Canada through the International Development Research Centre (IDRC) and since 2000 from USC-Canada through its Seeds of Survival (SoS) Programme. Social scientists at the University of Guelph, Ontario, have been close partners with FIPAH throughout the process.

From the outset, the CIALs searched for crop management alternatives that would improve on their existing practices. This involved simple split plot trials in which new seeds or techniques were evaluated against current practice. EAP Zamorano provided most of the new germplasm for these experiments. After more than three years of experiments, conducted by the CIALs at multiple locations, it became clear to FIPAH and CIAL members that communities at higher elevations were not seeing many benefits from the newer technologies. In most cases their own seeds outperformed breeder's materials. This gave rise to the recognition of the potential for improving local bean germplasm through participatory plant breeding (PPB). There was a demonstrable demand for PPB from local farmers, which coincided with an opportunity for PPB funding provided by a small grant from the Consultative Group on International Agricultural Research (CGIAR) through its system-wide programme on Participatory Research and Gender Analysis (PRGA).

8.1.2 Problem addressed and local conditions

Beans in Honduras, as elsewhere in Central America, provide the poorest people with most of the protein in their diets. Farmers' bean varieties are mostly small in size and red in colour. Black beans are also consumed in smaller amounts in rural communities but they have little commercial value. Breeder's varieties have tended to be darker in colour than farmers' varieties and have frequently been rejected by farmers because of the low prices that they receive for these on the market. This, combined with the unreliable and frequently inferior yields of improved materials particularly at higher altitudes meant that poorer farmers, living in remote upland locations, had little interest in adopting newer varieties.

In spite of the disincentives to poor farmers to adopt breeder varieties, farmers readily admit that their own varieties are far from ideal. Through a visioning exercise, focus groups of Yorito farmers (17 women and 20 men) at higher altitudes came up with the following wish list of traits for their ideal bean:

- *(non-trailing) bush beans, 35-40 cm in height*
- *yields of 25-40 pods/plant*
- *disease resistant*
- *even ripening*
- *thick stem*
- *resistant to heavy rain and drought*
- *thickish pod to prevent the beans from sprouting during wet weather*
- *7-8 beans/pod*
- *longish, thick, heavy bean*
- *dark reddish colour, shiny*
- *easy to shell*
- *firm bean skin to prevent pest infestation in storage*
- *produces a thick soup when cooked and doesn't need lard*
- *expands in the pot*
- *soft, good tasting bean*
- *cooks quickly without much fuel*

Early maturity is also appreciated because it allows for food/income to be generated earlier in the season, which is particularly important in Yorito where the hungry period is lengthy and pronounced. However, there is a trade-off here against yield, and overall yield was considered by farmers to be the more important characteristic.

8.2 Local production and the seed system

8.2.1 Production system

As in many other parts of the country, Yorito, has a six-month dry season from approximately November through to May. Farmers plant beans twice annually: once in May/June, when the rainy season begins, for harvest in July/August and again in October, at the end of the rainy season, for harvest in December. Beans are produced for both consumption and for sale. Maize is generally only sown once per year: planted in June and harvested in September or October. Most hillside farmers only produce maize for consumption purposes; they generally do not own enough land to grow it commercially. Seed, traditionally selected by women at home, is generally saved from one cycle to the next. Other crops include coffee, grown at higher elevations, and small quantities of vegetables and fruits for home consumption. Soybean has recently been introduced through the CIALs.

8.2.2 Role of women

Women's responsibilities in Honduras typically include managing small livestock, chickens and pigs, close to home. Responsibility for maize and beans, often grown on hillsides far from the house or village, is generally left to men. When women do participate in agricultural tasks away from the house, it is limited to certain activities, such as the coffee harvest or pulling up beans. Usually their involvement in these activities is a sign of poverty, as local mores dictate that women's rightful place is in the home (Sturzinger, et al., 2000).

The inclusion of many women within the CIALs has bucked this trend. In Yorito, women make up around 40% of all CIAL members. This can partly be explained by poverty, but also partly by the indigenous backgrounds of many of the women. In addition the facilitation skills of FIPAH staff and farmer facilitators, which have provided a welcoming environment for women, have also contributed to this.

8.2.3 Seed System

The Honduran Government is responsible for seed regulation. In the past, it also played a key role in research but cutbacks in the early '90s saw much of the research function passing to EAP Zamorano, which conducts seed research both publicly and privately. Since the inception of the CIAL project in Honduras, FIPAH and the CIALs have been partners with Zamorano, testing out new germplasm as members of a network conducting regional adaptive trials. This has permitted Zamorano to acquire feedback on its materials from much less favourable resource areas than was previously possible.

8.2.4 Other important socio-economic and agro-ecological conditions

Like other poor farmers in the region, CIAL members report that climatic conditions have become more extreme over the past decade. Drought and torrential rains appear to be more common than anyone can remember in the past. Given the marked effect that the hungry season (*los junios*) has on people's lives, any perturbation in weather patterns that delays the start of the rainy season or lowers grain yield during the growing season is a cause of major concern to local people: hunger is never far away. The decline in coffee prices in the early years of this decade added to this concern and contributed to increased out-migration.

8.3 Organisational and institutional structures

The Yorito CIALs are the largest organisation of CIALs in Honduras: there are 105 men and 102 women members in 24 local (adult) CIALs. Nationally there are 710 CIAL members, spread across 80 CIALs in five regional associations, known as ASOCIALs. CIAL members in Yorito belong to the Yorito, Victoria and Sulaco ASOCIAL. Together the five regional associations make up the Honduran Federation of CIALs (ASOHCIAL). Information exchange between ASOCIAL chapters is common and farmers meet annually or biannually to present research findings to one another in national 'encuentros' or meetings. Thus the results of PPB are readily disseminated through the country's CIAL network to hundreds of other farmers who are equipped to test out new materials against their own seeds.

In Yorito, four CIALs (comprising 30 men and 23 women located in the communities of Santa Cruz, Mina Honda, La Patastera and Chaguito) carried out PPB in beans on behalf of other high altitude communities in the area. The socio-economic characteristics of CIAL members vary somewhat between communities. In Mina Honda and La Patastera, they are extremely poor as are most people in these two upland communities, and many are indigenous Tolupan. While most families have access to a small amount of land (1-2 manzanas or <1.5 has.), this is generally of very poor quality. In the other two communities, there is more variation amongst CIAL members: a couple of the members own around 5 manzanas, or approximately 3.5 has. In Santa Cruz, two CIAL members are also farmer facilitators working with FIPAH and have considerable knowledge of experimentation and are acknowledged leaders in the ASOCIAL. This is also true of one of the CIAL members in La Patastera. The inclusion of three farmer facilitators in two of the CIALs conducting PPB undoubtedly helped accelerate the knowledge generated by PPB. PPB is congruous with CIAL's methodology. CIAL members are familiar with conducting controlled experiments and members are generally regarded by others in their communities as leaders in innovation and research (Classen et al., undated).

8.4 Methodologies adopted in PPB and farmer participatory (breeding) practices

The research proposal submitted to the PRGA by Zamorano on behalf of the other partners (University of Guelph, FIPAH) sought to compare the results of three processes: PPB with farmers (on farm), conventional plant breeding (on station) and thirdly, distributing all materials generated on-station to farmers for selection in the 6th generation through single seed descent. EAP-Zamorano received funding from the PRGA to cover the costs of this PPB programme, including the salary of a recent Honduran agronomy graduate who had carried out his thesis research with the CIALs in Yorito. Under the guidance of FIPAH staff, the agronomist facilitated the PPB process in Yorito. When PRGA funding finished in 2002, he joined the FIPAH team as a staff member, continuing to support the PPB work, as well as being involved in other CIAL activities. He was an important line of communication, reporting results back to the scientists at Zamorano, who made few field visits in the early years of the project. Project decisions were jointly made by farmers and FIPAH.

8.4.1 Materials used

At the outset of the project, Zamorano provided segregating materials from F4 generations to participating CIALs to accustom members to the challenge of working with such materials. Most previous CIAL experiments had involved participatory varietal selection with F6- and more advanced materials and CIALs had little or no experience in working with unstable materials where characteristics present in one generation might not appear in the next. Farmers had to learn how to manage such instability.

While the farmers were practising with these first materials, the breeder crossed the most frequently utilised farmers' bean variety, Concha Rosada, with breeder's materials: Tio Canela-75, SRC 1-12-1, MD 23-24, SRC 1-1-18 and UPR 9609-2-2. A population of 120 families in the third generation (F3), in which Concha Rosada was the maternal parent, was sent to CIAL members in Yorito for the early planting (*primera)* in 2000. A second population of 105 families, in which Concha Rosada was the paternal parent was provided to CIALs in the *postera* cycle in the same year. The latter population failed to produce beans of a desirable colour and was subsequently rejected.

The original plan, outlined in the proposal, was to keep all the materials together in one 'collective selection site' in the community of Mina Honda until the F6 generation with the four different CIALs conducting field and post harvest evaluations with the F3-F6 materials at this site. Land was provided by a community member in exchange for maize provided by the CIAL. However, almost immediately the CIALs voted to decentralise the trials and the selections that they made in the F3-trials were taken back to their own communities at the end of that cycle. They felt this would permit greater genetic adaptation of the materials to emerge at an earlier stage in response to local environmental variations. The communities were located at different altitudes, between 1550 metres above sea level (La Patastera) and 1260 metres (Santa Cruz) with Mina Honda (1350 metres) and Chaguitio (1460 metres) located at intermediate altitudes.

8.4.2 Evaluation

Field Selection: Prior to the field evaluations a workshop was organised in Mina Honda by FIPAH for participants from the four communities. The workshop explained to participants the background of the project, its objectives, why they had been invited to attend.

After the workshop participants carried out an evaluation involving the identification of disease and other characteristics in the PPB (F3) beans. The groups were broken down along gender lines to gauge differences in selection criteria between men and women. Each individual participant toured the experimental plot, seeking out materials that met his/her expectations. Individual selections were marked by coloured tags and the information was subsequently collated by the secretary of each CIAL. A trained team noted down the criteria utilised by each participant in selecting or rejecting materials. In this way, the most widely used selection criteria within the communities, broken down along gender lines, were obtained.

This process involved the use of open questions, such as, "which criteria did you use to choose a particular family of beans", "what is a good plant height", "what is a good plant colour", "why do you think that trait is important", "what do you call that disease", "do you have anything else to tell us"? This allowed interviewers to get a clear picture of the guiding selection criteria employed by participants.

Fig. 8.1 Post-Harvest Selection from F6 Lines in the Community of Santa Cruz and Mina Honda, Yorito, Honduras (February 2002)



Grain Selection. Workshops on criteria of post-harvest selection and grain quality were carried out by FIPAH with the members of each CIAL team. Seed from each of the materials singled out during field selection was taken to each participating community. In each community a table and benches were set up on which to display the materials. The seed from each plant family was then placed on a plastic plate with a label displaying its code or name. Five men and five women from the team, or from the community were invited to observe the materials and comment on them. The other evaluators were kept at a distance so that they remained unaware of each other's choices. The preferred materials were marked and recorded by the secretary of each CIAL. The evaluators were also interviewed to find out the criteria for their decisions to select or reject a given material. These interviews consisted of questions such as, "which, in your opinion, is the best of the families that you voted for?" "Why do you consider it the best?" "Which other trait do you like in this particular family?" and "Why didn't you vote for this or that one"? The information gathered from these questions was then displayed on a flip chart to derive a scoring for each family. At the end, this information was analysed and consolidated to determine which selection criteria were the most important in that community. In subsequent analysis

the families that had the highest frequency in field and grain selection were selected to continue with the F4-planting.

A very diverse range of selection criteria were identified but the most frequent were: resistance to rust, Anthracnose and powdery mildew (Oidium); bush architecture (with a preferred height of 30-40 cm); uniform maturity and; a good yield (20-30 pods/plant). Farmers preferred a thick and heavy, longish bean. At this stage of selection, grain colour was excluded from consideration. Gender differences in selection criteria were not significant. It was noticeable that, although men had more experience in the field, the women found it easier to evaluate and select, rapidly seeing differences between traits in the different materials. Their evaluations and selections were often more discriminating than those of the men.

Figure 8.2 CIAL Members in Mina Honda revise Notes from Field Evaluations prior to making Post-Harvest Evaluation of F4 Trials, Selection of Families from F4 Trials in the field in La Patastera and from the harvested plants in Mina Honda (February 2001)

Selection was based on architecture, number of pods per plant, number of beans per pod, etc. Because of the threat posed by grazing animals in the community of Mina Honda, the beans had to be uprooted and brought back to the community for selection. Removal of the materials from the field clearly affected people's decision-making regarding specific environmental effects. This illustrates one of the challenges that PPB faces, compared to carefully controlled on-station breeding.

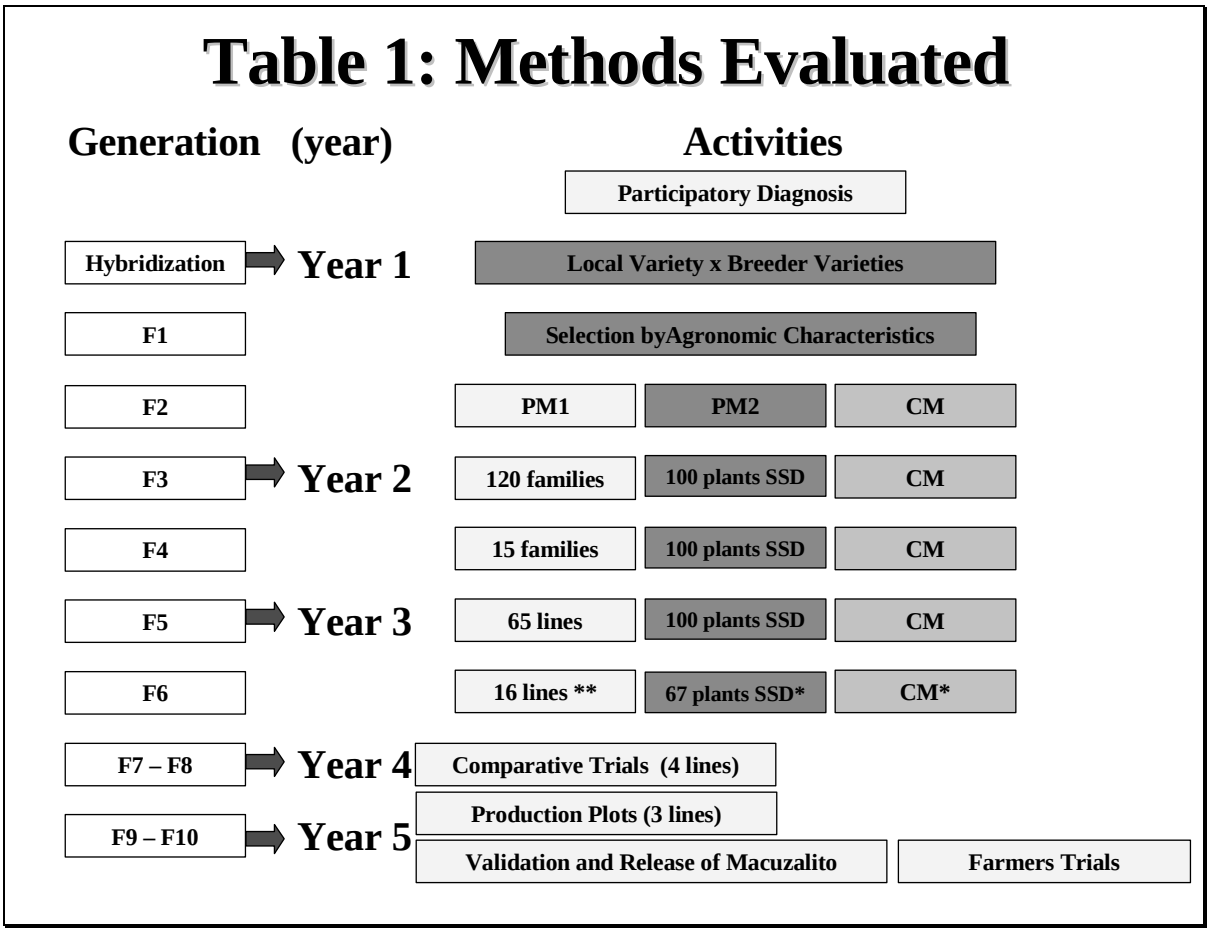






The field and grain evaluations continued in the four communities until the F6 stage, as described in Table 1 below. At that stage, 10 materials selected by the communities and 5 materials selected on-station at Zamorano were put into comparative trials, along with a local control, Concha Rosada. The participating communities selected quite different materials. This was partly due to different selection intensities and partly to different cultural preferences between the different communities. Other factors, such as environmental conditions, also played a role. For example, La Patastera CIAL made the broadest initial selections with members retaining more than 50% (63) of the original F3 materials. In F4 they selected 23 materials but then subsequently lost all their selections in F5 due to poor weather conditions. Two of the other communities, Mina Honda and Santa Cruz, over-selected at the outset (retaining less than 13% [15 out of 120]) which probably limited the genetic variability and hence the possibilities for making the best selections in F4. The fourth community, Chaguitio, retained 19% (23 families). In short, selection in this first attempt at PPB occurred by trial and error with both farmers and the NGO learning along the way. In the following table, only the selections made between F3-F5 in Mina Honda (the original collective site) are recorded. The complete list of materials put into F6 trials resulting from selections made by the three communities, as well as by the breeder, is given in the legend below Table 1

Table 1: Methods Evaluated



Legend:

PM1 = Participatory Management 1 (PPB conducted by farmers from F3 in the community of Mina Honda).

PM2 = Participatory Management 2 (Single Seed Descent. At F6, *67 materials were provided to CIALs by Zamorano for participatory selection in separate trials. None were eventually selected by farmers).

CM = Conventional Management (Materials selected on station at Zamorano.

*5 best bet materials were provided to farmers for inclusion in PM1 F6 trials).

**F6 trials contained materials selected as follows: Zamorano: PPBY-5, -9, -11, -13, -15; Mina Honda: PPBY-1, -4, -6, -10, -12, Santa Cruz PPBY-3, -8; Chaguitio: PPBY-2, -14, -7 + plus the local control (Concha Rosada). La Patastera lost its F5 materials due to excessive rain and cold weather. The F6 trails were conducted in the 4 communities: Mina Honda, Sta. Cruz, La Patastera, Chaguitio.

(*FIPAH, ASOCIAL, adapted from field display chart, 2004)*

8.5 Results

As demonstrated in Table 1, farmers selected four lines for advancement from the F6 trials; all four of these selected materials came from the local PPB trials, none of the breeder's selections were advanced beyond the F6 level. The results of the F7 trials are given in Table 2.

One of the lines (PPBY-1) was discarded in F8 trials owing to unfavourable agronomic traits. Three lines (PPBY-2, PPBY-14, PPBY-8) were advanced for production and subsequent validation. Macuzalito (PPBY-8) was later released as a new variety in August 2004 in the municipality of Yorito. As shown in Table 3, this variety was considered by farmers to show the best overall traits; the other two varieties had good individual traits but contained at least one drawback, such as poor commercial colour or comparatively lower yield than Macuzalito. Nevertheless, these varieties were kept for local use because of their useful characteristics, such as earliness in the case of PPBY14 (an important trait as it helps to shorten the hungry season) and high yield in the case PPBY2, which was beneficial for food security.

Table 8.2. Average yields (kg/ha) in Comparative Trials in Three Yoro communities, Spring 2002 (adapted from Humphries et al. 2005).

No.	Line*	Santa Cruz	Mina Honda	La Patastera	Total	Average
1	PPBY-8	1823	1686	2727	6236	2079
2	PPBY-14	1648	1629	2822	6098	2033
3	PPBY-2	1686	2008	2292	5985	1995
4	PPBY-1	1515	1610	2405	5530	1843
5	C. Rosada**	1515	1175	2386	5076	1692
6	Tío Canela***	1563	1023	1705	4290	1430

*Lines selected from F6 trials: Mina Honda: PPBY-1; Chaguitio: PPB-2, -14; Sta Cruz: PPBY -8
**Local Control
***Universal Control

Table 8.3. Farmers' evaluations of PPB Varieties (Humphries et al, 2005)

Attributes	**PPBY-8 (Macuzalito)**	**PPBY-14**	**PPBY-2**
Maturity	Moderate	Early	Late
Uniformity of maturation and colour	Uniform with attractive red colour	Uniform but a lighter red colour	Uniform but with white pods*
Disease tolerance	Medium	Medium-low*	Medium-high
Architecture	Excellent, medium height with well distributed pods	Good, low height* with well distributed pods	Good, medium height with well distributed pods
Yield	Good yield	Regular yield	Excellent yield
Commercial value	Good	Good	Poor*

*Traits considered unfavourable by farmers

8.6 Reflection on Experiences

8.6.1 Empowerment

As mentioned before, PPB is a special case of participatory research with the CIALs. As with other shared CIAL experiences farmers feel they have learnt a great deal, and have come out of that experience feeling greatly empowered. This has been especially true of PPB since farmers have not only acquired new knowledge through undertaking PPB (working with segregating materials, etc.) but they have also succeeded in creating a new variety from their own local material. This is a source of great pride as it signifies the importance of local seed conservation by communities: the farmers are very aware that the successful outcome of the programme was due to them having conserved this material locally. This has provided a real impetus for the conservation of agro-biodiversity and, with the support of USC-Canada, seed banks have been set up in 6 communities to continue this.

CIAL members are cognisant of the time and energy that they have invested in this process, in other words, of the opportunity cost of their labour, but they still think that it has been worth it overall. They feel they have invested in their future. Women, feel particularly empowered as they have acquired new knowledge in an area formerly largely controlled by men. The recognition that CIAL members have received from other institutions has also been a powerful motivator for them, along with getting to know new people, networking, etc. Other benefits are less closely associated with PPB *per se*, but rather have come to them from their CIAL membership. These include access to loans, tools, information and from the development of community infrastructure (e.g. meeting rooms).

Participants also mentioned difficulties encountered; the length of the process and the poor weather which caused set backs and made the process even longer than anticipated. Some CIAL members had a hard time understanding PPB and had to be carried along by others in the group. Illiteracy was felt by some to be a real handicap that prevented people from fully grasping the process.

In a reflection on the process three of the CIALs engaged in the project came up with the following definitions of PPB:

- CIAL Mina Honda: "*It is to improve a variety, get rid of the bad things that it has through crossing it with improved varieties and so obtain a better harvest. And it is participatory, involving the participation of men, women, technicians and organisations*."
- CIAL Santa Cruz: "*It is a process in which we make changes in the varieties, exchanging ideas with different actors: technicians, farmers and scientists*".
- CIAL La Patastera: "*It is to change a variety: its appearance, its form, yield, etc. taking into account the criteria and experiences of all of the group or the community*."

8.6.2 Genetic Selection and Diversity

One of the side benefits of PPB has been to substantially increase genetic diversity in the participating communities. For example, in Mina Honda, the community has gone from relying almost solely on Concha Rosada to utilising a number of new PPB varieties: apart from Macuzalito, Mina Honda residents have also adopted Liberal (PPBY10), Dominguez (PPBY2) and Santa Marta (PPBY14) - varieties derived from the 15 lines evaluated during F6 comparative trials, which were multiplied and retained for local use. In addition members selected a variety known as Marcelino from one of the early segregating materials that the breeder gave them to practice with at the very outset. One CIAL member from Mina Honda also retained a few lines from F5 trials, took them back to her plot and together with her husband advanced these independently, eventually selecting one variety known locally as La Esperanza. Other earlier PPB materials discarded by the CIALs are undoubtedly present in the four participating communities and in local use. In addition, farmers have become reacquainted with a host of landraces, such as Pedreño, Careto Negro and Rojo, Bocado, Carmelito and others. Thus PPB has played an important role in highlighting the importance of conserving landraces. In these respects PPB has contributed substantially to increased local agrobiodiversity.

8.6.3 Other Findings and Lessons:

At the end of the PPB activities, a workshop was conducted in each participating community to gauge the reaction of CIAL members to the overall process. A great majority of participants said they would prefer to work with early generations (F3) in the future, and some would prefer to carry out the crosses themselves. As people said, "in this way we learn more about how to improve seed" and "it is like

raising a child and seeing it grow, knowing the part you played in it". A few said they had invested too much time in PPB and would prefer to start at F6; even less said they would prefer to restrict themselves to validating new materials.

The preference to continue with PPB expressed by the majority of CIAL members is not surprising. In spite of the fact that advanced breeder materials have been, and continue to be, evaluated by the CIALs, they have not produced the anticipated results. While a few of the materials, e.g. Amadeus-77, are being used by farmers in low-lying areas, none of these materials have been adopted by farmers at higher elevations.

8.7 Institutionalisation of PPB

Macuzalito was 'released' in August 2004 and has since been tested and multiplied in 30 locations. CIALs in the ASOHCIAL are leading this process and results are being shared between the members of the different regional associations. While the 2004 release took place at the municipal level, CIAL members still dream of having Macuzalito released at the national level once the extent of its adaptability has been assessed.

Macuzalito is being further improved by scientists at Zamorano through the inclusion of genes for resistance to Angular Leaf Spot Disease. To this end, 22 lines of Macuzalito have already been evaluated in Mina Honda, leading to the selection of five lines that are more resistant to the disease than the parent. These five lines were being evaluated at the time of writing. The same 22 lines are also being tested out by another CIAL (Ojo de Agua) in a different region of the country. Thus the improvement of Macuzalito is already under way, as are trials to test its adaptation in other regions. Whether PPB will be institutionalised through scaling out the farmer improved seed generated by the CIALs, or by seeking to introduce PPB into other communities where a CIAL does not exist, remains to be seen. However, given the skills involved, and the time and resources needed to support their development, it may be worthwhile to focus on the CIAL federation, rather than trying to replicate this process in communities where such skills and organisational forms are lacking.

8.8 Management of the products of PPB

In August 2004 a special act of the Municipal Government of Yorito recognised the Yorito, Victoria and Sulaco ASOCIAL as the rightful owners of Macuzalito; and prohibited commercial use of the seed. But can this be enforced? CIAL members have the advantage of knowing how to manage PPB but are not in a position to profit from it commercially. They have small properties, inadequate for commercial production. This means that others may become the beneficiaries of their investment and labour. And this is proving to be the case. Following the release of Macuzalito, several CIAL members involved in the PPB process sold seed to wealthier farmers with access to irrigation. Supported by a large international NGO these farmers have multiplied up Macuzalito in order to sell it back to the NGO for distribution. Similarly, FIPAH has purchased seed from the participating CIALs to take to other CIALs for testing in their regions. While this is certainly beneficial from the perspective of up-scaling, there is little payback for CIAL members other than the personal satisfaction of knowing their seed is helping other poor farmers. It is hard to imagine that such altruism will stand the test of time and it is likely that some form of monetary incentive will be required in the future.

8.9 Outlook

If PPB is to endure as an alternative to conventional breeding it may be necessary to provide appropriate incentives for participants. Since there is no readily available mechanism available to provide protection to seed created by farmer breeders (and farmers do not appear interested in seeking protection), breeding contracts should be sought to subsidise the difference between the external (social) benefits from PPB and private returns accruing to farmer-breeders. NGOs which support PPB

will need similar financial assistance. PPB cannot follow the pattern of so many other activities that have been downloaded into communities without available funds to support them. While PPB is an exciting new activity it does, like all research, involve costs and these will have to be factored into future planning.

8.10 References

Beaudette, A., 1999. Household wellbeing and natural resource management in three rural communities in the municipality of Yorito, Yoro, Honduras. MA thesis, University of Guelph, Canada.

Classen, C., S. Humphries, J. Fitzsimons, S. Kaaria with the Foundation for Participatory Research with Honduran Farmers (FIPAH) and the Association of CIALs (ASOCIAL) of Yorito, Victoria and Sulaco. "Beyond Food Security: Seeking Innovation Oriented Sustainability through Participatory Development with Asset Poor Farmers". (unpublished paper – currently under review).

Humphries, S., Gonzales, J., Jimenez, J., Sierra, F. Searching for Sustainable Land Use Practices in Honduras: Lessons from a Programme of Participatory Research with Hillside Farmers. AgREN Network Paper No. 104, ODI, UK. July 2000.

Humphries, S., O. Gallardo, J. Jimenez, F. Sierra with members of the Association of CIALs of Yorito, Sulaco and Victoria. 2005. Linking Small Farmers to the Formal Research Sector: Lessons from a Participatory Bean Breeding Programme in Honduras. *AgREN Network Paper* No. 142, ODI, UK. January 2005.

Sturzinger, U. & Bustamente, B., 1997. La distribucion de tarea entre hombres y mujeres en el area rural: resultados de un diagnostico participativo aplicado en comunidades rurales de Honduras. Colección ASEL, Agricultura Sostenible en Laderas, Tegucigalpa.

9 ENHANCING FARMERS' ACCESS TO SORGHUM VARIETIES THROUGH SCALING-UP PARTICIPATORY PLANT BREEDING IN MALI, WEST AFRICA

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9.1 Introduction: setting the scene

9.1.1 Origin of the initiative

This project was initiated by ICRISAT, following the realisation that West Africa's sorghum breeding programme was in need of a complete re-orientation (see below). Two plant breeders (Dr. E. Weltzien and Dr. H.F.W. Rattunde) with extensive experience in participatory plant breeding were given responsibility for this task.

The project is being carried out in collaboration with the NARS, NGOs, farmer organisations and the University of Hohenheim, Germany. Project coordination and scientific leadership is being provided by a team of ICRISAT staff members, consisting of the team leaders (see above) Benoit Clerget (crop physiologist) Ibrahima Sissoko (*Striga* and pathology specialist) and Aruna Sangaré (research technician). Leadership for social science activities has been assigned to Sonja Siart (agricultural social scientist) from the University of Hohenheim.

Other collaborating institutions are:

- **NARS:** Institut d'Economie Rurale (IER)
- **Farmer groups:** Union local des producteurs de céreales à Dioila (ULPC), Association des Organisations Professionelles Paysannes au Mali (AOPP)
- **NGOs:** Association Conseil pour le Développement (ACOD)
- **Government extension services:** Service Local d'Appui Conseil d'Aménagement et d'Equipement Rural (SLACAER), Office du Haute Vallée du Niger (OHVN)
- **University:** Institute for Social Sciences of the Agricultural Sector, University of Hohenheim, Germany.

Funding has been provided by the CGIAR and the German Ministry for Economic Co-operation and Development (BMZ); and in 2005, additional funding was provided by USAID for the Mandé zone (PRODEPAM project), and by IFAD, through an IPGRI managed Technical Assistance Grant on managing on-farm diversity.

9.1.2 Problems addressed and local conditions

In 1996, ICRISAT conducted an economic impact assessment of its Sorghum and Pearl Millet Breeding Programme in Mali (Yapi et al., 2000). This covered the major production regions of these crops in Mali and revealed that farmers' adoption of newly bred varieties, particularly those not resembling the local *guinea*-landraces types, was very low. When farmers did adopt new varieties they were almost exclusively purified *guinea*-race sorghum landraces, selected from local materials. Such selections have only a small yield advantage compared to traditional landraces, their main advantage being their slightly earlier maturity.

This impact assessment provided a point of departure for re-orientating ICRISAT's sorghum breeding programme in West Africa, with the aim of redefining breeding goals so that they accorded more closely with farmers' preferences and needs (Weltzien, 2005, p.120-121). The project aims to support farmers' efforts to improve the productivity and stability of sorghum production by increasing their access to new varieties which they are more likely to adopt. The project recognises the importance of developing institutional and organisational mechanisms to enhance the flow of genetic resources and of information, both among farmers and between farmers and researchers. This is mainly being done by strengthening farmer and community organisations and their linkages to research organisations, and by scaling-up participatory testing of varieties and decentralised seed production so as to reduce the time-lag between variety development and adoption.

9.2 Local production and seed system

9.2.1 Production system

Sorghum (*Sorghum bicolor* (L.) Moench) is the fifth most important crop in the world and is the typical staple crop in the 700-1200 mm rainfall zones of Mali, where the soils are not too sandy. On very sandy soils and under low rainfall conditions, pearl millet is grown instead of sorghum, and in the higher rainfall areas (above 1000 mm), maize is the predominant cereal.

The project's activities are concentrated in two regions of southern Mali: Mandé and Dioila Cercle. Both areas have similar agro-ecological conditions, a mean annual rainfall of between 800 and 1000 mm and 4-5 months of rainy seasons (from May/June to September/October). However, there are great differences between the regions in terms of the degree of market-orientation, mechanisation, infrastructure and organisational development. Dioila is one of the longest established cotton production areas of Mali; and has higher levels of market-orientation mechanisation (animal traction) and use of external inputs than the Mandé district, where cotton is less important as a crop and farmers have in the past had less access to loans and equipment.. Sorghum is the main staple crop in both areas, but maize, pearl millet and rice are also cultivated.



Fig. 9.1. Mandé is about 60 km west of the capital Bamako and Dioila about 160 km southeast of Bamako, in the triangle between Bamako – Sikasso – Ségou.

Sorghum is generally grown on soils that are unsuitable for cotton, for example those characterised by one or more of the following conditions: shallow soils, acidity, low nutrient availability or slopes. It may also be grown in rotation with cotton, or with cotton and maize. In such situations, the sorghum crop can profit from residual fertiliser effects. In areas and farms where cotton is an important crop, sorghum becomes of secondary interest to the families, is frequently sown and weeded late and is not thinned after plant establishment.

Farmers grow sorghum on two different types of fields: bush fields and house fields. The former are quite distant from the village, and are where the bulk of the harvest is produced. Due to the large distances involved and associated transport problems, these fields usually receive only small quantities of farmyard manure. The house fields are located near to, or within, the village, and receive much more manure, as the farm animals are tied up there at night in the dry season. These fields are sown later than the others as the animals continue to graze there at the start of the rainy season. Yet the fields also receive more attention as they are closer to the houses and bird scaring, for example, is more practical. In cotton growing areas, the differences between bush and house fields are reducing, as farm families are increasingly moving into hamlets closer to their bush fields, to reduce transport distances.

In Mali, as in other West African countries, agriculture is the main source of livelihood. Land availability is generally not a limiting factor for cultivation. Population densities are low, and fallow periods are still long in some areas. They are however shortening, and land disputes between farming and pastoral communities can take violent dimensions, due the increased pressure caused by population growth.

Agricultural land is not privately owned. Land use is governed by user rights, which tend to be administered by a *chef de terre* for each major lineage in a village. A recent decentralisation of government powers has made the communes the guardians of their natural resources, including land. A *commune* is composed of several villages and has elected officers. The traditional village chiefs and rules continue to govern land use, but efforts to privatise land ownership are underway, and have are already been implemented in some peri-urban areas.

Farm households in the two project areas tend to be extended families headed by a *chef de famille*, usually an older man. They are typically composed of several nuclear families which are related to each other. The households or *unités de production agricole* are usually defined as people who eat together. This normally means that they also work together, at least in the family fields. Individual family members also work their own fields and some work in groups to earn cash; others do social work for the village as members of a local organisation.

9.2.2 Role of women

Sorghum is mainly grown for subsistence, with only some degree of commercialisation observed in the Dioila region.Cotton is the main cash crop in the system, followed by groundnut, which is typically a women's crop. Sorghum is primarily a men's crop, usually grown in the family field. Every male family member and unmarried girls spend a certain number of days per week working in the family field. Women also grow sorghum, usually as an intercrop in their groundnut fields. The women's sorghum crop is often grown to feed their children. Some women also grow sorghum as a cash crop, often as part of a group which cultivates a field together and sells the harvested grain.

Generally, women rather grow groundnuts and rice, mostly in inland valley areas where water collects during the rainy season. In some areas they may grow sorghum around the rice fields, where there is some water but not enough for rice. In the dry season, older women sometimes grow vegetables on small plots with irrigation. Men tend to be responsible for land preparation, ploughing, sowing and weeding, sometimes assisted by young women and girls. Harvesting is done jointly by all family members; members of different households may work together to finish individual fields more quickly.

As sorghum is mostly a men's crop, the selection of panicles to be kept as seed is done by men, particularly the older men, and only by women if they grow different varieties of sorghum on their own plot. Old women sometimes engage in panicle selection, for example if the man is sick or absent.

9.2.3 Seed system

A detailed seed system analysis in the two study regions showed that most farmers produce their own sorghum seed and rarely obtain seed from other family members, neighbours or the market. A formal seed market is basically non-existent for sorghum in these areas.

Most farmers select panicles for use as seed prior to the harvest, and store them separately from food grain. Each family keeps 1-3 and in some cases up to 5 or 6 different varieties of sorghum, which vary in the time it takes them to mature, their adaptation to different soil conditions and uses. On a village level, 10-15 different varieties of sorghum can be found.

A positive aspect of the seed system is that the farmers maintain a large number of varieties. Furthermore, selection of panicles for seed is an important skill of farmers, and many of them test new varieties on their own land and multiply seed for their own use. New varieties are mostly acquired through personal relationships (conversations with other farmers, travel, and sometimes from grain markets). They also receive small quantities of seed from other farmer as gifts or bigger quantities in exchange for other grain (usually on 1:1 exchange). (Diakite, 2003; Siart et al., 2005). Selling seed of the traditional staple crops is a taboo in traditional society.

The main weakness of this system is that access to new varieties from the formal system, i.e. breeding programmes or gene banks, is very limited. The National Seed Service only produces small quantities of sorghum seed, and does not have a strong marketing programme. Moreover, the exchange of varieties, seed and information among farmers is slow and geographically limited.

9.2.4 Other important socio-economic and agro-ecological conditions

Agro-ecological conditions in the sorghum production zone of Mali have markedly changed over recent decades. The length of the rainy season has decreased since the severe droughts of the early 1970s, and mean annual rainfall in the Sahel in the thirty years to 1997 was between 20-49 per cent lower than in the period between 1931 and 1960 (IPCC, 2001).

Soil fertility is also changing. It is decreasing in the bush fields, due to shorter fallow periods, but is increasing on those fields where cotton is grown, due to use of mineral fertilisers in cotton production. Therefore, there are demands for sorghum varieties that could profit from residual fertiliser effects and others that are adapted to low-input conditions.

Lack of labour is an important limiting factor to agricultural production. There is a general trend for people to seek sources of income outside of farming, for example through part-time jobs or temporal migration, and children and young people increasingly go out to school. This trend can only partly be compensated for by mechanisation; less than 50 per cent of the farm households in the project area have oxen for animal traction, and tractors are not used at all. People commonly have to sell their oxen in low rainfall years.

9.3 Organisational and institutional structures

The main partners in this project are ICRISAT and IER, with support from the University of Hohenheim (National Sorghum Breeding Programme) as research institutes, and one farmer organisation in each project area. ICRISAT established agreements with each partner organisation, defining each organisation's overall responsibilities. The specific responsibilities of each partner, their work plans and budgets are established annually based on agreements made in village meetings and the approximately 50% per cent of the agreed budget is transferred to each of the partners at the beginning of the year, and the rest is transferred once 75% per cent of the first fund tranche is spent and documented with receipts.

The main partners are farmers' organisations. In Dioila this is the Union Local des Producteurs de Cereales (ULPC), a large union of 56 village level cooperatives formed to facilitate bulk commercialisation of cereal grain. The village level cooperatives are grouped in five communal level organisations which all have representatives on the coordination committee of the overall union. The union has a farmer president who is assisted by a professional accountant. It has a permanent office in Dioila. The ULPC was initiated by aDutch Development NGO SNV. SNV continues to support the evolution of this organisation.

In the Mandé area the main partner is the Association des Organisations Professionelles Paysannes (AOPP), a national association of farmers' organisations. AOPP has three active member organisations in the Mandé area, which have very different objectives and activities. AOPP does not have a specific representative for the Mandé area, but has an office for the whole of the Koulikoro Region, which includes both Dioila and the Mandé.

For the purpose of this project a trained technician with experience in variety testing, and technology exchange was seconded to each of these organisations. Their primary role is to facilitate interactions between the researchers and farmers and to assist with the technical supervision of breeding activities.

Generally the main technical support for the breeding activities comes from the locally based state extension service. In the Siby commune (Mandé) this role was taken on by ACOD, a local NGO, as the extension service is not strongly represented there. This NGO has a long-term presence in this commune, implementing a variety of projects relating to food security and income generation. They have been very successful in mobilising local farmers, and have established a network of village level *animateurs*, who facilitate project activities in their villages. The project supports these services with some additional operating funds.

The project activities are planned on a yearly basis. In each of the two project areas a planning meeting is organised well before the start of the rainy season. All partners and nearly all the villages where trials take place send representatives to these meetings, where the results from the previous season are presented by the researchers. These are discussed in detail in commune level working groups, to identify those varieties to be retained for further testing or for seed production. Revisions to the testing methodology are also discussed, as are specific roles and responsibilities and the training schedule for the different partners.

9.4 Methodologies used for farmer participatory breeding

9.4.1 Materials used

Exploratory variety evaluations conducted in different sorghum cultivation areas in Mali had shown that farmers were in need of higher yielding sorghum varieties which are well adapted to the local conditions (climate, soil fertility and parasites). Both ICRISAT and IER programmes were shifting the emphasis of their work to achieve these goals.

In Mali the *guinea* race dominates sorghum productionin the Sudanian and North Guinean agro-ecological zones. This race differs from the *caudatum* and *kafir* races, which make up the bulk of the breeding materials which have been advanced in other regions of the world. The main differences include its growth habit (3-5 m height, low tillering), photoperiod sensitivity, grain and panicle characteristics, as well as good adaptation to low soil pH, and poor fertility. To date, this race has received very little attention from professional plant breeders.

The ICRISAT programme diversified a population based on a broad range of guinea-race landraces with sources of later maturity and short plant height and using male sterility. Using large population sizes for crossing and backcrossing several new populations were created for selection with farmers. Farmers have been involved in the development of these materials on-station, by conducting mass selection in the random mating generations. Farmers have also selected progenies for further testing, and random-mating.

The IER sorghum breeding programme is using a wide range of materials based on interracial crosses between *guinea*- and *caudatum*-race parents, based on a pedigree breeding approach (see box 9.1).

Box 9.1. The breeding strategy

The ICRISAT programme increased its use of a *guinea*-race specific population, which had been inter-mated using a gene for male sterility. This gene came from a generally unadapted source of the *caudatum* race of sorghum, which also carried dwarfing genes. The *guinea*-race parents were 14 landrace varieties from Mali and Burkina Faso, which were back-crossed twice to the donor of the genetic male sterility gene. This population was diversified by crossing it with varieties that were of specific interest to farmers or germplasm accessions from other West African countries which had traits of interest, i.e. photo-period sensitivity, strong expression of specific yield components such as large grain size or high numbers of grains or midge resistance. Population crosses between the individual new varieties were made onto a minimum of 50 sterile plants of the population. Single plants from these single plant crosses were selfed for two generations before selecting lines for an initial on-station yield trial.

In all cases S_0 plants cases were selected in isolation plots with input from farmers. Farmers visiting the research stations selected preferred individual plants by tying a ribbon around them. During the single plant harvest, both in the isolation plots, as well as during the following pedigree selection, a breeder and a farmer worked together to ensure that all important plant, panicle and grain traits were considered during the selection process. The S_2-generation derived lines, which were then once multiplied as bulks to provide sufficient seed for the on-farm testing. At the same time these S_2-lines were grown in a preliminary yield trial to select entries for the farmer managed yield trials.

9.4.2 Farmer-breeders and the group

We distinguish here between the different project activities and how they were organised:

Conducting large scale yield trials

From 2003 onwards, the project organised variety testing in 10-12 villages and on 3 research stations. The same 32 varieties were grown at each location. Some varieties changed from one year to the next.r

Eight of these villages were situated in Dioila district, the more intensive agricultural area. Many farmers there are literate and well organised. Five sites were managed by the farmer organisations which form part of the ULPC and three were managed by village organisations, initially formed to manage cotton production.. The researchers had already developed good working relationships with these latter organisations, through collaboration with the extension service of the cotton para-statal Compagnie Malienne du Developpement des Textiles (CMDT). In the Mandé area, villages were suggested by the extension partners, who had longstanding relationships with many villages.

Participating farmers were chosen by the farmers' or by the extension services/NGO. The fa. THermers were responsible for selecting the field for the trial and two local control varieties: one common to the whole village and one of specific interest to the farmer who provided the field. Four farmer participants, together with the technician, chose the village level control variety one of the main varieties used in the village. The farmers were involved in the choice of other entries in the following manner:

1. Some varieties were retained from a precursor trial, based on farmers' choice and yield in the trials.
2. Farmers involved in the trials visited the ICRISAT research station during the pre-harvest period. They were shown the S2- progeny trials from the diversified *guinea*-race populations, from which they could select entries for their trials. They scored each plot from 1 to 3, using colour-coded pieces of paper. Farmers' preference was one main criterion in choosing varieties for the trials.
3. Farmers did not, however, visit the IER breeding stations, and thus experimental varieties from IER were primarily chosen by researchers. However IER conducts some of its selection programme in close collaboration with farmers and thus some materials had been selected by

farmers in other areas. The entries were fixed lines, which had previously been tested in multi-location station trials.

Farmers were responsible for managing the trial field and for visual evaluation of a range of previously agreed upon traits. Farmers received a basal dose of N and P fertiliser, which they applied at sowing time and the seed was treated (if the treatment was available in the local market). Each farmer grew one replication of the 32-entry trial. The 6, 5-metre long, row plots were arranged in 4 ranges of eight plots, and randomised as alpha lattice designs with 4 plots per block. Students and local extension officers supported the farmers with sowing, plot identification, recording of observations, management decision-making, and at harvest. Weighing the yield of each individual plot was a key responsibility of the technical support staff. They also arranged for other farmers to visit the trail plots and for testing the grain for its processing and culinary qualities (see below).

In the Mandé region, where agriculture is more extensive and less cotton is grown, the same trials with 32 entries were undertaken in four villages and were supported by government or NGO extension agents. Responsibilities were shared in the same manner as in Dioila.

Farmer visits to the trials were organised at one research station and in at least 10 villages each year. All the visiting farmers scored all varieties for their overall performance and acceptability, on a scale of 1 to 3 (again using colour coded paper slips) (Christinck et al., 2005, p.96). After harvest, a two-day workshop was organised for each pair of neighbouring trial sites to discuss the yield results and to evaluate grain and culinary qualities. On the first day the results of the yield evaluations, the farmers' selection, and other key observations were presented to participating farmers and other interested villagers. The results were discussed and four varieties were chosen for evaluation of processing culinary quality on the following day. Participants were also invited to evaluate the grains of each variety visually, using the same scoring system.

After these tests, further workshops were held in each project zone with all the participating farmers to discuss the outcomes of the first year's trails, identify those to be carried forward for further testing and any necessary changes in the management of the trials, their monitoring and the diffusion of results.

Some of the entries were retaie for a second year of testing, if their performance and farmers preference were superior to the controls, and if they were acceptable for local processing, and culinary characteristics

Participatory on farm variety evaluation

The four selected entries – and, in most cases, one control variety – entered the second stage of testing, which was done on larger plots and under full farmer management. A minimum of 4 farmers grew the trial varieties in each test village. They received 100g of seed of each variety, along with a form in the local language for recording their observations and opinions. In the first year of these trials, farmers were asked to grow 10 row plots of 12 metres length. In subsequent years farmers chose their own plot dimensions, provided that all the plots in one field were of uniform size. Farmers were free to choose the conditions under which they want to test these varieties. Some farmers started to test them in intercropping arrangements with groundnut or early maize. Each farmer grew one replication of the trial.

The selected varieties differed between the two project areas and the different villages. Selection was influenced by the choices made by villagers at the village meetings, the trail results obtained and by the general preferences of farmers in each area. The large-scale testing of 4 to 5 varieties was conducted under the leadership of farmers, several extension services and NGOs in 60 villages of Mali, including those beyond the initial project areas.

Seed production by farmer associations

The researchers initiated a seed system analysis, combining formal questionnaires and participatory tools (such as classification exercises and 'four square diversity'). They also initiated a study to follow up experimental sales of seed to farmers made by the government extension service (Diakite, 2003; Siart, 2005).

All seed distribution activities have to take into account that farmers usually cannot directly sell sorghum seed to other farmers, as this runs against traditional rules. In 2003 and 2004, each of the farmer organisations founded farmer committees for seed production. In the Dioila zone this was primarily an internal process of the farmers' union ULPC. In the Mandé zone, the AOPP representative involved all the key stakeholders who formed a committee to cover the two communes in the project zone. The aim of the committees is to initiate decentralised seed production of farmer-preferred varieties, and to organise distribution at the community level in a non-traditional way. The committees are responsible for planning production, distribution and financing and they have appointed a board to co-ordinate these activities. Some external input and training is still required, for example in financial planning and marketing. The community level committees and the central office of ULPC have been selling seed of four different varieties. They sold 600 kg to some 150 people.

In the Mandé region the farmer committee organised a seed fair which gave the seed producers an opportunity to sell their seed at a jointly agreed price. More importantly, the seed fair provided wider access to these new varieties of seed and farmers who had experience with these varieties were able to provide information to those interested. The fair also attracted a local vegetable seed trader who started to sell the seed of these newly developed sorghum varieties. Similarly a small farmer-group which normally purchases inputs also started selling these seeds. On the second day of the fair, farmers also started trading seed of other species, especially rice and maize. Three sorghum varieties were offered for sale, some produced by different farmers from different villages. In total, approx. 700 kg of seed were sold to a total of 300 people. Evaluations of these seed sales are ongoing.

Training

Training is an important part of the project, which strengthens the capacities of farmers, farmer groups and extension agents who are involved in the project. The extension agents and one village level animateur (in the Mandé region), usually a literate farmer, received half a day of training monthly on a topic related to the implementation of these trials. The village animateurs and all technical staff also received one week's training in participatory breeding tools. A manual was produced in French and Bambara for this course. The animateurs and extension agents then shared the results of the training with other participating farmers, with the assistance of specially hired communication specialist. The need to assist farmers with financial planning for seed marketing was initially underestimated and the need to develop suitable training programmes has been identified.

9.5 Results

9.5.1 Selection

The main selection criteria were related to increased yield potential and responsiveness to soil fertility, while assuring adaptation to locally important stresses (such as unpredictable sowing dates, soil acidity and *Striga hermonthica* infestation) and meeting food quality requirements. Improving stover quality for animal nutrition was a further, secondary, priority.

As the primary focus of the project was on improving the yield potential of well-adapted germplasm, it was essential to establish a testing scheme that permitted yield estimates from a reasonably high number of progenies/experimental varieties at several locations covering the range of growing conditions within the target zones.

Entries in the participatory yield trials were mostly S_3-lines derived from population crosses or the newly random-mated *guinea* dwarf population bulk(see box 1). Some of the entries selected by farmers during these trials were not uniform enough to qualify as varieties whose seeds could be released for crop production. These entries were subject to one or two further generations of pedigree breeding, with selection for specific traits. These reselected entries were tested again for one year in these trials before going into the participatory on farm evaluation.

The project has recently started to experiment with mass selection by farmers in the selected, but segregating bulks. The visual evaluation of panicles and grains selected by farmers appears very promising, but yield evaluations of these selected bulks are still required.

9.5.2 Results of yield trials

Results of yield trials

The results of the yield trials were very encouraging in both years (2003, 2004), in the sense that all trials were harvested and evaluated. Only in a few cases were individual replications of trials abandoned. The two seasons were markedly different. In 2003, the rainy season was very good, started early and continued until mid October in all the project areas. The heavy rainfall even led to some difficulties, such as water logging. In 2004, however, the rainy season started late and ended earlier than expected, so terminal drought stress occurred, particularly in fields with lower water holding capacities.

In 2003, farmers in each village identified varieties that they preferred over the local controls. Yield gains however, were fairly low, between 10-20 per cent on a variety mean basis for individual villages. A number of new dwarf lines performed relatively well in these trials. These are as yet unfinished varieties and their potential could be further exploited to improve yields.

Table 9.1: Yield [1] and preference of the best performing varieties and the controls in Wakoro village, 2004 rainy season. The names of the best varieties are given in brackets.

Variety	Rep 1 Nonkon Dembele	Rep 2 M'Pie Dembele	Rep 3 Moussa Bengaly	Rep 4 Tiecoura Traore	Overall Wakoro	
	Yield	Yield	Yield	Yield	Yield	Preference
Replication Mean	14	11	12	10	11.7	48%
Village Control	15	11	12	9	11.9	68%
Farmer Control	12	13	12	11	12.1	85%
* Best variety	**23** (Bolibana)	**17** (Lafia)	**22** (Kalaban)	**16** (Coni)	15.0 (Kalaban)	41%
* 2nd best variety	**23** (Coni)	**16** (Quinzen)	**19** (Sebekoro)	**16** (Kalaban)	15.0 (Lafia)	51%
* 3rd best variety	**20** (Magnan)	**15** (Koura)	**17** (Grinka)	**15** (Weli)	14.8 (Coni)	48%

[1] expressed as 100kg bags/ha

In 2004, some of the new varieties showed clearly superior grain yields compared to the farmers' control entries in both project areas, and were generally ranking high in the farmers preference scoring. This was partly due to their earlier maturity, an advantage under the end-of-season drought conditions encountered that year. Mean grain yield varied widely between locations, and there was even considerable variability between individual replications within the same village. This made the data evaluation more difficult. The flowering dates were only recorded at the research stations. Table 1 gives the results from one of the villages in the Dioila area, which was presented to farmers at the annual meetings.

In 2005 it was planned to split the trial up into two parts, with one trial for short entries and one for tall entries. Each trial will be replicated twice in a farmers' field, but will be grown only by two farmers per village. There is increasing interest in the shorter sorghum varieties, as they exhibit better stover quality than the tall varieties that are highly lignified. Farmers also find them easier to harvest.

Results of informal on-farm testing

The large scale informal on-farm testing resulted in increased demand for seed of all the varieties tested. However, yield data from the trials was not so informative. Greater efforts are needed to collect more specific information about growing conditions and the performance of the varieties. More explicit criteria for farmers' evaluations have been agreed on with the different farmer groups.

Results regarding seed system development and seed production

The capacity of the informal seed system to support innovation and the introduction of new varieties is limited by traditional, cultural, constraints on individual farmers selling seed. Yet there is a clear demand for seed, particularly from part time farmers, who do not generally keep their own seed stock. Full time farmers are able to buy smaller quantities of specific varieties for testing purposes and for further multiplication. The establishment of seed producing associations provides an answer to this limitation because if seed is sold "for the benefit of the group", the practice becomes more acceptable.

The foundation of farmers' seed production associations was initiated on a small scale in 2003, with seven farmer associations in the Dioila region producing 4 different varieties on about 0.5 hectares per association. The associations developed their own marketing and distribution plans. In 2004, the activity was expanded to twelve farmer associations in both project zones, and commercialisation became an integral part of the project's activities. Ten farmer associations in the Dioila region produced seed of five varieties, and two associations in the Mandé area produced seed of two varieties. However, the total amount of seed produced and sold remained low, due to drought conditions and general shortage of sorghum in the project regions. It now seems that demand for seed is growing, as information about the new varieties is spreading, and experiences are being accumulated. The seed fair appears to have been very useful in giving many farmers access to seed and to information about the varieties offered.

9.6 Reflection on experiences

9.6.1 Participation

Farmers' interest in conducting trials and producing seed has often outstripped the capacity of the project to provide seed and manage the trials. This has mostly been addressed by increasing the opportunities for village groups to conduct the farmer-managed trials with 4-5 entries. The impacts of these trials on demand for seed and adoption of the varieties still needs to be evaluated.

At the same time the project is increasingly collaborating with individuals who are keen observers of sorghum diversity. These farmers are becoming increasingly involved in the selection of individual plants in population bulks, and segregating progenies. Some farmers are also starting to select in grow-outs of outcrosses they find in their fields (after sowing with seed harvested from the trials, or which they find occasionally in the trial plots).

9.6.2 Genetic selection and diversity

Farmers appear to regularly select a range of varieties for testing, and not to focus on just one specific plant type. For example, many farmers will choose a tall and a short variety, or two very different grain types, or plants that mature at different stages. Thus there does not seem to be one single plant ideo-type which is acceptable to or preferred by farmers.

Informal discussions with farmers reveal that many have adopted one of the new varieties, although adoption rates have not yet been quantitatively evaluated. In some cases this adoption has meant that another variety has been abandoned. However, more often farmers have added a new variety to the portfolio of varieties already maintained on their farms. The main reasons for adoption are related to some varieties providing new opportunities to farmers to use specific growing conditions to obtain better yields. Some examples of this include: early maturing varieties, which can be sown later than the existing varieties but which still give a good yield of good quality; early varieties that break the hungry season earlier, or offer the opportunity to sell grain when market prices are still high; varieties which are adapted to prolonged waterlogging, which can be grown near lowland rice fields and in wet years; varieties with a higher level of *Striga* tolerance; varieties which have similar yield to local ones, but

have a much better taste; and late varieties which are suitable for intercropping with early maize or groundnuts.

It is very clear that the farmers are looking for a wide range of varietal options. This allows them to exploit the particular niches and growing conditions where a variety has a specific advantage. There are indications that the trial system established in the project, along with the seed production and diffusion activities have increased the varietal diversity at the farm level, and possibly at the village level. In the longer term this varietal diversity could increase the stability of production and the total sorghum production for individual families.

9.6.3 Other findings and lessons

Distributing seed of varieties derived from participatory breeding requires specific planning and experimentation if they are to be widely distributed within a short period of time. Most individual farmers do not consider this as a personal priority. Thus farmer organisations, with a strong culture of improving the productivity of their members, and even of non-members, could play a key role. Involving market actors (such as local traders) seems a promising route to follow, but requires good local contacts, as personal integrity is the key for success. Seed quality and information provision need to be credible for farmers acceptance.

9.7 Institutionalisation

1. *Multi-location yield testing with farmers:* The project has shown the power of testing new varieties and lines in early generations over a wide range of growing conditions, and the importance of understanding farmers' responses in a range of situations. The results of the trials are often better than those on-station; IER and ICRISAT will prioritise finding the means to continue supporting these trials over a key range of environmental conditions.
2. *Farmer-managed variety evaluation trials* are clearly very useful tools for engaging farmers' interest and support, and that of NGOs involved in agricultural development. However, diffusion based on trials appears to be slow; and the reasons for this need investigating and addressing.
3. Planning *seed diffusion activities*, even when done from the onset of a project, requires that institutions work in arenas that they may not be so familiar with. This project has put in place some new models but they are not yet sufficiently established for their effectiveness to be evaluated.

9.8 Management of PPB products

Improving farmers' access to new varieties has been one of the key goals of this project. The analysis of the seed system, with its strengths and weaknesses, and the establishment of institutional links and information exchange between farmers and research institutions, has provided a foundation for long-term cooperation.

Seed production by farmer associations was instigated at the beginning of the project. The current legislative framework leaves two options for farmers. The first, heavily regulated, option is to produce and disseminate certified seeds. This requires that varieties are registered on the national variety list and involves regular visits by inspectors from the appropriate authorities. The full cost of certification has to born by the seed producer, which would make such seed prohibitively expensive and put it out of reach of normal farmers.

Farmers can also trade their own seed without certification or control. This project is based upon this option. Control is provided through trust between producers from the same areas. However sale over wider geographical scales, especially national boundaries, cannot readily be achieved under such a system. Thus, in the longer term we expect that one of the national partners will propose one of the new varieties for registration on the national variety list as a first step towards creating opportunity for sales over larger areas.

The National Association of Farmers Groups (AOPP) is also actively seeking to influence the policy process, and facilitating farmer managed seed production and the diffusion of locally bred varieties.

9.9 Outlook

In addition to the issues discussed above, the project is currently trying to implement the following activities:

1. Earlier farmer involvement in the breeding process, followed by progeny-based recurrent selection at several locations. Farmers should take a leading role, with some degree of researcher involvement, especially at sowing time, to ensure that fields are well chosen, and that plots are correctly labelled.
2. Expansion of the key elements of the selection and testing scheme, as well as the seed production arrangements, to other countries in the region; with the inclusion of locally relevant germplasm..
3. Assessment of the impacts of the trial schemes as well as different seed diffusion activities, in terms of their capacity in reaching many and diverse types of farmers over a wider geographic and possibly ethnic scale.
4. Additional research and training in order to increase farmers' capacity to manage seed diffusion in a sustainable manner, most probably through collective organisations.

9.10 References

Diakite, S., 2003. Le système semencier local: description, evaluation et valorisation (cas du sorgho dans 7 villages au Mali). Centre de Recherche sur le Savoir Local. Bamako, Mali.

IPCC (Intergovernmental Panel on Climate Change/Working group science), 2001. Climate change 2001 – Impacts, Adaptation and Vulnerability. Cambridge, UK.

Siart, S., E. Weltzien, M. Kanouté & V. Hoffmann, 2005. Understanding a local seed system. The example of sorghum in southern Mali. Conference proceedings. Deutscher Tropentag, October 11-13 2005, University of Hohenheim, Stuttgart (www.tropentag.de/2005/abstracts/full/363.pdf).

Christinck, A., E. Weltzien & V. Hoffmann, 2005. Setting breeding objectives and developing seed systems with farmers. A handbook for practical use in participatory plant breeding projects. Margraf Publishers, Weikersheim, Germany & CTA, Wageningen, The Netherlands.

Yapi, A.M., A.O. Kergna, S.K. Debrah, A. Sidibe & O. Sanofo, 2000. Analysis of the economic impact of sorghum and millet research in Mali. Impact series. ICRISAT, Patancheru, Andhra Pradesh, India.

10 CONSOLIDATING FARMER'S ROLES IN PARTICIPATORY MAIZE BREEDING IN NEPAL

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10.1 Introduction

10.1.1 Origin of the initiative

Maize (Zea mays) is an important crop for the hill people of Nepal. According to official statistics 59% of the area used for maize in Nepal is planted with improved varieties, yet the replacement rate of the seed is very low (<1%). These improved varieties are mainly used in the more fertile low-lying Terai areas. Maize production systems in the western hills of Nepal, particularly in the districts of Palpa, Gulmi, Arghakhanchi and Pyuthan (fig. 1), are set in unique geo-physical environments, which differ from Nepal's other maize growing areas. These areas are remote and the district head quarters (main villages) are only accessible by road in the winter season. Farmers in these areas have poor access to improved genetic materials and information. In the past 10 years, only 16 tons seed of modern maize varieties were distributed by the formal system to cover an estimated 58,000 ha of maize area (Kadayat et.al., 1997). In addition the existing research system has not addressed location-specific problems and hence, the impact of the formal research system is very limited. This is reflected in the relatively small area planted with improved maize varieties (Table 1). Building on an earlier participatory variety selection programmeLI-BIRD (Local Initiatives for Biodiversity, Research and Development) identified the possibility of addressing these gaps. LI-BIRD recognised the scope for improving maize productivity through strengthening farmer-breeding and developed a project proposal which received support from the CGIAR System-wide Programme on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation (PRGA) in 1998.

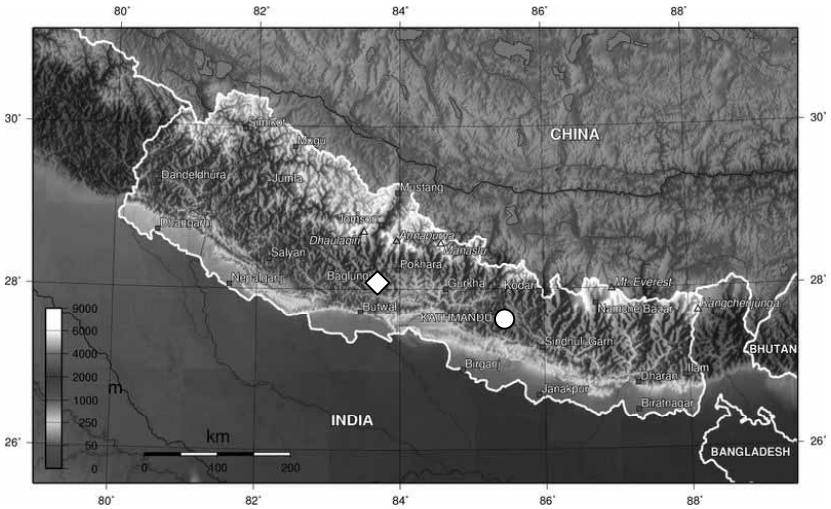


Fig. 10.1. Gulmi (◇), the site of the LI-BIRD PPB project in Nepal, between Baglung and Butwal, ± 300 km from Kathmandu (9-10 h by car) (○)

The project is jointly implemented by LI-BIRD and farming communities in the Gulmi district in collaboration with National Maize Research Programme (NMRP). Its purpose is to use farmers' local knowledge and resources in order to strengthen their role in local crop development processes.
The underlying rationales of this participatory research project include:

- Voluntary participation of farmers so the research addresses their needs and problems.
- Deployment of new, unrelated genetic variation (from Mexico), thus broadening the base of locally available germplasm.
- Strengthening the capacity of the farming community in local crop improvement processes
- Empowering farmers through their setting of breeding goals and through skills transfer.
- Combining farmers' and formal knowledge to develop appropriate technology.
- Exposing formal sector breeders to participatory crop improvement and strengthening farmers' role in setting the breeding agenda.

This report focuses on the initial activities of the project (1998-2000) in the Gulmi district of Nepal.

10.1.2 Production system in project sites

To select research sites, a multidisciplinary team of researchers from LI-BIRD and Nepal's Agricultural Research Council (NARC) carried out a series of field visits to 28 villages in different parts of the western hills of Nepal. Two villages in Gulmi district, Darbar Devisthan (800-1500m) and Simichaur (800-1800m), were finally selected on the basis of maize diversity, diverse biophysical and agro-ecological conditions, the directional aspects of the slopes, remoteness, community interest and constraints. The site characteristics of the two villages are summarised in Table 1. They are characterised by rolling flat lands with red clay soils and varying altitudes and ethnicity. Along the boundary of flat lands fodder and fruit trees are planted.

Maize diversity and farmer livelihoods

Around 90% of Gulmi farmers depend upon maize production for their livelihoods (Subedi and Shrestha, 2000). Five major cultivars are grown in the district: Thulo Pinyalo (accounting for 75-80%), Sano Pinyalo (10-15%), Sano Seto (3%), Manakamna-1 (1-5%) and Khumal Yellow (3%). The first three of these are landraces, and account for the great majority of maize grown in the area. Other landraces grown in smaller amounts include Kaude (mixed coloured), Rato Danthe (red stem) and Thulo Sto (big white). Households keep only a small limited number of varieties, regardless of gender, ethnicity and wealth. The existing maize landraces are the products of farmer breeding, whether deliberately or not, carried out continuously over many generations.

Table 10.1. Comparative site characteristics of Gulmi villages, Nepal 1999

Characteristics	**Darbar Devisthan**	**Simichaur**
Altitude m	800-1500	800-1800
Land use- Bari land[1]	95%	97%
Land aspect- East, West, North and South	30,45,10,15	12,50,28,10
Number of households	1100	1200
Ethnic composition: - Brahmin, Chhetri/ Magar/Newar and Kami/Damai/Sarki (%)[2]	20,60,10,10	75,0,22,3
Average family size (number)	6	6
Food self sufficiency (months)	7	7
Off-farm labour %	72	72
Seed replacement in last 5 years (%)	38.6	39
Wealth category (%)-R,M,P	35,30,35	
Area under modern maize variety %	13	13

[1]Bari land refers to a type of rainfed land with no system of irrigation and maize/millet crops are predominate the system

[2] See two paragraphs below for description

(Source: Baseline survey, 1998)

10.2 Methodology

After identifying the two project sites, a reconnaissance was carried out before engaging in breeding activities. This included a village workshop and a gender and user analysis.

Village Workshop
A village workshop was conducted in both villages to involve the local communities in the project and inform local government and stakeholders. The event was used to:

- understand the existing diversity of maize
- analyse the traits that farmers preferred and did not desire
- assess needs and problems
- set breeding goals
- identify institutional roles
- establish working mechanisms
- establish a Farmer Research Committee (FRC)
- select farmer-breeders

Gender and user differentiation
The gender analysis was a condition of project funding. It looked at decision making patterns among men and women farmers, and analysed differences in their varietal preferences. The user differentiation was done on the basis of differences in the ethnicity and wealth status of farmers. Three ethnic sub-categories (Brahmin/Chhetri/Jogi, Gurung/Magar/Newar and Kami/Damai/Sarki) and three wealth categories (Rich, Medium and Poor) were included in the analysis. The same categories were used in the implementation, monitoring and evaluation phases of the project.

Need assessment and setting research agenda
From the outset of the project it became clear that farmers had the ability to identify emergent problems and set breeding goals accordingly. The preliminary PRA identified lack of access to modern varieties and low productivity as major constraints. However consultation with the farming community at the village workshop led to more refined research objectives.

Farmers expressed their desire to maintain *Thulo Pinyalo* (literally meaning "big yellow"). This variety accounts for around 80% of the total maize planted in the region and is the product of farmer breeding. The majority of farmers like the variety because of its high yield potential, good culinary traits, higher grit recovery[3], resistance to storage insects and disease, fodder quantity and palatability and its adaptation to local management practices. However, *Thulo Pinyalo* is prone to lodging due to its unusually tall stature (as high as 6.5 metre). The gender/user analysis revealed that women and poor farmers have strong preferences for high quality maize varieties which provide a high yield and a similar quantity of fodder to *Thulo Pinyalo,* but which can also be used in inter-cropping with legumes. Focus Group Discussion (FGD) also revealed the importance of the quality of the maize when roasted whole as green cobs as almost 25% of maize is eaten in this way to supplement food scarcity of poor farmers.

It is common practice for farmers to select their seed for next season by choosing large and long cobs from the harvest and not from the standing plants (Subedi and Shrestha, 1999). Since such cobs are usually derived from tall plants, the seed selection pressure is unwittingly towards taller plants, something that the farmers were unaware of.This explains excessive plant height of the maize available in Gulmi district and its high risk to lodging which can cause up to 80% losses in bad years.

The good characteristics of *Thulo Pinyanlo* lie in its broad genetic base, derived from many exotic and local landraces of diverse origin, selected over time for preferred characteristics. Farmers were also not aware that the spontaneous crossing between exotic and local varieties grown in the area results in a heterogeneous population in the subsequent generation. This feature however offers farmers the opportunity to select a non-lodging population, combining the best traits of *Thulo Pinyalo* with other

[3] In Gulmi rice fields are limited and therefore maize is milled to produce high proportion of grit (rice shaped flour) recovery so that they can be cooked and served like yellow rice. % of grit to corn flour of *Thulo Pinyalo* is preferred traits of farmers and consumers. This is not a common trait for selection in national and international corn breeding programme.

raits preferred by them (Sthapit *et. al.,* 2000). Farmers and maize breeders jointly discussed these problems and sought to improve the population of local landraces through participatory methods. While this method may appear more complex than simply introducing new maize germplasm with preferred traits, it more appropriate for remote areas where logistical problems would lead to a poor seed replacement rate of improved varieties and consequently to lower yields.

Thus, the project aimed to transfer knowledge, skills principles and techniques on population improvement of maize and strengthen the local capacity to develop new populations of *Thulo Pinyalo* with reduced plant height. These priorities emerged during the participatory focus group discussions, village workshops and through working together with farming community.

10.3 The breeding approach

Strengthening local research capacity
A Farmer Research Committee (FRC), consisting of 6 men and 5 women, was formed to empower farmers in making their own decisions in the breeding process and ensure their access and control over the products of the selection process. Male and femail farmers willing to participate in the programme were selected by the villages on the basis of their knowledge and interest.

Breeding strategy
Different strategies were employed to improve the maize population of the two villages. These largely drew on population improvement principles, i.e., increasing the frequency of genes in the population that met the desired traits of farmers. The initiatives were implemented in 1999 and 2000 and carried out in parallel. They include:

- introduction of elite germplasm from CIMMYT and NMRP for broadening the genetic base of local landrace populations
- enhancing diversity by introducing (released and pipeline) cultivars through a participatory variety selection (PVS) method (Joshi and Witcombe, 1996)
- mass selection of the major landrace: Thulo Pinyalo
- improvement of the population of selected landraces
- farmer participation in goal setting, selection, evaluation and the seed diffusion process.

1. Diversity deployment through PVS trials

The long term overall purpose in introducing new maize genetic diversity was to provide access to new germplasm and introduce this into the local seed supply system so as to broaden the base of local population.

Introduction of elite germplasm
In 1999, 32 lines from CIMMYT and 3 maize composites from NMRP were evaluated in the two villages to demonstrate and compare new varieties with the existing ones and to identify good parent materials. A farm walk was organised at the time of crop maturity for participatory evaluation. Six cultivars were selected by farmers and their seeds were distributed to those who requested them.

2. Diversity deployment through PVS

In addition to the introduction of elite germplasm, LI-BIRD facilitated the introduction of small quantities of seed from 13 cultivars for evaluation in farmers' fields. These cultivars were identified by the researchers on the basis of an analysis of farmers' preference for traits and were obtained through the National Maize Research Programme of Nepal Agricultural Research Council and CIMMYT. In 1999, 1 kg packages of seed of each cultivar were provided by LI-BIRD to the Farmer Research Committee (FRC) who distributed them among 40 farmers in each of the two villages. The FRC provided one variety to each farmer for comparison with their local variety. A team of farmers, scientist and extensionists evaluated the performance by organising a travelling seminar during the maturity stage of the crop. Farmers also conducted their own preference ranking of the varieties through focus-group discussion during the later stage of the travelling seminar. After harvest, a household

questionnaire was administered to obtain farmers' responses on the post-harvest traits of the tested varieties.

In 2000, 93 packets of the 6 most preferred varieties from the 1999 PVS evaluations (Pop22, Tlaltizapan, Upahar, Narayani, Khumal yellow, Rampur composite) and three additional ones (Hill pool yellow, HPW, P21) were distributed among participating farmers. After this stage farmers identified two preferred varieties: POP-22 (now released as Manakamana-3) and Rampur Composite (a variety from the national system already released in the Terai and inner Terai areas). Farmers have continued to produce seeds of these varieties since 2002.

PVS also helped farmers in selecting parents as part of the process of improving the local maize variety Thulo Pinyalo through crossing. The selected parents were Khumal yellow, POP-22, Rampur Composite and Ganesh-1 (all released varieties).

3. Population improvement of Thulo Pinyalo *through crossing and selection.*

Crossing. In 2000 and 2001 ten farmers collaborated in a crossing programme designed to to reduce the lodging problem in *Thulo pinyalo*. The crosses involved: Thulo Pinyalo x Ganesh-1, Thulo Pinyalo x Khumal Yellow, POP 22 x Thulo Pinyalo, Ganesh-1 x Rampur Composite, Ganesh-1 x Thulo Pinyalo. The farmer-breeders were trained 'on the spot' for planting parent materials and detasseling female plants.

Planting. FRC identified farmers to make the crossings. Each of them found an isolated 500 square metre area (e.g. the top of a small hill or one having natural barriers, such as forest) for crossing. They planted 1 row of females with 3 rows of male, with a 75 x25 m spacing. The planting date of the male rows was staggered to avoid possible problems because of de-synchronised flowering of the male and female plants. The first row of the male parent was planted 7 days before the females; the second male row planted at the same time as the female row and the third one 7 days after. Farmers were closely supported and supervised by the staff of LI-BIRD, which included a professional maize breeder.

Selection. Up to the third generation, the farmers practiced negative selection. With this form of mass selection they removed all off-types to increase uniformity, taking out very tall, diseased, weak and thin individuals. After the fourth generation, positive selection was practiced. The farmers selected better performing individual plants, cobs and seed that have acceptable plant height with two cobs placed at the middle of the plant. The number of selected cobs varied from cross to cross. In the F4 and F5 generations farmers usually selected 150-200 cobs from their plots and in subsequent generations they selected more.

Most of the materials selected were flint types, whose eating and grit-recovery qualities are preferred by farmers in the area. But, some planted varieties, such as Ganesh-1 were dented-type maize and as a result some crosses gave a semi flint type of maize, which is not preferred. Two of the maize varieties used were white grain type varieties. These were selected out as the farmers prefer yellow grain type maize.

The populations were also evaluated through preference ranking and organoleptic assessments. Of the five crosses, the progeny (F7) from Rampur Composite x Thulo Pinyalo wasmost preferred by farmers. Farmers are now producing the seeds of this progeny and have named it Gulmi–2.

4. Population improvement of Thulo Pinyalo *through mass selection.*

Parallel to these activities, 19 farmers from both villages carried out population improvement of Thulo Pinyalo through selecting smaller plants from their own population with good cobs. The aim was to improve lodging resistance through mass selection carried-out by farmers who had received village-based training. Farmers were trained in detasseling undesirable (lodged, tall, thin, weak, malformed, diseased, and late) plants and selecting seed from dwarf plants. Farmers practised this selection for two seasons. However, progress was very slow in terms of genetic gain to reduced plant height and the farmers didn't realise any visible improvement in Thulo Pinyalo. The process did provide the farmers with practical knowledge on how to maintain variety for a longer period through selecting desired characteristics from within a standing crop. They are now adopting this skill to maintain maize varieties by themselves.

5. Development of Rampur Composite through PPB

In 1999, the project distributed a small quantity of F1 seed from five randomly crossed maize cultivars (Rampur Composite, Rampur-1, Across-9331, Naryani and Rampur-2) obtained from the NMRP to farmers for PVS. Mr. One farmer from each village (Om Prakash Ghimere from Simichaur and Mrs. Shibakala Khattri from Darbar) grew mixed seed of these cultivars in 2000 and found the resultant population to be very promising. They advanced this population by adopting the recurrent mass selection technique with technical support from the plant breeder from LI-BIRD (see box 1). They detasseled undesirable plants from standing crops and selected seed at harvest. In all they detasseled almost 20% of the total population. At the green cob stage, farmers marked individual plants which had not been detasseled with coloured thread, only marking those plants that were uniform and had desirable traits such as: medium plant height (< 3 m), a centrally located cob with complete husk cover (for harvesting of seed) and a strong stem. Farmers selected between 150-200 cobs in the F4-F5 generations and gradually increased this to 500-600 in subsequent generations. After two years of selection and recombination, farmers felt they had developed a promising maize population with desired traits and named it Resunga Composite, after Resunga Mountain, a regional Hindu shrine. They continued selecting through mass selection for homogeneity.

The seed of this has been spread through the area through PVS and Informal Research & Development (IRD) activities and farmers groups have started community based seed production of the material (Joshi & Sthapit, 1991). They are selling the seed through seed entrepreneurs (e.g. Agrovets), government offices, NGOs and farmers. LI-BIRD is supporting this initiative by maintaining the breeders' seed and facilitating wider testing of the variety in the region in collaboration with the District Agriculture Development Offices. The seed has also been sent to the National Maize Research Programme for multi-location testing and evaluation which are necessary for formal release process.

Box 10.1 Farmers' curiosity and fear

Mrs. Lal Kumari Basnet is one of the enthusiastic FRC members who agreed to carry out population improvement (Thulo Pinyalo x Ganesh-1 program in a 500 meter plot). This was done without consultation with her husband. When the project staff asked her to detassel the plants she was worried if the grains would set after she had removed the tassels. During the training it was explained that the detasseled plants would be pollinated by adjacent plants. As all her fellow farmers agreed to remove tassels she did so, but reluctantly. Every day early in the morning she visited her plot and opened up each cob with her nails to check whether the grains had set or not. She was worried as she had done this over a large area and had no other crop to fall back on for food security. She expressed her fear, curiosity and dilemma in the 2001 International Asian PPB meeting in Pokhara, Nepal. She is now a great inspiration for other farmers and is also a co-author of this chapter.

10.4 Results and lessons

10.4.1 Farmers' initiative

In reaction to LI-BIRDS initiatives, in 2000, after just one year of project work, farmers took the initiative to implement their own breeding programme. Observing the field performance of Rampur Composite (RC) in the 1999 farm walk and the crossing techniques used with the Thulo Pinyalo populations, farmers wanted to incorporate the preferred traits from RC into Thulo Pinyalo. While they like most of the characteristics of RC, they do not like its taste. Hence, the FRC requested RC seed and training from the project. A broadly similar methodology was followed as in the previous year when 10 farmers had been crossing Thulo Pinyalo with improved materials (see above). This time however the farmers chose the parents, set the objectives themselves and designed their own breeding plots. The FRC selected 200 farmers (50% female) and distributed 1 kg of RC seed to each of them, to be grown on their plots (average size of about 1000-1500 sq. m.) of Thulo Pinyalo, to facilitate spontaneous crossing. This led to positive results. According to the farmers observations the problem of lodging in their local maize was minimised and the yield also improved to some extent.

10.4.2 Performance of improved materials

A total of 259 farmers evaluated the 7 PVS varieties in 2002. In addition, groups of male and female farmers in Darbar Devisthan independently ranked six varieties (PVS and PPB) including the local variety *Thulo Pinyalo (Table 2),* to identify varieties for seed production. They ranked *Rampur Composite* most highly and *Resunga Composite* and *Manakaman-3* jointly second (Table 1). Male and female farmers expressed quite similar preferences (r = 0.93). The following year seed producers started to produce seed from of the three most preferred varieties.

Table 10.2. Correlation coefficient of preference ranking of six maize populations by male and female farmers in Darbar Devisthan, Gulmi (2002).

Maize Varieties	**Preference ranking**		
	Male	*Female*	*Overall ranking*
Rampur Composite	1	1	I
Thulo Pinyalo	4	3	III
POP-22 (Manakaman-3)	3	2	II
ZM 621	7	7	VI
Hill Pool Yellow	5	4	IV
Hill Pool White	6	5	V
Resunga Composite	2	3	II
	Correlation coefficient of agreement (r)=0.93		

Mother trials of variance among maize genotypes in 2004 revealed significant differences among genotypes for many major agronomic traits (Table 3): plant height, days to maturity and farmers ranking differed significantly. The statistical mean separation using LSD (*p=0.05* probability level) indicated the local variety *Thulo Pinyalo* to be the tallest, latest to mature and highest yielding. However, preference ranking showed that farmers preferred the varieties Resunga, Rampur Composite and Manakamana-3 (Table 3). A household questionnaire related to the varieties planted in the baby trials (43 households in Arkale) showed that farmers prefer these varieties for their grain and fodder (straw) yield, lodging resistance and grain colour.

Table 10.3. Means of plant height, days to maturity, grain yield and farmers ranking for maize varieties in mother trials conducted in 2004 in Gulmi.

Variety	Plant height (m)	Days to maturity	Grain yield (t ha^{-1})	Preference ranking
Rampur Composite	2.46 *cd*	123.8d	4.0 b	4 bc
Resunga composite	2.68 *bc*	127.7c	5.15ab	6 a
Manakamana-3	2.67 *bc*	134.2ab	4.92ab	3 c
ZM-621	2.38 *d*	134.7ab	5.68a	2c
RC/TP	2.8 *b*	233.8b	4.46ab	3c
POP22/TP	3.33a	135.7ab	5.56 a	4bc
Local (Thulo Pinyalo)	3.53a	137.5 a	5.5 a	5ab
LSD at 0.05 prob.	***0.25***	***3.44***	***1.24***	***2.12***

10.4.3 Role of the NGO LI-BIRD

LI-BIRD played a catalytic role in bringing national and international germplasm into the local system. Through encouraging farmers' involvement it also assisted in providing *Thulo Pinyalo* to the national breeding system for its population improvement programme.

Training. LI-BIRD organised training for farmers in the concepts, principles and techniques involved in maintaining or improving the valued characteristics in their landraces. Both male and female farmers (whether direct participants or not) were invited to attend group trainings where their knowledge and views on maize improvement were elicited and discussed. LI-BIRD responded to the FRC's request for specific training on detasseling and mass-selection techniques. In 1999, a total of 62 farmers were

trained in-situ by the project staff and 545 farmers, of whom 316 were female, were trained in the following years.

Organisation and diffusion. LI-BIRD has insisted that farmers organise themselves collectively and this has helped the development of strong group cohesiveness. LI-BIRD also organised a travelling seminar as part of the monitoring of activities and this has helped highlight their activities at the policy level and helped establish linkages and collaboration with a range of stakeholders (government and non-government organisations and private companies). In addition LI-BIRD has also facilitated the community in maintaining the seed bred by the farmers, linked this with the National Maize Research Programme, and in meeting the prerequisites for the varietal release process.

10.4.4 Role of farmers and breeders

The roles of farmers and breeders were also analysed and some obvious differences with conventional farmer roles were noted (table 2). Breeder expertise was available within LIBIRD, but also NARC breeders became involved, principally to develop, pre-screen and provide breeding materals.

10.4.5 PVS Methodology

Two elements in the PVS methodology that LI-BIRD used have worked well and seemed complementary: the us of small amounts of seeds and large numbers of farmers, and with the village walks to evaluate the performance of PVS materials.The limited availability of improved maize seed drove LI-BIRD to adopt a system of distributing small amounts of seeds to a relatively large number of farmers for decentralised on farm testing and capitalised informal seed systems. Another benefit of this approach was to minimise possible production losses to the farmers while they tested new genotypes in a new environment. As LI-BIRD did not compensate farmers for such losses, it was particularly important to build the confidence of farmers about the value of on-farm testing of new genotypes. This is particularly important as Nepalese farmers generally have very small landholdings (the average holding per family is less than 0.5ha).

10.5 Conclusion

Not so long ago it was considered unscientific to involve farmers in plant breeding. While it is premature to conclude from this project that the integration of farmers into the plant breeding process accelerates local crop development they have clearly made an important contribution to plant genetic resource management and utilisation. LI-BIRD researchers have observed that farmers have now become more involved in experimentation, and that PPB is just one aspect of this.. The PPB process has enhanced natural, social and human capitals to generate financial capitals for their sustainable livelihoods. Farmers were empowered by this process as they learned from breeders about genetics and plant breeding and could apply to other crops. The PPB activities were an effective entry point for training in seed production and PVS for a range of crops. LI-BIRD has also found that formal breeders appreciate working with farmers and NGOs. Combining a development perspective with research objectives has been a beneficial process for all involved stakeholders. It has led to evident changes in breeders' perceptions of varietal characteristics (table 3). While there are clear differences between the objectives and practices of formal and informal institutions, this experience shows the benefits of working together, concretely in terms of developing more a solidly grounded breeding policy that favours farming communities in marginalised situations.

The gender/stakeholder analysis helped the research team to modify the project from production-oriented breeding to quality-oriented breeding. The gender analysis also revealed the importance of the role that women play in decision making in maize production and as a result, a high level (more than 50%) of women's participation was ensured at all stages of the project activities.

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Table 10.4. Identification of Institutional Roles.

Farmer Researcher Committee (FRC)	*LI-BIRD Researcher*	*NARC Breeder*
Strengthening local institutions • Mobilising and selecting participating farmers	• Mobilisation of farmers • Identifying farmers' preferred traits • Capacity building	• Participating in research process
• Planning and implementation of identified activities.	• Search for suitable material • Introducing participatory approaches to testing and evaluation	• Providing a wide range of germplasm, both exotic and local
Set breeding objectives • Assessment of existing diversity • Need and problem assessment • Choice of parent material • Contributing traditional knowledge and expertise	• Facilitate the setting of breeding goals • Choice of parent material • Blending traditional knowledge with scientific knowledge systems	• Assess technical feasibility • Providing scientific breeding knowledge
Creating variability • Share local material and knowledge • On-farm crossing, detasseling, saving seed within target environment	• Assisting with the creation of new variability • Training • Monitoring	• Creating new variation • Providing elite materials
Selection and evaluation • Mobilisation and selection of participating farmers • Selecting preferred material in target agronomic conditions • Post harvest evaluation	• Identifying knowledge gaps and train farmers • Organising farm walks • Promoting discussion	• Screening for stress not visible to farmers • Assisting in training
Seed Diffusion • Community based seed multiplication, sale and exchange	• Studying informal seed supply system • Distribution of seeds from PPB/PVS varieties	• Including in formal testing

Box10.2. Social and economic outcomes of the project

- **Improved access** of materials to farmers through PVS, seed networks and information designed for farmers' use on the characteristics and value of local varieties.
- **Integrating** locally adapted crop varieties and farmer preferences into national and local development and extension projects.
- Improving the **quality of farmers' participation** in the research programme through their taking initiative in setting breeding goals and demanding appropriate training.
- Strengthening **local research capacity** as farmers set up their own Farmer Research Committees.
- Increased participation of **women** farmers in training.
- **Skill transfer** on mass selection and detasseling.
- **Integrating locally adapted crop varieties and farmer preferences into national and local development and extension projects.**

Table 10.5. Changes in the perception of researchers after village workshops

Parameters	**Researchers' perception**	
	Before farmer's involvement	**After farmers' involvement**
• Introduction and adoption of modern variety	• Low	• Limited
• Landraces	• Poor yielding	• Good yield potential-yield, undermined by losses though lodging of 15-85%
• Problem	• Low yield	• Lodging, low yield
• Contributory factors to the problem	• Not known	• Tall plant and ear height • Thin and weak stalk • Wind speed
• Ethnic-perception	• Not known	• Landraces well adapted to micro-niches • Thulo Pinyalo has mostly good traits but is prone to lodging
• Objective	• Increase access to new genetic materials • Provide mass selection training to farmers	• Improve Thulo Pinyalo population for lodging resistance • Strengthen capacity of farmers to select preferred varieties

10.6 References

Kadayat, K.B., Rana, R.B., Joshi, K.D., Subedi, A. and Sthapit, B.R., 1998. Report on participatory variety selection on food crops in Gulmi district, Nepal. Need assessment and future strategy Gulmi Argakhanchi Rural Development Project/ LI-BIRD, Dec 1998.

Gyawali, S. , B. Bhandari & A. Subedi, 2002. Farmer-led Participatory Maize Breeding in Middle Hills of Nepal. Final Report of Second Phase of the Project (August 2001 – September 2002). LI-BIRD. http://www.prgaprogram.org/modules/DownloadsPlus/uploads/PRGA_Publications/Plant_Breeding/Small_Grant_Reports/libird_01-02_final_report.pdf

Joshi, A. and Witcombe, J.R., 1996. Farmer participatory crop improvement. II. Participatory varietal selection, a case study in India. Experimental Agriculture 32:469-485.

Joshi KD and Sthapit BR, 1991. Informal Research and Development. Lumle Agriculture Centre, Kaski, Pokhara, Nepal

Sthapit, B.R., 2000. Mass selection: a low-cost, widely applicable method for local crop improvement in Nepal and Mexico. In: E. Friis-Hansen & B.R. Sthapit (eds), Participatory approaches to the conservation and use of plant genetic resources, IPGRI, Italy

Subedi, M. and Shrestha P.K., 1998. Site selection report of Farmer-led participatory maize Breeding Program for Middle Hills of Nepal, LI-BIRD, Pokhara Nepal.

11 PARTICIPATORY PLANT BREEDING IN GUANGXI, SOUTH-WEST CHINA

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11.1 Introduction

Participatory plant breeding efforts have been underway in Guangxi province in Southwest China since 2000. These efforts build on an impact study carried out from 1994 to 1998 to assess the impact of CIMMYT's maize germplasm on poor farmers in Southwest China (Song 1998). This study critically analysed the processes of technology development and diffusion. One of the key findings of the impact study was the systematic separation between the formal and the farmers' seeds systems. This separation resulted in inadequate variety development, poor adoption of formally bred modern varieties, an increasingly narrow genetic base for breeding, and a decrease in genetic biodiversity in farmers' fields (Song 1998).

The PPB research project has its origin in the impact study referred to above, which resulted in the PhD dissertation of the first author of this case study. The study of the maize breeding program and its varieties, and the contacts with farmers in the South-west China, gave rise to a mutually shared interest to experiment with possible improvements. The PPB project that grew out of this interest received financial and technical support from the International Development Research Centre (IDRC) and the Ford Foundation. It set out to identify technological and institutional options for developing more effective linkages and mutually beneficial partnerships between the formal and farmers' seed systems. The goals were to enhance sustainable crop development, and in-situ/on-farm management of genetic resources, and to bring direct benefits to poor maize producers. At the same time, the research aimed to strengthen women and men farmers' capacities to manage agrobiodiversity and improve their livelihoods (CCAP 1999, and 2004).

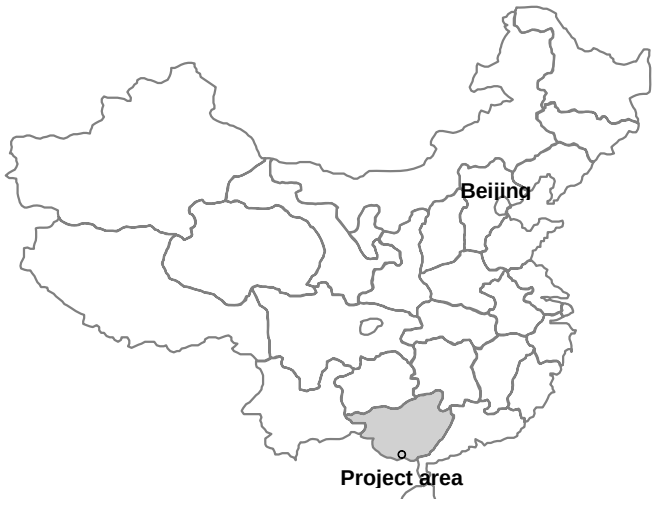


Fig. 11.1. Project area in the Guangxi Province, South of China.

11.2 Local Maize Production, and the Formal and Farmers' Seed Systems

11.2.1 The formal seed system

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 upland areas in the South-west. The government of China has followed a modern technology-oriented approach, relying predominantly on its formal seed system. The development and distribution of modern varieties, mainly hybrids, for the three main staples 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. Hybrid maize is now grown on approximately 80 percent of the total maize-production area in China, particularly the uniform and high-potential areas of the Northern Plain. At the same time, farmers' needs for and interest in Open-Pollinated Varieties (OPVs) and locally adapted varieties in the remote and harsh areas in the uplands of the Southwest are more or less marginalised by the modern technology development process (Song 2003).

11.2.2 Local maize production and farmers' seed systems

The remote upland areas in the South-west are an economically poor, but agro-ecologically diverse and rich area, and the centre of maize genetic diversity in China. It is believed that South-west China is the area where so-called "waxy" maize is thought to have originated from (Liu 1991, Zhang 1995). Farmers in South-west China have cultivated and relied on maize for their survival for generations. Despite being ignored by the formal system, 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. The CIMMYT impact study revealed that, in the study area, more than 80% of the seed supply is from farmers' own seed systems (Song 1998). Today, this region is a treasure trove of maize genetic diversity that is vital to the future of maize cultivation in China.

11.2.3 Issues and needs for collaboration

Poverty and farmers' livelihood security remain major issues in the remote mountainous areas of the South-west. This is perhaps even more so following China's entry into the World Trade Organisation and the increasing and rapid market oriented economic development process currently underway, which is not generating the expected benefits for all farmers.

Meanwhile, the genetic base for maize breeding in China has been dramatically reduced during the last two decades. Although the total national maize germplasm collection has around 16 000 entries, five dominant hybrid maize varieties now cover 53 percent of the total maize growing area in the country. In Guangxi, the total maize germplasm collection has around 2 700 entries and among them more than 1 700 are landraces from the region. However, the utilisation of these collected materials in breeding is very limited. Only three main hybrid breeding crosses are used and all the 14 hybrids bred out in the last 20 years share the same inbred line to different degrees. At same time, in the South-west provinces, landraces in farmers' fields are degrading and disappearing as a result of the continuing spread of modern varieties (Vernooy and Song 2004).

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 (most men have migrated to the cities), 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 PPB research in South-west China.

11.3 Organisations

The Centre for Chinese Agricultural Policy (CCAP) is the organisation that hosts the project. CCAP provides coordination and guidance with regard to research design, implementation and use of the research results. The research is implemented by a team of women and men from various organisations and groups (see below), with different disciplinary and professional backgrounds and operating at

different administrative levels. Five women farmer groups, six villages, six township extension stations, and two formal breeding institutes have been directly involved in the PPB and participatory variety selection (PVS) design and implementation process. They represent a team of different disciplinary, professional, and socio-cultural backgrounds, that is operating at different levels, from the local to the international. In detail:

- *The Institute of Crop Science* (ICS) is the leading Chinese organisation for crop research and breeding under the Chinese Academy of Agricultural Science (CAAS). It works on technological and related policy issues in maize improvement and genetic biodiversity management.
- *The Guangxi Maize Research Institute* (GMRI), a provincial-level organisation under ICS and part of the Chinese Academy of Agricultural Sciences (CAAS), collaborates in the formal plant breeding work, with direct involvement of selected villages and other related local organisations.
- *Six farmer-plant breeding villages*, Wenteng, Zhichen, Niantan, Zurong, Guzhai and Huaguang, and five women farmer groups from these villages represent the farmers' seed systems. They collaborate with formal-sector plant breeders, extensionists and other stakeholders in the research activities.
- *Five township extension stations* from the areas where the trial villages are located operate as local facilitating groups and link the two systems by facilitating the PPB and PVS processes.

Recently, several post-graduate students from the College of Humanities and Development (COHD), China Agricultural University (CAU), also joined the research efforts to carry out field-work for their Master's and PhD degrees. Their research is jointly being supervised by the project team, IDRC staff and COHD/CAU staff.

11.4 Methodologies adopted in participatory (maize breeding) practices

The research uses a participatory plant breeding methodology adapted to the local context. Our work (i.e the work of the entire team, including farmers) builds on local women farmers' maize breeding experiences and expertise developed over many years. At the same time, we actively involve and seek the knowledge and expertise of formally trained plant breeders. As far as we know, our work is the first of its kind in China and as such, we are experimenting with a variety of methodological elements. We are making breeding improvements through a number of crossing techniques and/or through various variety selection processes. This included use of detasseling, mass selection, line selection by farmers – with support from breeders. Breeders use more complex methods on station. Our work has covered a range of parallel activities over a number of years with different materials to identify parental materials (through PVS), make improved populations (involving local and formal system materials) and further selection to advance the populations into varieties. Trials in the six trial villages and on-station (at the GMRI in Nanning) include both participatory plant breeding and participatory variety selection experiments. The trials allow for comparison in terms of locality, approach, objectives, and the types of varieties tested (Song, 2003; see for details, the tables in Song and Jiggins, 2003).

11.4.1 Materials used

As a result of a series of discussions among farmers and formal plant breeders jointly and separately, it was decided that the PPB and PVS field experiments would target four types of OPVs and landraces, i.e., so-called exotic populations (from CIMMYT and elsewhere), so-called farmer "creolised" varieties, farmer maintained landraces, and formally conserved landraces. More than 70 varieties were identified as target varieties for PPB and PVS on-station and on-farm trails during the period from 2000 up to 2005. The characteristics of the four types of varieties used, and the purposes of the trials are:

- *Exotic populations and materials* (from CIMMYT, other Asian countries and other regions in China). Populations, i.e., Tuxpeño 961, 962, 963, 964, 965, and 966, introduced by CAAS from CIMMYT in 1996, were identified as starting points for improving OPVs based on farmers' preferences and requirements. They were planted for field experimentation and regional adaptation selection at the Guangxi Maize Research Institute (GMRI) in the first cropping season of 2000 (note that there are two maize cropping seasons per year in the research area: the first lasts from February until the end of June, the second from July to November.) During the pre-harvest season, the first PVS field day was facilitated by the project team with participation of

farmers (80% of them were women) from the six villages, formal-sector plant breeders, extensionists, and public seed company managers. Based on the results of these field trials, joint discussions and voting, two varieties (961 and 963) were selected by both the formal plant breeders and farmers, and agreed upon by other participants, for inclusion in farmer-led PVS trials in farmers' fields in the following cropping seasons. Other exotic materials, such as Suwan 1, Zhongmai 1, and Shanzhon, were then also introduced and tested through similar PVS methods and processes.

- *Farmer "creolised" varieties.* These are materials originally delivered by formal breeders and then improved and locally adapted ("creolised") by farmers. One popular variety, Tuxpeño 1, which came from CIMMYT in the early 1980s and was effectively diffused through farmers' systems in Southwest China and then "creolised" by farmers (see Song 1998 for more details), was included in on-station and field trials. These materials were tested through farmer-led PVS trials.
- *Farmer maintained landraces.* About 25 landraces currently used by farmers in the trial villages were collected and included in on-station and field trials. These materials are being tested through farmer-led PVS and PPB trials.
- *Formally conserved landraces.* During field days at the GMRI station, farmers have selected more than 15 varieties from 100 formally conserved landraces for farmer-led PPB trials in the two in-depth case-study villages, to be crossed by farmers with the landraces they are currently using. These landraces were collected by the GMRI from 1995 to 1997. Originally, the aim was to use them for conventional formal breeding and test and analyse the genetic features of these landraces for population improvement. In total, 100 land races were tested together with four standard testers, i.e., M17, 330, Bass (Reid) and Lancaster. This has been taking place since 2001.

11.4.2 Trials

The field experiments use both breeder-led and farmer-led approaches with different research foci in each trial for comparison. Based on a baseline study, varieties were collected and discussed among farmers and formal-sector breeders, and field trials with the four types of varieties were established in the second cropping season of the first project year in 2000. Work started at the Guangxi Maize Research Institute (GMRI) and in two in-depth case-study villages, Wenteng and Zhicheng. In the following cropping seasons, the trials were scaled out to include all six villages. Each trial site has its own focus for PPB and PVS comparison. The decision making about the trials and the division of labour between farmers and breeders differ depending on the type of trial.

Table 11.1: Comparison of Variety Selection Criteria used by Women and Men Farmers in Trial villages

Criterion	Frequency of Selection (%)	
	Women (N=20)	Men (N=20)
Drought resistance	100	100
Lodging resistance	90	83
High yielding	80	83
Seed self-saving	80	50
Grain Color	70	50
Cooking quality	50	33
Plant shape/intercropping	50	83
Low fertilizer rate	40	33
Maturing time	40	33
Plant height	30	33
Rate of damage resistance	30	33
Disease resistance	20	33
Insect resistance	20	33
Growth cycle	10	50

Source: CCAP. Data collected in the project villages in 2001.

11.4.3 Selection criteria

Farmers and formal plant breeders discussed and decided on morpho-phenological and other characteristics of the tested varieties to be recorded. Farmers' preferences regarding these trial varieties are elicited during the PPB and PVS processes, e.g., in the course of discussions during trial design, PPB/PVS field experimentation and field visits. The farmers (predominantly women) from the six villages, extensionists, formal-sector breeders and other relevant professionals are invited together to evaluate and "vote" on the tested varieties in both the farmers' fields and on-station during the growing season, pre-harvest and post-harvest. It is important that after each "voting" event, a meeting is held for the "voters" to explain the reasons for their selections: this then leads to an agreed summary.

The assessments that are made during the field trials, field visits and field days by the farmers and the formal-sector breeders are regularly analysed by the team according to sex, type of households, and local agro-ecological conditions to identify and reflect on the main differences and changes over time (Song and Jiggins, 2003). The following table 1 is an example of farmers' variety preferences, disaggregated by sex.

11.4.4 Results

So far, more than 70 varieties have been used in our trials at the GMRI station and in villages. Based on 6 years of experimentation, three farmer-preferred PPB varieties have been selected and released in the project villages. In addition, five varieties from CIMMYT that were showing increasingly poor results have been locally adapted. Another five landraces from the trial villages have been improved with joint efforts of farmers and formal breeders. Agronomic traits, yields, taste and palatability of all these varieties are satisfactory. Varieties are also showing better adaptation to the local environments (CCAP 2004). A women farmer improved variety, known locally as "New Mexico 1," with as parents a variety from Wenteng village and a local white-coloured maize from Zhicheng village, has been tested over a number of cycles and certified by the formal breeding institution. Its robustness and taste make it a very popular variety that is now widely used in the area. Farmers from neighbouring areas who heard about it are coming to learn more and to ask for seeds. In the research area, varietal diversity is increasing. Meanwhile, formal breeders have identified in farmers' fields a number of very useful breeding materials selected for inbred lines that have a valuable, broad genetic base (for more detail please refer to the appendix).

11.5 Reflection on experiences

The project's participatory plant breeding field experiments, both in farmers' fields and on-station, have been functioning successfully as a platform to involve the main stakeholders from both formal and farmers' systems. They have facilitated effective interaction, communication and collaboration. Initially, some individual women farmers showed great interest in seed and selection activities. Later,

Fig. 11. 2 The China team, collaborators from different organisations



more women and also men joined the research activities. There are a few key women-innovators who have been involved in the project from the beginning and have become core team members. Farmers, women in particular, are now speaking up in meetings and expressing their ideas, needs and interests. In a still strongly top-down research and policy environment this represents a major change. It should also be seen in the wider Chinese context in which men increasingly seek work elsewhere and women are left with the responsibility for the farm (Song and Jiggins, 2003).

The participatory breeding activities have also strengthened the local level organisational and decision-making capacity of farmers. Groups of farmers have started to define specific support that they would like to receive from the extension service. They have put forward the idea to initiate seed production and marketing in particular of OPV varieties bred out by the team. Marketing research is underway in Guangxi and neighbouring provinces (CCAP 2004). The aim is to add value to the women farmers' produce. This is expected to make the on-going activities and process of participatory plant breeding and agrobiodiversity management more sustainable. In addition, following the organisation of a first successful diversity fair in 2003, farmers organized the second diversity fair in 2004, and a third in 2006. They are now planning follow-up fairs in their villages and possibly in the city of Nanning, the provincial capital (Vernooy and Song 2003; CCAP 2004). They plan to sell theirs seeds at these fairs.

11.6 Institutionalisation

Some changes can already be observed in attitudes, and in policy considerations in the formal system. For instance, farmers' needs and interests have been considered and included in the breeding plans and research priority setting of the two involved breeding institutions starting from the year 2001 onward. The Guangxi Rice Research Institute, under the Guangxi Academy of Agricultural Science, has also requested the project to introduce the PPB and PVS approaches to their rice breeding program, which is one of the biggest rice breeding programs in China. This new collaboration is currently being planned in more detail. The Ministry of Agriculture has recently agreed to include the project's participatory approaches and methods in its national extension reform pilot program. Another result of the project is that the Guangxi Maize Research Institute has adopted an approach to combine gene bank conservation with in-situ conservation of landraces. In addition, the Guangxi local germplasm conservation efforts are considered to be included in the national plan for the broadening of the maize genetic base by the Institute of Crop Science.

The research approaches, activities and achievements have been introduced and presented in various important policy occasions and conferences. For example, the project was presented and discussed in a national policy-planning workshop on maize research priority setting, co-ordinated by CCAP and CIMMYT in Beijing, March 2002. This was the first time that the farmer participatory approach as an alternative and complementary methodology for crop improvement and agrobiodiversity management was discussed and considered by a group of forty prominent national policy makers and scientists gathered in this important conference (Vernooy 2003). The project's PPB and PVS approaches and results have also been presented at the 9th Asian Maize Research Workshop coordinated by CIMMYT and CAAS in Beijing, in September 2005. Participants from across Asia gave positive feedback to the team.

11.7 Management of products of PPB

However, several important challenges remain. There are policies and laws for plant breeders' rights in China, but is there a need for new policies and legislation to count for farmers' rights? For instance, how to deal with the newly developed PPB varieties (New Mexico 1, Zhongmai 1 and 2, and others) in terms of the questions and issues of "ownership" (i.e. whose varieties are they?). PPB varieties are the result of efforts made by many people: farmers, plant breeders, other researchers, extensionists, etc. This raises many key questions concerning the proper recognition of the contributions to the new variety (ideas, knowledge, skills, time, energy, money, genetic materials and other resources), adequate access to the new varieties, usage of the new varieties, the commercial and non-commercial benefits

that the new varieties bring, and the fair sharing of these benefits. Since early 2004, we are involved in two global initiatives and networks dealing with these questions.

11.8 Outlook

We conclude that our farmer participatory approach has successfully enabled small farmers –women and men– in the marginal areas in South-west China to participate in maize breeding as equal partners alongside the breeders, other researchers, and extensionists. Together, these partners have been sharing their know-how, expertise and seeds and contributed, in a complementary manner, towards the agricultural diversity enhancement, crop improvement, and farmers' livelihood security. But we realize that to put such new approach into practice on large(r)) scale will require fundamental institutional and policy changes in agriculture and related research and policy fields. To deal with this challenge, we recently embarked on a new phase of our research entitled *"Rural Livelihood Security and Policy Changes--Enhancing Community-based Crop Development, Natural Resource Management and Farmer Empowerment in Guangxi, South-west China,"* focusing on policy linkages through policy experimentation supported by the Chinese government, and by IDRC. We are hoping that these policy experiments will broaden the support for our work in Guangxi and also allow others to follow in our footsteps.

11.9 References

Center for Chinese Agricultural Policy (CCAP). 1999. Exploring the potential for crop development and biodiversity enhancement: fostering synergy between the formal and the farmers' seed systems in China. Research proposal. Beijing: CCAP/Chinese Academy of Agricultural Sciences.

Center for Chinese Agricultural Policy (CCAP). 2004. Exploring the potential for crop development and biodiversity enhancement: fostering synergy between the formal and the farmers' seed systems in China. Final project report phase 2. Beijing: CCAP/Chinese Academy of Agricultural Sciences.

Liu Ji Ling. 1991. *Maize Breeding.* Guangzhou: South Press House. (In Chinese).

Song, Y. 1998. "New" seeds in "old" China: impact study of CIMMYT's collaborative programme on maize breeding in Southwest China. Published PhD thesis. Wageningen: Wageningen Agricultural University.

Song, Y. and J Jiggins 2003. Women and maize breeding: the development of new seed systems in a marginal area of South-west China. In: P.L. Howard (ed.) Women and Plants-gender relations in biodiversity management and conservation. London and New York: Zed Books, pp. 273-288.

Song, Y. 2003. Linking the formal and informal systems for crop development and biodiversity enhancement. In UPWARD, Conservation and sustainable use of agricultural biodiversity: a sourcebook, pp. 376-381. User's Perspectives with Agricultural Research and Development. Los Baños, the Philippines.

Song, Y. and R. Vernooy 2003. Participatory maize and Livelihood improvement in Southwest China. *Agricultural research and Extension Network Newsletter* No. 48, July 2003, p. 8.

Vernooy, R. 2003. Seeds that give: participatory plant breeding. Ottawa: IDRC. Available at http://www.idrc.ca/seeds

Vernooy, R.; Song, Y. 2003. Celebrating diversity. *ILEIA Magazine* 19-3: 36, October.

Vernooy, R; Song, Y. 2004. New approaches to supporting the agricultural biodiversity important for sustainable rural livelihoods, *International Journal of Agricultural Sustainability*, 2004, Volume 2, No. 1: 55-66.

Zhang Shihuang. 1995. Some suggestions for maize genetic base broadening by a systematic utilisation of exotic germplasm and landraces. Draft working paper. Beijing: Chinese Academy of Agriculture Science. (In Chinese.)

12 BUCAP AND CBDC: EXPERIENCES AND CHALLENGES OF A SOUTHEAST ASIAN ROAD TO FARMER PLANT BREEDING

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I Set up and overview of the programmes

The Southeast Asian Regional Initiatives for Community Empowerment (SEARICE) has been coordinating two regional programs on plant genetics resources conservation, development and use (PGR CDU) for the past 10 years. These are the Community Biodiversity Development and Conservation Program (CBDC) initiated in 1994 and currently in it's third phase of implementation and the Biodiversity Use and Conservation in Asia Program (BUCAP) started in 2000. Both programs deal with farmer plant breeding/participatory plant breeding (PPB) as one of the paths for PGR CDU. The different contexts in which SEARICE partners work in the various countries allows for diverse approaches and methods to farmer plant breeding. In February 2006, SEARICE with CBDC and BUCAP partners called for a meeting of farmer plant breeders and plant breeders from the formal institutions working with CBDC and BUCAP for a discussion and analysis of the regional experiences. This paper presents the results and reflections from this meeting starting off with an overall presentation of the two programs, its contexts and the problems (both macro and micro) that the programs attempt to address. This is followed by country cases prepared by CBDC and BUCAP partners that detail the country specific experiences and reflections of partners. Finally, a synthesis of the national experiences is presented bringing the experiences back to a regional context and reflection.

12.1 Why?

Agriculture still is a major, if not the prime economic sector in most Asian countries.
There is increasing pressure to modernize and develop economies with governments pushing for modern agricultural technologies and in the past ten years towards global market integration through trade liberalisation. A The push for market integration puts pressure on agriculture.

At the same time, there is growing recognition and consciousness about the agricultural biodiversity in Southeast Asia brought by increase environmental awareness and its importance in agricultural development.development of its agricultural sector.

There is growing concern in Asian societies about the vulnerability of small resource poor farmers as guardians and managers of agricultural biodiversity when integrated in the market and associated effects of structural and policy changes. Hence, there is a need to strengthen the capacities of farmers to manage their agricultural biodiversity and at the same time to become productive under changing market systems.

This is the context in which BUCAP was developed, specifically looking at changing farmers' seed systems . CBDC, an older program initially looked at conservation of farmers' PGR in the context of green revolution developments. Initially the emphasis in raising agricultural productivity was on the top-down introduction of modern technologies viewing farmers as mere end users of technologies and finished products such as new plant varieties. At the same time, economic liberalisation stimulated private companies to take an interest in the seed market as part of 'improving' agricultural production

in Asian countries. In these developments existing and time-tested farmer seed systems were viewed as out-dated and the extensive and locally adapted agrobiodiversity, managed and used by farmers threathened. CBDC was initiated in response to such developments, emphasizing the value and inherent strength of farmer seed systems and the importance of conserving the genetic diversity in those systems.
CBDC and BUCAP aim to offer opportunity/space for farmers to take control over the development of their own seeds, of their own choices, for their own purposes. This is done not only by optimising use of traditional knowledge, but also by strengthening farmers' position by the development of appropriate institutional and legal frameworks. These are part and parcel of farmer plant breeding/PPB in the Asian context. It is not simply a technical intervention but also, and perhaps more political and social intervention in the present agricultural and political context.

12.2 Where?

CBDC is a global program created in 1994 as a response of civil society groups and some concerned national genebanks to abate the erosion of plant genetic resources in farmers' fields. CBDC is implemented in Africa, Latin America and in Southeast Asia specifically in Thailand, Vietnam and the Philippines. It is a research and development experiment aimed at understanding farmers' systems and its agrobiodiversity. The hypothesis of the program is that a decentralised, locally focused conservation and research by farming communities is efficient and effective. CBDC is also an institutional experiment in terms of developing formal -informal sector linkages (e.g. genebanks and farmer groups with NGOs) and North – South linkages. The basic idea is that farmers' role is best supported by a combination of institutions and community actors in research and policy in the North and South. This comes from a common understanding among partners that farmers are the central players in agricultural conservation. In addition, vulnerability of agroecosystems and farmer communities warrant an increased role of farmers and involved actors in conservation work.

The presence of strong civil society groups in Thailand and the Philippines were the determinant factor in the choice of country. Vietnam was chosen in CBDC because of the Mekong Delta where there is serious erosion of PGR in especially that of rice. In addition, the institutional partner was also a partner of SEARICE in one of its earlier attempts in conserving traditional varieties through the establishment of a genebank.

BUCAP in turn is implemented in Bhutan, Lao PDR and (North and Central) Vietnam. These countries represent countries in the region with rich agricultural biodiversity and whose agriculture is in various stages of development and degrees of integration into the global market. Bhutan is farthest from the global market with mainly subsistence agriculture. Lao PDR is straddling in between, with its agriculture in transition from subsistence to market orientation. Vietnam is highly market oriented being one of the top rice exporters of the world. Here the challenge is to maintain or increase genetic diversity in prime irrigated areas under threat of genetic erosion.

12.3 Who and What?

CBDC, coordinated by SEARICE has projects in Vietnam, the Philippines and Thailand with financial support from HIVOS/OXFAM-the Netherlands, SwedBio, IDRC and the Development Fund of Norway (DF). SEARICE is a regional NGO based in the Philippines working on the seeds issues both at field/technical level and policy level. SEARICE directly implements the CBDC project in the Philippines.

The CBDC project in Vietnam is carried out in a partnership with the Mekong Delta Development Research Institute (MDI). MDI keeps a genebank and is part of Cantho University involved in plant breeding and biodiversity conservation work.

CBDC in Thailand is carried out with. Hug Muang Nan Network, a civil society network working on sustainable agriculture and community forestry. It aims at raising awareness of youth and raising awareness among the youth through radio programs and youth camps..

As a research and development experiment, CBDC-Southeast Asia focuses its work on rice-based farming systems with rice as the main crop of study. Root and tuber crops diversity and farmer

management are additional topics of concern in Vietnam and the Philippines. Indigenous vegetables are the secondary concern in Thailand.

In 1997, there was a shift in CBDC Southeast Asia from primarily conservation (through community conservation projects, seed banks and on-farm trials) to crop improvement/development. CBDC Southeast Asia adopted participatory plant breeding (PPB) as a way of not just conserving traditional varieties, but utilising them as parents in combination with other materials. The objective was to get better varieties while maintaining or increasing the genetic resource base. In this process, CBDC Southeast Asia moved from working with seed safers to working with farmers in crop improvement. This was done by forming farmer interest groups and offer training and facilitating improved farmer practices. In 2000, CBDC adapted the Farmers' Field School approach to genetic resource management as developed by BUCAP.

BUCAP was initiated in 1996 by SEARICE with support of the Norwegian Development Fund (NDF). The objective was to strengthen on-farm management and use of PGR through PPB. Exploratory visits were made to various countries in South East Asia in 1997 and 1998 to assess the possibilities of setting up BUCAP and identify potential sites (countries and communities). Three countries were finally identified, namely Bhutan, Lao PDR and Vietnam.

BUCAP differs from CBDC in terms of institutional formation in that it not only involved specific farmer communities, but from the on-set involved government institutions as well. The idea behind this was that support of and acceptance by such institutions as extension services and national plant breeding was considered important to anchor PPB approaches in national development strategies. Hence the scope of work of BUCAP in that it sought national program status, implemented by national institutions with mandates covering service to the whole country. Hence, while CBDC represented a number of local specific provincial interventions in the Philippines and Thailand and in the case of Vietnam, a specific Mekong Delta intervention involving a single institution, BUCAP partnerships are more complex.

In Bhutan, BUCAP is coordinated by the National Biodiversity Centre (NBC) of the Ministry of Agriculture. NBC also manages the Royal Botanic Gardens, the national genebank and the national herbarium as the primary institution responsible for *ex situ* conservation and policy formulation on environment related matters. NBC works in partnership with the Renewable Natural Resources Research Centres, the agriculture research institutions located in the four major regions of Bhutan. BUCAP Bhutan also works in strong partnership with the Dzongkhag Agriculture Offices (DAO) of Thimpu, Paro, Wangduephodrang, Monga, Trashigang and Punakha. DAO is administratively responsible of the agricultural extension work in the district. At the national level, BUCAP Bhutan also engages the Department of Agriculture for extension services and the Policy Planning Division of the Ministry of Agriculture for policy related issues.

In Lao PDR, BUCAP is coordinated by the Plant Protection Centre of the Ministry of Agriculture and Forestry in partnership with the Nappok Agricultural Research Centre (NARC) of the National Agriculture, Forestry Research Institute. NARC is the research centre in Lao PDR in-charge in developing rice varieties through plant breeding and conserving traditional rice varieties in a genebank. BUCAP works with Oxfam Solidarity Belgium in Lao PDR for administrative and advocacy/policy research support. BUCAP Lao also works in partnership with the Luang Prabang Agric ulture and Forestry College and the Champassak Agriculture and Forestry College by engaging students through an internship program to look into the research and extension work of BUCAP.

In Vietnam, BUCAP is coordinated by the Plant Protection Department (PPD) of the Ministry of Agriculture and Rural Development and linked with the National Integrated Pest Management Program of PPD. PPD works in partnership with the Agriculture Genetics Institute (AGI), the Vietnam Agricultural Science Institute (VASI), Mekong Delta Development Research Institute and the National Institute for Plant Protection for technical backstopping and support especially in the areas of plant breeding. BUCAP in Vietnam has widened its financial base and is now supported by Danida, CIDSE Vietnam, EU-Son La Lai Chau Rural Development project and Oxfam Hong Kong.

II Country Cases Bucap and CBDC

Chapters 13-16 present country specific cases, as prepared by CBDC and BUCAP partners on their experiences in rice and corn PPB. The Philippine case documents the experiences of farmers as plant breeders while the other country cases document the institutional and program level experiences on PPB.

13 CBDC PHILIPPINES: BOHOLANO FARMERS' EXPERIENCES ON RED RICE DEVELOPMENT

13.1 Introduction

13.1.1 Origin of the initiative

Historically, farmers play a great role in the development of crops. The first breeders were farmers who domesticated wild plants that resulted in cultivated crops grown today. With the introduction of high yielding varieties (HYVs) in the late 1960s, plant breeding became centralized in research institutions. Since then, the use of HYVs together with chemical fertilizers and pesticides had a negative impact to the sustainable farming system of farmers.

Moreover, the introduction of HYVs displaced many traditional rice varieties. In the Philippines, there were around 3,500 traditional varieties before the government launched Masagana 99, the program that was mandated to distribute HYVs together with chemical fertilizers, pesticides and loans to farmers. Despite all these developments at the international and national level, Boholano farmers conserved, developed and continued to utilize local red rice varieties with assistance of the Southeast Asia Regional Initiatives for Community Empowerment (SEARICE). It is a Philippine-based nongovernment organisation (NGO) that directly supports and works with local farmers in on-farm conservation, utilisation and management of Plant Genetic Resources (PGR) and has been documenting, disseminating information and results and experience from local farmers' initiatives on PGR.

This study documents the Boholano farmers' experience in red rice breeding. Specifically, it aims to:
1. Determine the breeding objectives for red rice varieties;
2. Examine the red rice seed development process; and
3. Identify problems encountered in breeding red rice varieties.

The municipality of Bilar is 41 kilometre (km) away from Tagbilaran City. Barangay Campagao is one of the 19 barangays and approximately 10 km away from the town capital. It is an agricultural community characterized by flat and rolling lands with scattered hills. Most of the rice fields are irrigated lowland.

The population of Campagao is 7 percent (or 1092) of the total population of 14,926 of Bilar. There are 181 households with 6 members as the average. The people in Campagao are socially active and almost all are involved in various organisations. Among these is the agriculture-based cooperative, the Campagao Farmer Research Association, and Farmer's Association.

SEARICE farmer-partners in Bohol successfully conserve and develop rice genetic resources. Among the 150 farmer-partners organised through the Community Biodiversity Development and Conservation (CBDC) Bohol project, five Boholano farmer-breeders were interviewed on their breeding objectives, seed development process and challenges in breeding red rice varieties These farmers, namely: Jeremias Rubilla Sr., Venancio Cesar, Gerardo Calamba, Bebiano Adlaon, and Bonifacia Rebuta shared their transformative experiences on rice breeding and off-type selection.

13.1.2 Breeding objectives

The Boholano farmer-breeders preferred creating their own new variety adapted to their field conditions. This is specially the case of farmers Rubilla and Cesar who experienced crop failure when they used the modern varieties provided by a technician from the Philippine Department of Agriculture. The common breeding objectives are as follows: early maturing, long panicle, strong culm, heavy weight, pest and disease resistant, aromatic, good eating quality and good selling price. All farmers preferred a red rice variety since it commands high market price and more nutritional content. These farmers not only considered their own breeding objectives but also regarded the needs of their fellow farmers and the need to create economic opportunities with a reliable source of seeds in their communities.

13.1.3 Seed development process

The farmers acquired the much needed knowledge and skills from the Farmers' Field Schools on PGR sponsored by SEARICE. The seed development process was primarily influenced by the breeding objectives of each farmer.

Rubilla chose the F1 from *Japan Red* and *Japan White* and crossed them with *Hubahib* and *Hinumay* using a three-way cross method. The F2 cross-bred from *Japan Red* and *Japan White* was obtained through bulk selection method. The F1 (F2 (Japan Red x Japan White) X Hubahib) had the following characteristics: strong culm, good eating quality, aromatic, heavy grain weight, pest resistant, and the grains do not easily shatter. The characteristics introduced from the parent material *Hubahib* are good eating quality, longer panicles and compact grains. His F1 produce is now maintained in his field plots.

With the influence of other farmer-breeders in the nearby barangay, Cesar bred *Hubahib* and *Japan Pula* because of their good field performance. Cesar got the seeds as parent materials from another farmer-breeder. *Hubahib* served as parent material because of its resistance to pests and diseases and good grains. *Japan Pula* was likewise chosen as a breeding material for its resistance to diseases, strong and big culm, big grains and good eating quality. The resulting variety is named VCC, after his name Venancio Cabusao Cesar to identify his efforts to other farmers. At F1 stage, the offsprings were uniform but when they reached F2, the different characteristics from both the father and mother materials were sgregating. Selection was already practiced at the F2 stage. Cesar selected five different potential rice varieties which were distributed to other farmers for testing to motivate them to experience the selection process. He emphasized though that only after the F6-F8 stages does a variety become uniform and stable.

Another farmer Calamba chose *Japan Pula* as the father for its red color and big grains which was paired with *RC 18* for its long panicles and high yield although its grains shatter easily. Using the panicle method of selection, he picked the short and erect panicles with red color and big grains and was able to generate 9 types, which was named and numbered *Radix Breeding Line* (*RBL* 1-9). From these selections, his neighbours preferred *RBL*-7 red and white and *RBL*-3.

Adlaon first thought that off-types should be removed so that materials will be pure, but he later on realized through the intervention of SEARICE that single-plant off-type selection was possible and multiply the ones with superior quality. He then selected an off-type *Pilit* (sticky rice), and came up with *Red Horse* variety with heavy panicles, good milling recovery, compact grains, pest resistant, aromatic and high yielding. Characteristics not present in *Red Horse* are short height and big culm, so that the plants will be sensitive to lodging. His other selections were *White Gold*, *Red 2000* and *Beb 2000*. Among his four selections, only the *Red Horse* was maintained, while the other three were incidentially sold and where shared with fellow farmers not only in Bohol but also in Mindanao.

Rebuta used *Red 15*, a traditional variety and *RC 18*, a modern variety as parent planting materials. *Red 15* is commonly planted in her area owing to its red grains, strong culm and early maturing qualities, while *RC 18* is the first modern rice variety widely used by farmers in her area due to its desirable traits such as high yielding, heavy weight, big grains, long panicles, strong culm and disease resistance. After four seasons of planting her bred rice, she has maintained four selections.

The seed development process enabled the farmers to reduce farm expenses since they did not have to buy planting materials. Farm productivity was enhanced with the use of organic fertilizers such as rice straw and *madre de cacao* leaves. These farmer-breeders also gained revenues from the sales of their seeds, aside from the high sales derived from the improved yields of varieties selected.

13.2 Problems encountered

Plant breeding and varietal selection proved to be very tedious processes, yet the farmers were persistent with their work. Even if other farmers did not appreciate their efforts, they were not discouraged but were motivated by their desire to attain their breeding objectives of acquiring good quality seeds and rice diversity.

The Philippine Plant Variety Protection Act of 2002 is in conflict with the breeding of farmer-breeders. Despite this situation, these farmer-breeders did not hesitate to share the seeds with other farmers who are interested in the newly developed varieties since they believe that no one can claim ownership over the seeds in the communities. The farmers did not rely on seeds from the government because they self-sufficient in developing their own varieties.

13.3 Conclusion

SEARICE was the catalyst for development of farmers to realise on their farms conservation, use and management of PGR. The diversity of red rice in farmers' field in Bohol illustrates the role of farmers in increasing genetic diversity. The level of genetic diversity within farmers' selections is higher than in modern varieties. Rice breeding helped in establishing a reliable source of planting materials adapted to local field conditions. The farmer-breeders are not only assured of good quality seeds but are also empowered with knowledge and skills on plant breeding and varietal selection. These farmers encouraged their fellow farmers to continue sharing the knowledge, skills and the seeds to other farmers to promote open access to seed diversity.

14 BUCAP BHUTAN: THE CASE OF RICE

14.1 Introduction: setting the scene

14.1.1 Origin of the initiative

Bhutan has a high altitudinal and climatic variation, and therefore is blessed with a rich biological diversity and a wealth of plant genetic resources. Rice is the staple food crop, grown from the lowlands (200m) in the south to elevation as high as 2700m in the north, west and east. The total rice area in the country is estimated to be around 20,000 hectares, most of which is irrigated.

The Renewable Natural Resources Research Centre at Bajo, Wangdue is the leading centre for rice research. In 1984 the centre was linked with the International Rice Research Institute (IRRI), Philippines and systematic research on rice was started. In collaboration with IRRI, several local rice varieties were crossed with improved cultivars. Bhutan sent germplasm of its local varieties to the Philippines, where IRRI plant breeders crossbred them with improved varieties and sent back F2 seeds for field evaluation and selection in Bhutan. The objectives of the crossing program were to develop elite cultivars that would outperform the existing varieties by overcoming the constraints specific to Bhutanese conditions. Efforts were made to improve traditional rice varieties by incorporating desirable genes from improved parents for high yield, red pericarp, grain quality, cold tolerance and resistance to diseases, especially blast.

In the year 1995 a severe blast epidemic caused by fungus *Pyricularia grisea* raged through the higher elevations (1,800–2,700 m) which affected an area of 1,799 acres, resulting in the crop loss of 1,099 metric tonnes with an average disease severity of 71% (MoA,1995). To prevent future blast epidemics, the Ministry of Agriculture formulated a long-term strategy with an objective of developing blast resistant, high yielding, cold tolerant varieties for medium and high altitude areas. The RNRRCs Bajo and Yusipang and the National Plant Protection Centre at Semtokha jointly initiated high altitude rice improvement program at Gaynekha, which was identified as blast hot spot area. RNRRC Yusipang then started to screen and select cold tolerant blast resistant high yielding improved rice for high altitude rice growing areas.

In 2001, the Biodiversity Use and Conservation in Asia Program (BUCAP) in collaboration with National Biodiversity Center (NBC) and SEARICE, Philippines initiated the on-farm rice conservation and participatory breeding program. The project worked with communities and was able to institutionalize the participatory plant breeding in the country. In the West Central region participatory plant breeding was undertaken on rice, whereas maize was the main crop in the eastern region. BUCAP facilitated the exchange of experiences at farmer, extension and breeders level.

14.1.2 Problem addressed & local conditions

More activities were concentrated on rice as it is the main crop and has a huge potential to increase the production in the region. Moreover, farmers did not have access to new and improved varieties. The ones available had undergone decades of cultivation thereby exhibiting poor performance especially in yield. The main objective was to explore with farmers the potential of creating better adapted improved varieties to make farmers self sufficient in rice, while at the same time ensuring on-farm conservation and utilisation of rice diversity in the country.

14.2 Local production and seed system

14.2.1 Production system

Rice is grown in terraced fields and the main sources of irrigation are rivers and streams. Such rivers and streams are largely dependent on the monsoon for recharging. Dominant cropping patterns in the wetland are rice-fallow, rice-wheat, rice-mustard and rice-vegetables. Research has demonstrated that rice-rice cropping is feasible in medium and low altitudes. In the high altitude region a nursery is

established on dryland in February- March and transplanting is carried out in May to June. Harvesting begins from October.

In the mid-altitudes rice nursery is sown in semi-dry beds in April and transplanted in June-July. Harvesting starts from end of September and continues till October. In the low altitude rice nurseries are established in June and transplanting takes place in July-August. Harvesting is in November. Rice, potato, oranges, apple, chilli and vegetables are the main sources of cash income for the farmers. Other important crops in the region are maize, wheat, mustard, millet and fruit plants. Some households raise livestock to provide for dairy and meat products and farmyard manure for the field.

14.2.2 Role of women

The role of women in Bhutanese agriculture is very important. They are actively engaged in all the agricultural activities from land preparation to marketing. There is no gender bias or discrimination in carrying out agricultural activities. Women also participate in agricultural trainings, demonstrations, meetings etc. Some households are entirely managed by women when their husbands are away doing non-farm activities. Women are also actively involved in selection of seed in the field before the harvest. For all the field activities from sowing to harvest women are actively involved. In the family also main decisions are taken by the mother but she also takes suggestion and consent from the father. Therefore Bhutanese women play a vital role in the entire agricultural operation.

14.2.3 Seed system

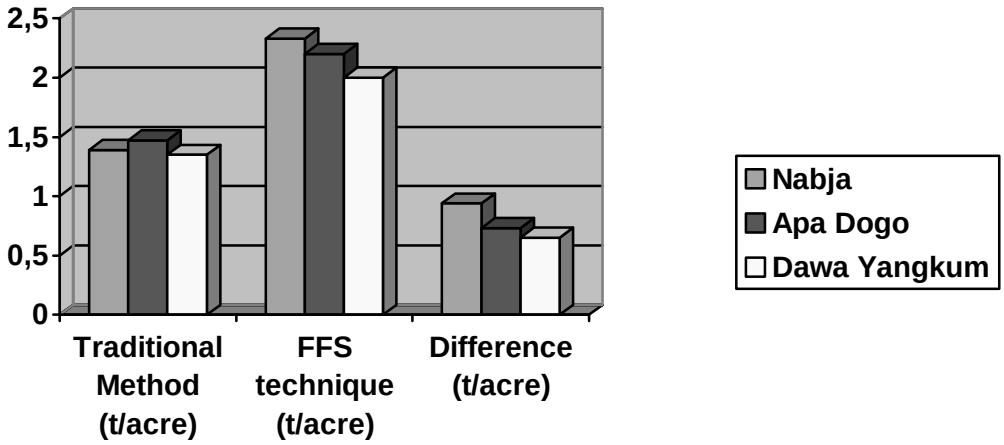
Preserving their own seeds for planting in the next season and exchanging with neighbors are the common practices for rice farmers. The exchange of seeds usually occurs from higher elevation areas to lower rice areas, as seeds are considered to be freer of pests and diseases due to cooler climate.



BUCAP has initiated a number of activities in the seed sector. Seed purification of traditional rice varieties has been done with the farmers' participation through Farmers Field School (FFS) approach. Rice varieties of Phulaychu, Bunap Kaap, Nabja, Apa Dogo and Dawa Yangkum have been purified by the farmers and purified seeds have been exchanged within the community for their higher yields.

Table 14.1. Yield Performance after seed purification

Varieties	Traditional Method (t/acre)	FFS technique (t/acre)	Difference (t/acre)
Nabja	1.39	2.33	0.94
Apa Dogo	1.47	2.20	0.73
Dawa Yangkum	1.35	2.00	0.65



Druk Seed Corporation (DSC) is the main formal agency for seed production and distribution to the farmers. The research centre that breeds and releases a new variety maintains the breeder seeds which are passed on to the DSC for further multiplication and supply to the farmers. DSC has identified farmers, called registered seed growers, who produce seeds in their field. These farmers are given foundation seeds to be multiplied and these seeds are bought by DSC. However, customarily, farmers prefer to save their own seeds
of cereal crops like rice or exchange with their neighbors.

14.2.4 Other important socio-economic and agro-ecological conditions

Bhutanese rice farmers are basically subsistence farmers who cultivate rice primarily for home consumption. They are socio-economically poor and often cannot afford external inputs and investments necessary for higher production. While such a situation is may be good news for sustainable agriculture, research and development workers find it difficult to bring about changes in the system that may increase productivity. The difficult terrain and remoteness are other factors constraining development.

Rice farmers depend on monsoon rains to recharge irrigation sources for rice transplanting but for last few years the monsoon has been irregular often forcing farmers to delay the transplanting. One of the solutions could be to develop early maturing varieties which could be transplanted late in the season in case monsoon is delayed.

Due to rapid economic development precious arable lands are taken by infrastructure and other developmental activities. The main challenge is to grow enough food from limited land for a population growing at the rate of 3%. In addition due to change in climate like late onset of rain, agricultural activities are adversely affected directly or indirectly.

14.3 Organisational and institutional structures

BUCAP is coordinated by the National Biodiversity Centre (NBC), Ministry of
Agriculture located in Thimphu and implemented in collaboration with Renewable Natural Resources Research Centres (RNRRCs) which are distributed through in different districts. The RNRRCs in collaboration with District Agriculture Office (DAO) identified the sites for the BUCAP projects in their respective districts. The DAO have their Agriculture Extension Agents (EAs) in the geog (blocks) and thereby forming the immediate counterpart for BUCAP in implementation and monitoring.

The RNRRCs estimate the budget expenditure for the particular financial year and submit to NBC for is release. The released budget is retained with the RNRRCs and amount is utilized as and when activities need budget support. Dzongkhags can also prepare plans and propose for budget from the RCs.
The monitoring visits, trainings and field days are all conducted jointly by RNRRCs and EAs. EAs often make visit to the site themselves when RNRRCs could not make the visit due to busy on station activities or some other circumstances. EAs suggest and advise the farmers about the agricultural activities during such visits and provide technical backstopping while trainings are rendered jointly by RNRRCs and EAs.

14.4 Methodologies adopted in PPB and farmer participatory breeding practices

BUCAP has initiated and introduced the concept of Farmers Field School (FFS) approach in the execution of collaborative activities like participatory varietal selection. This type of FFS participatory activities were new to the research system though the researchers used to select the promising lines through farmers' participation during the field days and also through on-farm trials. FFS approach by involving farmers directly in varietal selection according to season-long assessment and observation on the performance of promising lines for preferred traits facilitated participants' interaction helped in understanding issues of common concern. It facilitated drawing up and execution of relevant activities and finding suitable solutions to address their problems. Hence such an approach gave more opportunities for the farmers to decide on adopting or rejecting the new technologies introduced by the researchers.



14.4.1 Materials used

The plant breeding materials used were crosses made by the researchers in the research centre because farmers lacked as yet the required expertise to do so. The crosses made are between local and improved varieties to combine desirable traits from both parental materials. In general these are preferred household characteristics and assumed local adaptation of the farmer varieties with high yield potential of the modern varieties. Parents are selected based on farmers' feedback. The promising lines in various stages of development are then introduced to the farmer's field and subjected to selection by farmers on their own criteria.

Because of the problem of blast in high and mid altitude region, selection for blast resistance in high yielding lines were taken as a priority. Initially selection began with the introduction of over 500 entries generated through the breeding program. Some of the local parents used in crosses are Kaap, Maap, Zakha, Dumja, Zechum, Bjanaab, Attey, Thimphu Maap and others. The selected breeding lines released to farmers are being tested in different Agro- ecological zones. Some have already resulted into varieties (Ghimiray, 1999). A sample of crosses and their parents are shown in Table 1.

Table 14.2. A sample of crosses made for testing in farmers' fields

Variety	***Parents***
IR61331-2-148-B	Paro Maap/IR41996
CARD21-10-1-1-3-2-1	Local Maap/IR 64
CARD21-14-1-1-3-2-1-B	Local Maap/IR 64
IR61328-136-2-1-2-3	Bja Naab/IR41996-
IR65239-B-B-47-B	Attey/YR3825-
CARD20-21-3-2-3-1-1	Local Kaap/IR 64
IR62467-B-R-B-B-1-1-B	Attey/Suweon 358
IR61331-2-25-2-3-1-1	Paro Maap/IR41996-
CARD21-15-3-2-3-3-2-B	Local Maap/IR 64
IR62473-B-R-B-12-B	Zakha/Suweon 358
IR63332-B-B-B-26-B	Zakha/Akihikari
IR62467-B-R-B-29-B	Attey/Suweon 358
IR62467-B-R-B-34-2-B	Attey/Suweon 358
IR62472-B-B-50-B	Sukhimey/Suweon 358
IR66068-B-B-31-2-1	YR3825-//YR3825/Barkat
IR62746-B-4-8-1-1	Suweon 359//IR41996-/Th Maap
IR 80484	IR 65598-112-2/Dago Yangkum
IR 80485	IR 65598-112-2/Local Yangkum (red)
IR 80490	IR 71684-36-3-3-2/Dago Yangkum
IR 80491	IR 71684-36-3-3-2/Local Yangkum (red)

14.4.2 Farmer-breeders groups

In Bhutan PPB is a community activity using FFS approach involving selected farmers. The breeding lines are planted in a centrally located farmer's field of one of the participants. All the meetings and field related activities are conducted here with active participation from the FFS members. The EA and research personnel facilitate the whole process, including community meetings and field days.

14.4.3 Selection criteria

The EA and RNRRC neither impose nor force FFS members to select a particular variety. They only act as facilitators and help the members in technical guidance. Farmers themselves are the ones who select the varieties depending upon their expectations and criteria.

Assessments of the materials are done using different ranking tools. Matrix ranking were commonly used with farmers' participation in order to evaluate the varieties and to select the best lines. Some of the preferred criteria are yield, kernel colour, disease resistance, maturity, taste, height, easiness to thresh, grain type, straw yield, marketability etc. However a majority of the farmers consider yield and yield security as the main criteria.

14.4.4 Selection scheme

The early generation materials are evaluated based on the plant type, maturity, and disease resistance at station level by researchers and farmers who visit the station during field days. After a number of generations reasonable uniform and disease free lines are bulked. The materials with negative characters like late maturity, susceptibility to diseases, non-cold tolerance are all discarded. Farmers are primarily involved in selection in later generations from about F5 onwards in order to select on the basis of F5 or so in order to ensure varieties with farmers' preferred traits including high yield, resistance to blast, early maturity, panicle length, plant height, tillering ability and others. These evaluations in farmers' field are also used for assessing farmers' reaction to a specific practices and its suitability in their circumstances.

RC Yusipang in collaboration with NBC through BUCAP Project, Dzongkhag extension and other RCs. released two improved local varieties of rice resistant to blast, namely Yusirey Maap and Yusirey Kaap through participatory varietal selection Similarly, RC Bajo has released four improved white and red varieties over the years.

Selection scheme and time line, an example

2002 Being the first year, through participatory variety selection only one improved variety (Khangma Maap) was introduced in addition to three local varieties (Phulaychu, Gyamja Kaap and Gyamja Maap)

2003 3 more improved varieties (PP-238-4, Yusirey Kaap and Yusirey Maap) and 2 more local varieties (Buna Naap and Wangda Kaam) were added to the list.

2004 Gyamja Kaap, Gyamja Maap and Wangda Kaam were rejected due to their low yielding ability. Machapucherey, another improved variety was added to the list.

2005 Yusirey Kaap and Khangma Maap did not perform well and hence were rejected. Amongst the remaining varieties Machapucherey was found to be promising and hence adopted.

14.5 Reflection on experiences

14.5.1 Participation

When the project was started, many farmers were reluctant to become actively involved, reluctant to accept the risks involved.take up many activities due to less risk taking ability. In subsequent years confidence increased while the introduced varieties performed well. The timely and frequent monitoring of EA and RNRRC also helped in building confidence. Farmers saw the advantages of active contacts with facilitators through FFS in solving problems that arose. A majority of farmers felt that their skills in farming has been greatly increased and notably in the method of seed selection which was introduced as a part of the project.

Also researchers started to see the advantages of FFS in involving farmers in their breeding activities. In the past, a top-down approach of transferring technologies to farmers was followed, which was not very successful. Through BUCAP a shift has been realised from technology driven to demand driven research and adoption of new technologies. In the process farmers have gained confidence and became valued co-operators and equal partners rather than mere recipients in the research and extension process. A key role was played in these developments by the FFS approach adopted. It has provided a structure of co-operation between research/extension and farmers applicable beyond just variety development.

14.5.2 Genetic selection and diversity

The adopted varieties are distinct but differed in various characteristics. Some varieties are tall while some were dwarf. Some have big sized grain while some are small in size. The characters that farmers usually choose are big sized grains and moderately tall plant height since they need straw as the fodder

for their livestock. Red kernel varieties are more preferred than white ones. With the introduction these new varieties farmers have a wider choice to suit their respective requirements andand the genetic base of the crops has been broadened. Most of their native cultivars are still grown without affecting diversity adversely. After the incidence of blast epidemic in 1995, farmers were hesitant to grow their local varieties alone due to the yield loss experience during the disease outbreak. Most of the farmers switched to growing Khangma Maap, a blast resistant variety, on larger scale. Therefore to increase the diversity of improved varieties resistant to blast disease RNRRC Yusipang was mandated to develop and select cold tolerant, blast resistant and high yielding rice varieties for high altitude rice growing areas. This program in collaboration with NBC through BUCAP project, Dzongkhags and other RCs was able to increase the diversity of blast resistant varieties in the farmers' field.

14.5.3 Other findings and lessons

- Most farmers appear to prefer to work in a group in such project since time and labour requirement is more equally shared during field activities. Moreover, communication is improved since farmers can exchange jointly their views and perceptions with the extension workers and researchers.
- Incentives like working lunch, free supply of tools/equipments, trainings and study tours activate and encourage the farmers in project implementation.

14.6 Institutionalisation

The entire program was implemented jointly by DAO and RNRRC in co-operation with SEARICE. With the imparted training on method of seed selection, farmers themselves now select good quality seeds for ensuing seasons making full use of the existing farmer seed system.. Participatory varietal selection facilitate farmers in selecting the best variety besides creating awareness on existence of other improved varieties that are adaptable and good yielders than their local cultivars.

The concept of FFS helped farmers in problem solving and decision-making which was a new concept in the research system. Groups of farmers were selected in the initial start of the project where farmers got an opportunity to select and screen promising lines based on season-long assessments. The selection of the promising lines was done initially at the
research stations, then the most promising lines were taken to the farmers fields. Through the BUCAP project PVS, rehabilitation of local varieties, and seed selection have been carried out since 2000.

14.7 Management of products of PPB

As of now the FFS groups of farmers handle and manage the products of Participatory Varietal Selection. The selected seed materials are retained with the host farmer and later distributed to the interested FFS farmers for sowing in their respective fields. The non-members also get the seeds when there is enough stock. Only advanced lines are taken to the farmers' field to avoid the labour intensive work of crossing and managing early materials by farmers on top of their already heavy work load during the growing season. Also, initial selection and screening for major diseases like blast is better done on-station, partly to avoid the spread of blast disease in farmers' field when inoculation is needed for disease manifestation. The materials tested at the start of the project are maintained as back-up seed at station level.

14.8 Outlook

Challenge now lies in development of new varieties and maintenance of seed in farmers' field. Capacity building of extension, farmers and research assistants are required in meeting the challenge of development of new varieties through PPB.In addition, the present generation of Bhutanese farmers is

largely illiterate. Therefore to fully devolve rice breeding and selection to them will take some time. However, farmers, particularly from Thimphu and Paro, are showing interest in rice breeding and RC Yusipang has started to organise trainings to build-up their capacity gradually.

14.9 References

Chhetri GB, Ghimiray M, Pradhan N, 2000. Rice Genetic Resources of Bhutan. In Bhutanese Indigenous Knowledge, Issue No 6:68-81. Centre for Bhutan Studies. Thimphu, Bhutan.

Ghimiray M, 1999. Conservation and utilisation of Bhutanese rice genetic Resources. In:Tshering K, Tamang AM, Mal B, Mathur PN and Dorji R (Eds), Plant Genetic Resources – Bhutanese Prospective, Proceedings of first National Workshop on Plant Genetic Resources, pp 30-37.

Ministry of Agriculture, 1995. Report on the Rice Blast Out Break. REID, MoA Thimphu, Bhutan.

Ministry of Agriculture, 1995. High Altitude Rice Blast Hot Spot Breeding Proposal RNRRC Bajo, Yusipang, NPPC Semtokha, REID, Thimphu, Bhutan.

Pradhan, Neelam and P. Giri.2006. BUCAP and Participatory Plant Breeding: A Case in Bhutan. A paper presented during the Regional Plant Breeders Meeting, 14-18 February, 2006. Bohol, Philippines.

Shrestha et al. 2003. An Economic Impact Assessment of the Rice Research Program in Bhutan. Ministry of Agriculture, Royal Government of Bhutan and the International Rice Research Institute.

15 BUCAP LAO: THE CASE OF GLUTINOUS RICE

15.1 Introduction

15.1.1 Origin of the initiative

The main implementing institutions are the Plant Protection Centre (PPC) and the Secondary Agricultural Technical School in Luang Prabang and Champassak province. Both implementing institutions are under the co-ordination of the Department of Agriculture of the Ministry of Agriculture and Forestry. The Naphok Agriculture Research Centre (NARC) of the National Agriculture and Forestry Institute (NAFRI) provides technical backstopping and breeding materials to farmer partners of BUCAP. This program is funded by Development Fund Of Norway and coordinated by the South East Asia Regional Institute for Community Education (SEARICE), Philippines.

15.1.2 Problems addressed & local conditions

Farmers have an inherent interest in planting materials that better suit their requirements. However, to involve farmers in PPB, they need to have a basic understanding on rice varieties, the function of genetic diversity as well as the necessity of genetic resources conservation and opportunities of development. In addition it requires understanding of hybridisation, segregation, lines selection, the function of Observation Yield trial (OYT), seed rehabilitation and improved seed multiplication. This basic information is supplied through attending farmers field studies (FS) and farmer field school (FFS).

15.2 Local production and seed system

15.2.1 Production system

There are four basic groups of Plant Genetic Resource within farmer‘s production systems : rice, cash crops, home consumption crops, wild and weedy species. Mostly farmer produce rice for their owe consumption in wet season and vegetable cash crops like long been, cabbage, chilli, corn and cucumber in the dry season for cash income. The predominant crop is glutinous rice, grown on over 80% of the cultivated land. Almost all minor crops grown for home-consumption are local and traditional varieties . Many of the vegetables consumed in Laos are not cultivated but are wild vegetables gathered from the surrounding environment.

15.2.2 Role of women

Traditionally, men plough, make bunds and prepare seedbeds, and women do more then half of the transplanting of rice, weeding, harvesting, threshing and post-harvest operations. However women are increasingly involved in land preparation, irrigation and preparing bunds and seedbeds as well.

15.2.3 Seed system

There are several types of rice seeds production systems that exist in the country. These type are determined primarily by two factors; 1. by its eco-system and 2. by its market orientation. The main source of rice seeds in the districts including the improved varieties are exchange and own collection by farmers. There is an increase in demand for access to information and seeds of improved varieties for intensive and market oriented production.

15.2.4 Other important socio-economic and agro-ecological conditions

At the ecosystems level, there are three main types of rice production; irrigated, rain-fed lowland and upland systems. Within the irrigated, rain-fed systems there can be subtypes determined by the availability of water during the dry and wet season. Farmers are encouraged to increase production to satisfy market demands. For this, improved varieties are preferred because of generally higher yields in the main production environments.

15.3 Organisational and institutional structures

The Biodiversity Use and Conservation Asia Program is under Department of Agriculture' supervision. The Plant Protection Center is responsible for the implementation of project's activities, co-ordination and its execution. An important reason for this was familiarity with FFS through its involvement in integrated pest management projects. OXFAM is responsible for financial administration. SEARICE through BUCAP provides back-stopping support. BUCAP has projects in four provinces and through the Plant Protection Center involves a number of co-operating institutions and organisations:

- Luangprabang Province
  - Agriculture and Forestry Extension
  - Northern Agriculture Collage
- Vientiane Province
- Savannakhet Province
- Champassack Province
  - Agriculture Division
  - Southern Agriculture Collage

Napok Agriculture Research Center contributes by providing technical support and material.

15.4 Methodologies adopted in PPB and farmer participatory (breeding) practices

15.4.1 Materials used

The National Agricultural Research Center (NARC) is responsible for rice breeding in Laos. However, traditional farmer varieties, developed and managed by the farmer seed system are still widely used. Through BUCAP both systems are now co-operating. The BUCAP projects are supplied with breeding populations in the F3-F6 generation for further selection in farmers' fields supported by FFS. Both modern and traditional varieties are used in developing breeding populations. FFS are supported by local trainers, provincial extension services and plant breeders of the NARC. As BUCAP progresses, in the context of FFS farmers have also become involved in crossing. The overall objective is to produce varieties that are better adapted to various agro-ecosystems and market demand.

15.4.2 Farmer-breeders and the group

The BUCAP and NARC usually organize meetings and field trips to discuss and exchange experiences whit farmers 2-3 times per season. During these meetings also general problems about budget and technical issues are discussed. Attending farmers in FFS are trained to understand variety crossing, genetic segregation and lines selection, Observation Yield trials (OYT) are suggested and training in seed rehabilitation and seed multiplication provided. During field days at the end of the season, farmers of BUCAP groups, non farmer participants and local authorities are invited to attend in the meeting to discuss introduction of new varieties.

15.4.3 Selection criteria

The selection criteria depend on the actual eco-system.For example in northern Laos farmer like short plant type and southern farmers like tall plant type, because in the north soils are more fertile then in the southern Laos. Otherwise farmers mainly focus on traits like yield , disease resistance, cooking and eating quality.

15.4.4 Selection scheme

On lines selection from season to season , in addition to yield, farmers are also looking for minor traits like seeds colour, endosperm colour, grain shape, milling quality…etc

15.5 Results

The data that farmers collectare: Seedling vigor, Flowering data, Height at maturity, Lodging rating, Rating for damage by important pest and diseases, Maturity date, Grain yield, Eating quality .

15.6 Reflection on experiences

15.6.1 Participation

Through BUCAP farmers have gained expertise on the importance of geneti resources and conservation and various aspects of breeding and selection. Observation Yield Trials provide information about available varieties and allow farmers to identify materials that better suit their requirements. Through improved seed production and selection within their local traditional varieties (seed rehabilitation), improved planting material has been obtained. Through FFS and field days farmers share their owe experiences with each other, learn from each other. BUCAP has contributed in making farmers more self-sufficient and increased the amount available for sale in the market.

15.6.2 Genetic selection and diversity.

BUCAP in co-operation with the NARC has contributed to the adoption a wider range of new improved varieties. In a large portion of rain-fed lowland rice areas traditional varieties are being replaced by improved varieties in a continuous process and significant increases in productivity are being realised. Traditional varieties are still prevalent in the more marginal rice lands where water availability is a problem. Here seed rehabilitation through improved seed production practices is having an impact and, in time, through PPB new adapted varieties may become available.

15.6.3 Other findings and lessons

- The impact of BUCAP and PPB is very uneven. In favourable rice production environments progress generally is rapid. However when there are serious environmental constraints, notably in water availability, results are more difficult to realise. Adaptation to adverse conditions is a slow and difficult process.

- Participation of women in FFS and PPB is still low.

- The number of farmers involved in actual crossing and breeding population development is still low.

15.7 Institutionalisation

The Department of Agriculture and NARC are very supportive and showheir interest in the project. Also local governments give strong support. The projects have improved farmers' participation in development and their relationship with research and extension. Government staff has been impacted by BUCAP in ways they work with farmers and district trainers. Through BUCAP, plant breeding at the NARC has better access to farmers and their requirements, facilitates access to their materials and gives advice, as well as technical guidance and services to the national team members, organizes training of local trainers and farmers. Management of products of PPB

The production and diffusion of rice seeds of materials produced through the BUCAP projects are managed by farmers. Distribution of seed usually takes place during field days, at which out-side farmers are invited to the project sites. On request they usually are given a small sample of the desired material for testing and multiplication on their own farm. In case they want more seed, they usually can either buy it or get it on an exchange basis. When farmers want to register their variety for wider (coomercial) distribution, they can submit the required documentation to the DOA

15.8 Outlook

It is clear that PPB on rice has played important role in improving farmer practices on seed production and adoption of new varieties in Lao PDR especially in BUCAP sites. Farmer-to-farmer is contributing to wider distribution of promising lines beyond the project sites. Improved skills obtained through BUCAP are evident in many communities. in addition it has increased genetic diversity of rice in farmers' fields.

Based on above achievements, in phase II, BUCAP Lao has a strategy to expand its projects to other provincesm making use of trained trainers. An important additional objective is to strengthen the role of farmers in marketing their harvest and planting materials. Also it is felt that much can be learned from experiences and practices in other countries through BUCAP.

Xangsayapane Phetmanyseng and C. Bounphanousay. 2006. Participatory Plant Breeding in Lao PDR. A paper presented during the Regional Plant Breeders Meeting, 14-18 February, 2006. Bohol, Philippines

16 BUCAP VIETNAM: THE CASE OF RICE IN HOA BINH PROVINCE

By the Plant Protection Sub-Department Hoa Binh, Vietnam

16.1 Introduction: setting the scene

Vietnam is generally divided into South, Central and North Vietnam. BUCAP is implemented in 10 provinces, namely four in the North, four in the central part and two in the southern part of Vietnam. The funding from this project comes from SEARICE/Norwegian Development Fund and Danida. At this moment, Oxfam Hong Kong is also supporting the project. BUCAP involves many Vietnamese partners in government and NGOs at the provincial and district level.

In Vietnam, BUCAP is combined with the FAO/DANIDA IPM program managed by the Plant Protection Department. After learning from the experts of IPM program about PPB, we started with BUCAP. We also involved the youth union, farmers union, women's union and even businessmen.

Some major activities implemented by BUCAP in Hoa Binh province can be studied as a form of training on PPB and PVS for farmer groups to produce seeds for themselves and also for others. In terms of training, BUCAP Hoa Binh project already conducted several, with farmers and with the involvement of staff from the Plant Protection Sub-department (PPSD) and farmer trainers.

Hoa Binh is located in the mountainous area of Vietnam, where most of the households involved in agricultural production are indigenous people. There are seven ethnic groups/indigenous peoples in the 13 districts and town of Hoa Binh. BUCAP covers 7 districts, with 15 villages.

Breeding materials supplied to the farmers came from different breeding institutions like Mekong Delta Development Research Institute, Agriculture Genetics Institute and some university in the North. In, total BUCAP provided around 87 varieties to farmers. Of the 87 varieties, farmers selected 49 varieties suitable to the different agroecosystems of Hoa Binh.

Farmers are also involved in the seed improvement of land races and local seed variety. Farmers have purified 17 varieties amounting to 1.42 tons of seeds of traditional rice. Besides yield trials of 87 varieties, BUCAP also gave segregating materials for farmers to select. The source of segregating materials was Cantho University. So far, farmers have identified 17 promising lines. Of the 17, farmers selected 8 stable lines namely Giong MD25, MD26, TH4, TH5, G1, G2, D 2005 and TN2003 which are now planted on a large scale in many communes of the province. MD stands for Mo Da, the name of the community. TH is Than Hua while G is the initial of the name of the farmer.

Farmers also made 22 crosses and selected segregating generation. So far, 1 line from the segregating population has reached F7, almost a stable line. Major criterion for breeding is adaptability to local condition. For the materials used in breeding, the male parent comes from the research institute while the female parent comes from the local materials.

Among the 49 selected varieties from 87 varieties form local institutes, farmers already multiplied 37 varieties in 179 hectares. The total seed production is 442 tons which the farmers distributed to other farmers in the area and across the district.

BUCAP also provide good quality seeds outside of Hoa Binh province reaching 500 tons. The success of BUCAP in Hoa Binh led to local contributions (from the sales of the seeds and from local governments) amounting to 220.9M Dong or roughly US$14,726.67 which have been added to support the community based initiatives.

16.2 Farmers' experiences in seed production

16.2.1 Experiences in seed purification

Farmers from Mo Da hamlet, Ha Bi commune in Kim Boi district undertook seed purification of MD25, Nep Thom (an aromatic sticky rice) and 838 thuan. After three seasons, the seeds were tested against the seed standards of the Ministry of Agriculture for purity, germination and health. Seeds that pass the standards were allowed to be exchanged. For the past 5 years of BUCAP in Hoa Binh, the seeds of Mo Da always met the quality criteria and are highly appreciated by other farmers earning their trust.

16.2.2 Experiences in seed production

For three seasons in Thuong Coc hamlet, Lac Son District BUCAP generated varieties cover 25% of the total planting area. The commune has 21 hamlets and the local authorities convinced of the success of BUCAP created an organisation to expand the use of varieties in the commune. Every season, during farmer meetings of BUCAP, hamlet representatives introduce the characteristics of adapted varieties and see for themselves the actual field performance. Each hamlet selects the most suitable variety for their specific conditions for seed multiplication. In each hamlet, local authorities plan and set-up exclusive multiplication areas for all farmers in the hamlet to see. Then, farmers will contact hamlet authorities or directly with the field owner for seed exchange in the coming season.

Sa Th Binh Minh . 2006. Achievements and Some Experiences in BUCAP Implementation by Farmers from Hoa Binh Province. A paper presented during the Regional Plant Breeders Meeting, 14-18 February, 2006. Bohol, Philippines

17 PEDIGREA: USING THE FARMER FIELD SCHOOL CONCEPT AND INTEGRATING MARKETING ISSUES IN PARTICIPATORY PLANT BREEDING OF RICE AND LOCAL VEGETABLES

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I The program set up and overview

17.1 Introduction: setting the scene

Origin of the initiative
The Programme on Participatory Enhancement of Diversity of Genetic Resources in Asia (PEDIGREA) was established in 2002 to seek novel practical and sustainable approaches for the on-farm management of crop genetic resources. Since 2002, pilot projects for FFS-PPB have been implemented by PEDIGREA partners with selected farming communities in Indonesia, Cambodia and the Philippines, focusing on rice and local vegetables. The projects are primarily situated in rice-based farming systems with reduced crop genetic diversity resulting from the massive promotion of Green Revolution varieties. Since its inception, initial initiatives have been undertaken to expand the activities to the domain of farm animal genetic resources.

The establishment of PEDIGREA is a result of discussions by partners involved in the Community Biodiversity Development and Conservation (CBDC) programme, exploring how to build on and learn lessons from the collective experiences in other on-farm crop conservation and improvement programmes, both in Asia and Africa.



Fig. 17.1. PEDIGREA is a programme operationalising PPB in 3 countries in SE Asia: Cambodia, Indonesia and The Philippines.

Some distinct features of PEDIGREA are its deliberate focus on improving farmers' varieties, active collaboration with the public breeding sector, devoting substantial efforts to marketing of farmers' products, and most of all, in applying the farmer field school concept originally developed for Integrated Pest Management (IPM) in the area of genetic resources. Once sufficient experiences with farmer field schools for participatory plant breeding (FFS-PPB) have been gained, the approach can then be adopted in up-scaling and applied in other communities and on other crops and areas, with less external capacity needed.

PEDIGREA systematically aims to develop farmer-led approaches in participatory plant breeding, in which farmers, rather than scientists, decide upon the breeding objectives and breeding materials. Using this approach, PEDIGREA intends to empower and strengthen the capacity of farming communities to manage their genetic resources as an important component of local agro-biodiversity, thus contributing to the attainment of farmers' food sovereignty. At the same time, PEDIGREA recognises that maximum inputs are required to attain these goals and therefore pursues and facilitates close collaboration with other stakeholders, including scientists, researchers and policy makers.

17.1.1 Issues addressed and local conditions

PEDIGREA has been set up as a regional initiative in Southeast Asia. While conditions in each of the three countries where the project is implemented may differ substantially, some commonalities exist. All projects are implemented in typical small-scale farming systems with farmers owning from less than a hectare to a few hectares of land. Also, all project sites are located in areas which are accessible to large urban areas which makes the marketing of products resulting from the project initiatives well feasible.

PEDIGREA adopts a farming system approach, addressing both staple and additional crops. Farm animal improvement has already been initiated in Cambodia and is currently being planned in Indonesia and the Philippines. In each of the three countries, projects have been established in easily accessible rice-based farming systems thus PPB in rice has been the first activity undertaken by partners. In all project sites, sufficient rice varieties were available as source of breeding materials although these could be improved to better respond to local needs and preferences and to increase yields. In each of the projects, participatory variety selection (PVS) and PPB have been undertaken in local vegetables which remain as the communities' basis source of dietary enrichment aside from being a potential source of income for farmers. Selected vegetables are indigenous in the sense that the available varieties exhibit clear regional characteristics, and few commercial well-adapted varieties are also available. Cucurbits comprise the major share in the activities of the projects on vegetables. The efforts in the improvement of farm animals (pigs and chicken) are initially directed at improving the husbandry (i.e., better feed, disease protection) but also involved a discussion of desirable breed characteristics.

In the other aspects of the project, the project sites in the three countries have distinct characteristics, as detailed below.

17.2 Local production and seed systems

Production systems

PEDIGREA project sites are located in the coastal province of Indramayu, in northern Java at approximately 300 km east of Jakarta, which is considered as Java's rice bowl; in the vicinity of Phnom Penh (around 150 km) with low-lying rain-fed farming systems typical for Cambodia; and in the more elevated province of North Cotabato, close to Kidapawan City and some 200 kms from the regional capital of Davao City in the Philippines' most southern large island of Mindanao. All sites are located in areas with distinct wet and dry seasons, and within a distance of a few hours' drive from major urban consumer markets with population of a few millions.

All production in Indramayu is based on irrigation and the rice varieties grown include modern varieties originating from International Rice Research Institute (IRRI) and the Indonesian National Agricultural Research Station (NARS, Sukamandi Rice Research Institute) as well as farmers' varieties. Normally, two crops per year are grown. Most rice produced is for home consumption while surpluses are sold in the local markets. Local farmers recognise over 100 vegetable species that are

either grown or collected in the area. Some 10 – 20 species of vegetables are grown, mostly for the local market and in Jakarta mainly through middlemen. Chicken is the most common farm animal raised by farmers.

In Cambodia, production is dependent on rain and the flooding of the Mekong river. While most IRRI varieties have been bred for irrigated production systems and the national research infrastructure is poorly developed, few well-adapted modern varieties are available and rice yields are typically low. Vegetable production is concentrated in the dry season. Chicken as well as pigs (in addition to wild fish) constitute the main source of animal protein.

North Cotabato, in Mindanao, is well known as the fruit basket of the Philippines. Some farmers in the village sites have specialized in the production of either fruit trees or vegetables, but most farmers grow rice as the main staple, complemented by vegetable and fruit production. Rice is mainly produced for home consumption. Rice production is irrigation-based and most varieties grown come from IRRI and Philippine Rice Research Institute (Philrice), although farmers' varieties are also available. Most vegetable production is market-dependent, and most products are sold to middlemen who either sell the produce in Kidapawan or in Davao City. Since the past decade, vegetable production is notably no longer determined by the season.

In all three project areas, rice is produced for home consumption and seasonally varying surpluses are sold in the market, while vegetables form a major source of income. Also common among all sites is the interconnected goals of disease resistance, yield and short maturity in farmers' major breeding goals for all crops, as well as gastronomic traits such as eating quality. Notably, in all project areas, both men and women participate in decision-making, although men dominate in decisions concerning marketing. This may be gleaned from the profile of participation by gender in farmer field schools which exhibit substantial although not equal female participation.

Seed system

In each of the three countries the seed system is mixed. Most farmers produce their own rice seeds, while vegetable seeds are often purchased in local markets. This dependence on local markets for vegetable seeds often results in varying and unpredictable harvests, since in many cases no guarantee is provided on the origin, quality and adaptedness of the seeds. In Indramayu and North Cotabato, rice varieties released by IRRI and NARS are readily available and provide for most of the rice acreage grown, while in Cambodia the palette of available varieties is more diverse in origin. IRRI and NARS varieties are often produced informally by local seed producers. On the other hand, the vegetable seeds sold in the market come from different sources. Private sector involvement in the development and marketing of indigenous vegetable seed is still limited, although some of the vegetable seeds offered in the market come from abroad and often from the private sector.

17.3 Organisational and institutional structures

PEDIGREA is registered as a non-stock, non-profit foundation in the Philippines. The organisation is managed by two co-convenors sharing the coordination of the technical and policy components of the project, and supervised by a board consisting of representatives from the organisations listed below. Three NGOs operating nationally are primarily responsible for project implementation. These national organisations have previous experiences in working with the farmer field school model for IPM (Indonesia and Cambodia) or have some involvement in FFS in agrobiodiversity (the Philippines). They are supported by two partner institutions from the formal sector.

- Farmer's Initiatives for Ecological Livelihoods and Democracy Indonesia (FIELD, Indonesia)
- Srer Khmer (Cambodia)
- People, Plants Research and Development Inc. (PPRDI, the Philippines)
- Centre for Genetic Resources, the Netherlands (CGN) and Agricultural Economics Research Institute (LEI) of Wageningen University and Research Centre, the Netherlands
- International Plant Genetic Resources Institute, Asia and Pacific Office (IPGRI-APO), Malaysia.

The programme organise semi-annual regional meetings participated by all the partners. An exchange visit of farmers from Indonesia and the Philippines has been realized as well in 2005.

The PEDIGREA programme works on a very modest budget following a very simple organisation structure, thus setting a precedent for future farmer-led PPB programs. Each implementing partner is provided with a small annual budget, and has nominated a specific focal person responsible for developing and implementing the FFS courses. Supporting expertise from Wageningen has been made available from project funds, while financial resources have been provided by the Dutch Ministry of Agriculture, Nature Management and Food Quality through CGN, and by Food and Agriculture Organisation (FAO) in Rome.

Local organisation
Different levels of local organisation have been developed in the respective countries to support the FFS communities. In Indonesia, the entire FFS programme in Indramayu falls under the coordination of one farmer field coordination team (TPL). This team consists of three farmer-trainers, who are themselves actively involved in a community breeding programme. The team plans for new FFS-PPB, meet with the leaders and farmers in the communities, arranges for baseline surveys and timing of FFS, selects new farmer-trainers, and organises training of trainors (TOT) workshops and farmer forums once or twice a year, with the support of Field Indonesia. The team also can assign special task groups; currently there are two task groups in place: on village genebank and on FFS promotion, respectively. The team receives a modest financial and administrative assistance from Field Indonesia, and is primary accountable for the FFS to the community. The local team maintains strong links with the national farmer association, and with local authorities.

In Cambodia, the local organisation of FFS is still fragmented: local coordination exist, inter-regional exchange of breeding material take place, with support of Srer Khmer, but other types of institutionalisation such as independent farmer breeder forums do not yet exist. Srer Khmer has introduced the concept of Farmer Clubs. These clubs basically consist of a local platform for action research including PVS and PPB, advocacy and micro credit. By 2005 there were six farmer clubs active in the three FFS areas, which have been coordinating FFS implementation in the area.The focus of the farmer clubs however tend to appear more on local farmer representation and savings and credit schemes for local residents (due to the absence of rural banks). It is nevertheless foreseen that these structures will play an important role in the coordination of existing and new FFS in future.

In North Cotabato, the Philippines, the local coordination of FFS is arranged at two different levels: a farmer-breeder forum at the village level, and a farmer-breeder network at the district or provincial level. The village level forums meet monthly and focus on the exchange of seeds, the planning of land for trial purposes, and the updating of the overall progress of on-going and new FFS. The farmer-breeder network on the other hand meets once or twice a year and is composed of representatives of village level forums and aims at exchanging experiences, facilitate activities that can increase farmers' knowledge and skills, and study measures on how to gain farmer recognition for breeding and to maintain liaison with authorities.

17.4 Methodologies adopted in PPB and PVS

The work of PEDIGREA is distinctly anchored on the farmer field school concept. The programme has adopted a staggered approach, in which a community starts with a season-long training in rice, followed by a season-long training in the same village in vegetables, marketing and farm animals respectively. After the first season-long trainings the project staff remains involved in follow-up activities. The initial FFS course on PPB involves a large set of studies where farmers learn to compare and evaluate new varieties, conduct plant growth studies, experiment with breeding techniques, and review crop improvement strategies. The field is the primary learning stage for the participants, where they can practice their studies. Activities in this start-up course take place from pre-sowing to post-crop harvest. For rice and most annual crops, the FFS course takes 4 to 5 months or 18 weekly sessions to complete.

Selection of communities, farmers and crops
Communities were chosen based on previous experiences of partner organisations and a proven interest of communities in participatory projects. Other aspects such as crops grown, distance to urban centres and local availability of staff and/or trainers were also taken into account.

The FFS training is usually consist of about 25 farmers. Participants are selected from members of the farming community after the conduct of a baseline survey, based on the following flexible criteria:

- should have a farmland in the immediate village neighbourhood;
- should be an active farmer with keen interest in variety multiplication and crop selection;
- should have experience in the cultivation of selected priority crop(s);
- be in good health, between 18 and 60 years old, preferably with some basic education; and
- be committed to attend the training sessions over the full duration of the FFS-PPB.

The list of participants, unless otherwise decided, should include male and female, young and elderly farmers. From the experience of the projects, some persuasion may be needed to get female (or male) farmers to participate in the FFS, especially in some cultural settings and where a particular gender is predominantly involved in making decisions in farm management. The selection of vegetable crops (as well as of the farm animal species) is done in the baseline survey in close consultation with the community members.

Materials used

Breeding goals are set during the baseline survey, and serve as the basis for facilitators and farmer participants to arrange for the introduction of a number of previously untested varieties or segregating breeding populations in the community, usually between 10 and 15 seed lots. Once collected, these seed lots are included in the variety evaluation trial or in the selection process in segregating population and compared against local varieties popular among farmers. Suitable varieties or breeding populations may be collected from neighbouring communities, farmers in other districts, from research stations or national and international genebanks. When the locally available varieties do not have the required attributes, a field trip consisting of farmers and facilitators, or farmers together with experts, may be organised to actively search for varieties in other regions. The local organisers also help in linking with national and international genebanks and research institutions to request for suitable materials, such as foreign varieties and segregating materials.

Selection criteria

The breeding objectives set during the initial village baseline survey are revisited during the FFS, when selection criteria are also discussed. In this process, desired variety traits are prioritized and desired breeding and selection goals identified. Farmers focus on the traits that they wish to see in a particular variety ("dream variety"), and learn how to broadly set their breeding goals. FFS participants are requested to list the top five criteria that need improvement in the current crop, and to prioritize the criteria by using individual ranking methodologies, such as ballot box, cards, or just plain voting by hand. Farmers are also asked to take into account the broad categories, i.e. agronomic characteristics; characteristics for taste, texture and appearance; cooking and processing characteristics; and characteristics valued in storage and transportation. Much effort is taken to discuss the criteria in detail (e.g. length of fruit: how long?, resistance to particular pests: what pests, what diseases ? etc.). From experience, yield and pest and disease resistances and taste score high, as well as appearance (i.e., colour, size) for vegetables.

17.5 Results so far: participation, activities and improved rice and vegetables

A sign of success in the FFS is the high number of crosses made by farmers during the FFS start-up and follow-up seasons, showing not only the farmers' enthusiasm to indulge in the newly learned activities but also the farmer´s capability to identify varieties with outstanding agronomic and marketable traits through PVS. Most farmers have made crosses of the type local x exotic or local x high yielding varieties (HYV), indicating that the exotic varieties or HYV showed features that were not existing in the local types, and vice versa. Crosses were made in the Philippines primarily with tungro-resistant rice varieties; in Indonesia with brown plant hopper (BPH) resistant rice lines, in gourds and in luffa with a variety from Malaysia with good skin and leaf characteristics; and in Cambodia with pumpkin and wax gourd varieties received from Asian Vegetables Research and Development Centre (AVRDC). A more detailed description of cases of farmers' crossing and selection in the rice in the Philippines, the gourds in Indonesia and Cambodja are presented @@@)

Farmers in the three country projects have evaluated 140 varieties and selected a total of 158 varieties which were distributed across the different partner-communities. There are a total of 200 crosses in rice and 134 crosses in vegetables made by farmers since 2002. Farmers are currently managing more than 20 advanced lines and more than 400 segregating populations from their own crosses and those obtained from the formal sector.





(left) Fig. 17.2 Men and women farmers doing emasculation on rice during a FFS activity in Indramayu, Indonesia.
(right) Fig. 17.3 Women farmers emasculating eggplant flowers in a FFS trial in Cotabato Philippines.

Farmers had also successfully evaluated and rehabilitated local varieties that are popular to farmers but had been less favored because of deteriorating traits. In Cambodia farmers had rehabilitated 10 local varieties while in the Philippines, Bordagol - a farmer selection that was certified for release by the national government throughout the whole country is being rehabilitated by a skilled farmer breeder to restore its the original traits.

Thus far, in the Philippines, two promising high yielding farmer varieties, one with tungro resistance, bred by experienced farmer/breeders who joined PEDIGREA, are currently being tested by farmers in the municipality. At other locations, the FFS programmes have not yet progressed to this stage but appear to have developed several promising new lines, both in rice and vegetables. PEDIGREA´s experiences have been compiled in case studies and in a comprehensive field guide as well as training curriculums in rice and vegetables developed by project partners in local languages.

The project in Cambodia had also piloted the FFS in pig improvement in 2005. Farmer and government trainers facilitated the FFS in two communities and 48 farmers participated in the FFS. The FFS in poultry is being explored to be implemented in Indonesia and Philippines in 2006.

More than 80% of farmers who participated in the first FFS course in Indonesia and Cambodia, and about 60% in the Philippines, have signed up for the follow-up FFS activities. For breeding in self pollinating crops like rice, most farmer communities choose the pedigree selection method, others decided to use the method of bulk selection or a combination thereof. In cross pollinating vegetables, farmers choose to use the mass selection method (pumpkin, wax gourd) or a modified mass selection method, involving extensive manual crossing of selected siblings in the early generations to avoid unwanted out-crossing (bitter gourd, luffa). Farmers are also starting to experiment on their crosses employing not only single crosses but back crosses and top crosses in vegetables. This case is especially true in Indonesia where farmers had explored these crosses in pumpkin.

Participation of women farmers in the project has also been substantial. Thirty percent of the farmers trained in the FFS rice and vegetables are women. Participation and decision-making of women farmers on breeding and selection activities are enhanced with their involvement in the projects. Also, a number of the women developed breeding lines in vegetables and rice.

17.6 Constraints and challenges

Main constraints faced by farmers in the selection process are the lack of farm land or lack of funds to rent additional land for conducting trials, and the shortage of suitable facilities for storage of seed samples. Because of land limitations, in Cambodia and the Philippines, the entire community breeding programmes are often based on one or two varietal crosses only. In Indonesia, however, there are reports of farmers who have produced well over 20 varietal crosses in a single breeding programme. Needless to say that this causes some management problems in the field and in the seed store. Case studies indicate that the lack of resources creates problems with too rigid selection, late evaluation of quantitatively inherited characteristics like yield, taste and milling quality, and scarce possibilities to screen for pest and disease resistance, causing a narrow genetic base and missed chances. Few farmers are yet aware of this phenomenon. On the other hand, farmers appear to be well aware of the problem of limited storage facilities. This not only highlights the lack of low/cost storage conditions in the village, but also the limited capacity of farmers to administer, monitor and maintain seed lots during the breeding process. Models for decentralized low-cost village genebanks to support local breeding programmes have been proposed and introduced recently.

Another constraint is the limited available materials and its information that farmers used as parents in the breeding and selection activities. In the Philippines and Cambodia, vegetable varieties are mainly sourced from local markets which is limited due to the uniform preferences of consumers. In Indonesia, the rice varieties are mainly collected from within and nearby communities. However, tosome extent this concern has been addressed by tapping materials from national genebanks and research institutions. Still on the materials, the parentals sourced from formal institutions had no or limited characterisation data, resulting in mistakes in synchronisation of flowering dates (Indonesia), and in bottle-necks in farmers' work to further characterize the materials (Philippines).

Dormancy and poor germination rates of materials from one season to another season is sometimes also a challenge faced by partners (Cambodia).

In 2005 a start has been made with the systematic monitoring of breeding progress in the FFS. Participatory approaches are also being developed to address the monitoring of the progress and impact of PEDIGREA to farmers and communities. The partners in Indonesia used picturing impact as a participatory tool to monitor the developments of the PPB project while ensuring the participation of farmers involved in the project in impact assessment.

PPRDI took the initiative for local lobbying efforts in the municipality of President Roxas in North Cotabato towards the adopting of a Municipal Ordinance on Community Registry of Seeds and Traditional Knowledge. The project staff led a series of discussions with local government officials on the importance and details of community registry, coordinated farmers' direct participation in the discussions, and submitted the draft Resolution on the matter which was eventually adopted by the Municipal Council. In collaboration with a network of local farmer-breeders and organisations working on seeds conservation in the area, PPRDI is currently sustaining efforts to put in place the necessary political mechanisms and support structures towards the adopting of a Municipal Ordinance in 2006.

17.7 Reflection on experiences

A major issue that confronts PEDIGREA is how to sustain farmers' interest in project activities. While ample experiences in participatory work exist, most involves IPM and low-external-input agriculture, but less on PPB. A season-long FFS course in IPM is generally sufficient to train farmers on the desired elements, while in the case of PPB a number of seasons is required to obtain and test new farmers' varieties. In addition to sustained interest of farmers, consistent support by project staff emerged as critical to maintain the selection activities in later seasons. Farmers appear highly interested in acquiring skills to perform crossings, whether in rice or vegetable crops, but selection in later generations requires other skills and interests.

In communities where PEDIGREA implements FFS-PPB, at least three general categories of farmers may be gleaned: farmers who select parents and perform crossings; farmers who grow segregating selections in later generations supported by farmers of the first category;, and farmers who are not actively engaged but interested in testing and growing the products of PPB. As a self-evident observation among practitioners of PPB, although still strongly contested in other circles, a few individual farmers who are highly skilled breeders in any community would be sufficient to influence others and to serve as source of farmer-bred materials for the rest of the community and neighboring areas. This observation needs more thorough documentation.

Furthermore with the increasing number of crosses and segregating materials, a need occur to assist farmers in development of diversity monitoring tools and methods so that farmers selections and varieties development by farmers are broadening diversity and not the other way around. The materials used by the farmers as parentage of their crosses, in some instances, are similar due the limited available materials in the communities. Similar advanced lines distributed by breeder farmers are re-named by recipient farmers after selection in his farm, thus, names of varieties are sometimes not the best indicator of diversity.

The increasing interest of farmers in breeding had created a demand for more materials for parentals suited to their breeding objectives, and a challenge for the project to supply these needed materials to the farmers and communities. In the Philippines, the number of parentals of vegetables available in communities are limited to the local market supply as formal sector had very few released varieties. Sources and number of parentals and segregating materials for farmers to work in the FFS and their follow up studies should be augmented.

17.8 Institutionalisation

17.8.1 Scale of operations

To date, PEDIGREA had been working in more than thirty communities and had trained 1437 men and women farmers in FFS rice and vegetables. There are notable differences in the number of communities and individual farmers reached by each project. In Indonesia, the number of communities reached has increased to 12 and the number of farmers reached to 843 after three years of operation, activities in Cambodia have expanded to a lesser extent, i.e. to 10 communities and 411 farmers, whereas in the Philippines activities started a year later and now involve 9 communities and 183 farmers. Out of these 1437 FFS farmer graduates, thirty percent were women. 102 farmer trainers and 26 government district/agricultural trainers facilitated the FFS rice and vegetables.

In an effort to scale up the FFS, the project in the Philippines has piloted season-long FFS in vegetables in secondary schools attended by 22 students. As an outcome of this initiative, nearby schools expressed interest as well and there are current discussions to integrate FFS in the school curriculum in one municipality where PPRDI operates. Similar, initiatives are being implemented in primary schools in Indramayu by the Indonesian project.

17.8.2 Relationships with public sector

Diverse experiences exist among partners in building relationships with NARS. In Indonesia, collaboration with the Sukamandi Rice Research Institute has been quite intense, while its links with the Horticultural Research Institute in Lembang ties have remained weak mainly due to the very limited capacities in Lembang. In both institutions, the attitude of management and individual breeders towards the project has been generally positive. In the Philippines, rice varieties have been provided by Philrice, although under conditions that are difficult to meet in practice. The Institute of Plant Breeding (IPB) of the University of the Philippines Los Baňos has also been open to collaboration and has provided some useful starting materials, albeit informally. In Cambodia, collaboration with Cambodia Agricultural Research and Development Institute (CARDI) has remained very difficult mainly due to traditionally-held beliefs among some formal researchers that farmers cannot be breeders, and limited scope and infrastructures.

In all three countries, highly useful links were established with extension services, involving the training of extension officers to act as trainers in the FFS, along with farmer-trainers, which as proved

to be the most useful linkage with the public sector. Support from local governments was often instrumental in public relations (e.g., advertising for the FFS, reporting on its results) and making available some infrastructures such as providing the site for the FFS and even providing small grants. AVRDC in Taiwan was successfully approached to provide vegetable seeds, although data on the available germplasm was very limited necessitating pre-screening of the materials made available for vegetable PVS. No formal agreement has been concluded with any of the institutions in the three countries.

Small allowances were provided to extension staff participating in the Training of the Trainers. Major support to train partner staff as well as trainers (through Training of the Trainers) in technologies and other issues was provided by Wageningen staff and the co-convenors.

With regards to the private sector, no lasting relationship has been established. EastWest Seed Company was initially approached on the objectives of the programme and to inquire on the availability of germplasm, but it remained skeptical on the expected results especially since PEDIGREA's crop focus are of little interest to the company.

17.9 Management of products of PPB

Parallel to the plant breeding activities, supporting management and marketing activities were developed. Plant breeding needs to take into account the traits that are valued in the markets (such as taste, color, size), and therefore it is important that information is gathered at the beginning, when the plant breeding priorities are set.

Our experiences in Cambodia, Indonesia and the Philippines show that farmers are very interested in improving their marketing skills. Most farmers put relatively little effort into marketing for various reasons. Most vegetables are sold to the village collector(s) under different terms. Sometimes village collectors pay in advance (as a form of credit or in the form of fertilizers), and take part of the price risk, or pay when they have sold the produce. The village collectors have several advantages: they usually have good contacts with traders in market towns (or Jakarta, in the case of FIELD's experience in Indramayu), the materials for weighing and transport, and the cash for handling large transactions. If farmers want to benefit from higher prices in market towns, they need to take over these functions, which is not always easy.

A first step is to get to know the market better, by visiting several important markets and by talking to the traders, to find out what traders need in terms of produce quality, timing of delivery, packaging etc., as well as to obtain information on the location and specialisation of different traders, and (variations in) market prices. Along with a market analysis, farmers need to analyze their own production system to chart what their production potential is, what technology they are using, what their costs and benefits are etc. Especially when the farmers are planning to work together as a group, it is good to get good insights on what and how the farmers as a group can produce. For instance, in Indonesia, most farmers, but not all, have a pump, which is essential for irrigation (mostly for rice cultivation). When the farmers decided to work as a group, they could share the use of the irrigation pumps owned by individual farmers.

These initial analyses are useful as eye-openers to the farmers and help generate more ideas in marketing farmers' produce from PPB. Visiting markets can already interest traders who are willing to buy their produce. Farmers need to reflect on the information gathered, and see how they can respond to the opportunities that the market offers. Some problems can be overcome easily. For instance, in Cambodia, farmers recognise that price information was important, but hard to obtain since their only source of information are usually the village collectors. They decided to share information together regularly, which is a simple step to take. However, other problems are more difficult to overcome, and often need group coordination. Some eye-openers were the kind of produce the traders wanted. In Indonesia, some traders prefer small fruits (bitter gourd), while the farmers always aimed at big fruits to increase the volume of production. However, small fruits fetch higher price than big fruits per kilogram. Traders in all sites where PEDIGREA operates are very willing to discuss the type of produce that would do well in the market. They usually are very specific about color, quality, taste, smell etc., which are information that are important for plant breeding activities. Information on

marketing trends is very important at the beginning of breeding activities, as well as throughout the breeding process. Traders should also be involved when farmers want to find niche markets, especially for diverse products, such as traditional varieties, pesticide-free produce, or any produce that is not usually available in mainstream markets.

Two important lessons were learned during the pilot phase of marketing in PEDIGREA. First, group management and mutual trust is a crucial element in successful marketing. Our experiences showed that although it is relatively easy to develop a marketing plan with farmers, it is more difficult to put this into practice and establish a successful, sustainable marketing initiative. Since marketing involves handling of money, agreements need to be made when farmers start selling their produce as a group. Secondly, we learned that marketing is essentially about networking. Finding a buyer who is willing to offer good marketing terms (e.g., a supermarket that will buy at regular period at a relatively high price) can stimulate a group to work together. In cases where marketing diversity is targeted, niche markets must also be found through networking. NGOs can play a critical role in this, as farmers often lack the contacts or the resources to make such contacts.

17.10 Outlook

Finding sustained and long-term funding for PEDIGREA's on-farm management projects has been and will remain a major challenge.

In PEDIGREA's new four-year phase, attention and efforts will shift to address subsequent issues. New challenges concern (a) the need to create and improve local market channels and chains for farm products based on local preferences and rooted in local culture (creating markets for local diversity); (b) the need to widen the impact of participatory management of genetic resources making use of existing networks, human capacity and knowledge, and optimizing the effects of external support (up scaling participatory approaches); and (c) the need to evaluate and quantify the results of the PPB process in terms of new varieties and breeding populations introduced, new varieties developed, new varieties marketed, and the market share obtained, as well as the effects on technical capacity building and community empowerment. While policy and regulatory issues have hardly been addressed, the issue of access to breeding populations for farmer experimentation and the options, relevance and desirability of registering farmers' varieties will also need more attention. If the opportunity arises new projects may be initiated in other countries.

17.11 References and details of the project

More information can be found in the following websites:
www.pedigrea.org
www.cgn.wur.nl

II Three PEDIGREA Cases

17.12 The breeding and selection activities of two farmer-rice breeders in Mindanao, Philippines

In the Philippines, as in many other countries, there are numerous examples of successful farmer-bred rice varieties. Local farmer bred varieties like *Masipag and Bordagol*, continues to attract the attention of farmers, because these show more adapted to the specific stress conditions occurring in the local farming system and often better satisfy the local consumer preferences than modern varieties.

The case of two farmers who-became breeders, Florencio (58) and Voiett (39), residing about 5 km from each other in the municipality of Pres. Roxas, Cotabato, Mindanao. Learning of the technique of cross breeding in 1997 while attending a session on rice hybridisation during a farmer field school on Ecological Pest Management, they decided, independently from each other, to try out their newly acquired knowledge in the field. Over the past 8 years they have continued with their cross breeding activities and presently are about to release their first rice varieties.
to continue this work with the very little resources available to them?

Farmer Voiett
Voiett, a resident of Barangay New Cebu, made his first cross in 1997 between the rice varieties *Makaginga* and *Bordagol*. He exchanges some panicles of *Makaginga* with another farmer in a nearby community. The variety is grown primarily in non-irrigated areas, is drought and tungro resistant. It is also tall, late maturing and prone to lodging, and has awned grains, generally considered a negative characteristic by farmers. The other variety Bordagol is a wide-spread and at the time very popular farmer-bred variety, originally selected as an offtype from a field of the variety IR36. The variety is medium late, drought tolerant and has good eating qualities.

From a total of 30 crosses, Voiett harvested 12 seeds, which were grown in bulk to produce about 2000 F2 plants. In the segregating F2 population, he selected four superior plants (10 tillers per plant), bulked the seed, and planted the F3 in rows for further selection. From the F3 and onwards, until the F6, he used the pedigree (ear to row) method for selection, choosing 4-6 plants per generation, and 10 tillers per plant, which were individually harvested, stored, and planted again in rows in the next generation (see selection scheme fig 1). In the F6, three selections proved to have desired performance and stable enough to harvest in bulk for performance testing on a larger scale.

Presently, Voiett has three varieties listed for 'release': *Jemar-2, Jemar-4* and *Jemar-6*. (named after Jessie Magsayo Rice, Voietts real name). Features of the three varieties are quite different: whereas Jemar 6 is medium tall, drought tolerant and profusely tillering, Jemar 2 is tall and has average tillering with a purple colour stem base, yellow grain with brown-reddish endosperm. Jemar 4 on the other hand is very tall and has awns.

Fortunately, the years 1997 until 1999 coincided with a heavy Tungro infestation in the area. Tungro is a rare but devastating virus infection, transmitted by the green plant hopper. To test for Tungro resistance, Voiett arranged for a duplicate of the F3 and F4 lines to be planted in the middle of the highly Tungro susceptible variety Masipag 44. This gave him the information needed to make his final selection in the original F3 and F4 lines. All Jemar varieties have been shown to be highly Tungro resistant.

Subsequent series of crosses were performed in 2001 and 2005. In 2001, Voiett crossed *Makaginga* with a *PSBRC64*, a variety released by Philippine Seed Board (local name: Tonner), in order to combine Tungro resistance with high yield and good eating quality. Out of 28 crosses, he was able to harvest 8 seeds for planting the F1, and again 2000 plants in the F2. The progeny, particularly some of the F3 and F4 lines have been selected jointly with farmers in the FFS-PPB conducted by PPRDI under the PEDIGREA programme. Advanced lines derived from the 1st breeding cycle were used in the comparative variety trials in the same FFS-PPB course. Eleven early lines from the 2001 cross are now planted in the variety demonstration plot granted and managed by a member of the Barangay Council of New Cebu.

Voiett says he did not use any conscious strategy in the 1st breeding cycle, but took whatever looked good performing, he only screened for Tungro disease. In the 2nd breeding cyle he consciously selected for specific traits, including medium plant height (80 cm), more productive tillers (> 18), and plant and disease resistance. He also consciously selects for red rice in addition to the normal line of straw coloured lines.

In all four crosses made for the 3rd breeding cycle (2005) he has used Florencio's variety *Pagasa* in an effort to combine the high yielding capacity of this variety with drought and Tungro resistance, and to reduce the maturation period of Pagasa (125 - 130 days) to medium level (110-115 days). The performance in the 11 advanced lines looks promising.

Farmer Florencio

Similar to Voiett, Florencio started to make his first crosses in 1997 using two farmer-bred varieties: *Mindoro* and *Bordagol*. Seed of *Mindoro* was at that time obtained through a local fair on sustainable agriculture. From this cross, he was able to select, after six generations, three stable lines, including *Pagasa -97* (named after the year of cross). Other varieties that are presently on his list are: *Pagasa 47* (after his birth year), and *Pagasa 54* (his age at the time of stabilisation). Although very late maturing, Pagasa 97, has shown to outyield most other varieties grown in the locality.

In the following years, Florencio has made two more crosses using local varieties as parent varieties, In 2001, he crossed the tall *Marekit (MRT)* and the short *Masipag 35*. His primary aim in choosing these two varieties were to shorten the plant height of the good tasting but very tall *MRT*. In 2004, in the F5 generation, he has managed to select one stable line which he has called *Pagasa 04* (after the year of final bulk selection). A third cycle was started in 2004 crossing the aromatic variety *Azozena* with the short duration variety *Masipag 45*.

Selection techniques used in the three breeding cycles are very much alike. After making the parent crosses, he plants between 5 to 10 plants in the F1 and bulks the harvested seeds to plant about 100 single-hills in the F2 (100 plants). From this point onwards, he only uses the pedigree selection method (ear to row) until the population has become sufficiently stable, which is usually in the F5 or F6.

Selection pressure is high as well. Trusting his experience, Florencio selects five plants in the F2 to plant 12 rows of 10 hills in the F3 (120 plants). In the F3, he selects again five plants to grow out in rows in the F4, and follows the same procedure intil the F5 or F6. Thereupon, most of his lines have become sufficiently stable to bulk the row and start a larger plot for performance testing.

Presently, Florencio has 16 advanced lines, derived from the 2001 cross, all of which are planted in his own field (2500 m2). He had few possibilities to test Pagasa 97 outside his field: like Jemar 6, the variety was included in the FFS-PPB comparative variety trial in 2004. In addition, seed was given to a few farmers for outgrowing.

Motivation of farmer-breeders

Asked about their motivation to continue their breeding work, Voiett and Florencio react differently. Voiett says to be particularly motivated by his curiosity, to learn more about breeding technologies. At the same time, he experiences, that he receives recognition in his community and elsewhere as breeder and facilitator. Before he was just an ordinary farmer and labourer, now all people know him because of his breeding work and come to him to see his new varieties. He also retains up-to 13 local farmer varieties in his land to conserve the varietal characteristics for later breeding work and to promote the use of it among fellow farmers.

Florencio is primarily socially motivated. He wants to do something for his fellow farmers. In the past he has experienced poverty, and knows how difficult it is not being able to obtain seed for planting. This has opened his eyes to the value of seeds. Once he had to buy seed in a neighbouring village on credit and was pressed to repay 1 bag of harvested grain for one can of seed. The name Pagasa is derived from *pagsikap alay ng sambalupa,* which means: effort or hope for Sambalupa. Sambalupa is a local farmer group that he chairs.

None of the farmer-breeders conduct breeding for economic reasons: to profit from it. Voiet says that some day he may receive incentive from his breeding work, but at the moment he cannot yet see how.

Both farmers wish to register their varieties in community register for recognition of their work, whenever such system is established in their municipality.

Voiett and Florencio are engaged as facilitator in FFS-PPB courses (rice and vegetables) in the region, organised by the NGO PPRDI under the PEDIGREA programme. They receive a small incentive for this work. The programme has allowed them to increase their knowledge through TOT. Besides knowledge, Voiett also shares his breeding material with the FFS participants for joint selection and evaluation. He therefore has an additional stake and responsibility in the successful conduct of the FFS-PPB. In addition, the farmer-breeders are active in a farmer-breeder forum, a group of 16 individual farmers who have participated in the FFS-PPB and are still active in the plant breeding in their community.

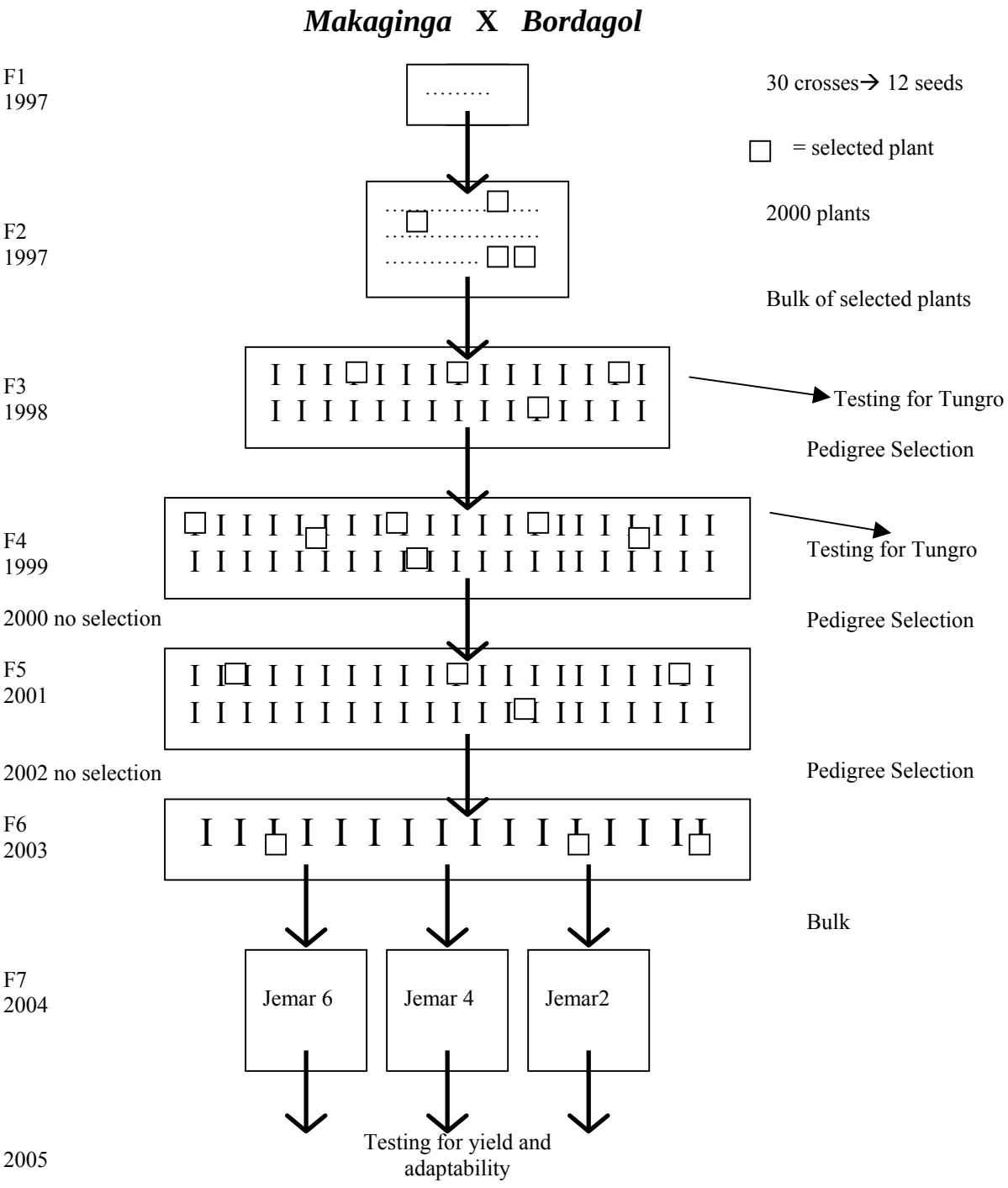


Fig 17.4 Rice Breeding Scheme (1st cycle) – Farmer-breeder Voiett

Mindoro (MRT) X Masipag 35

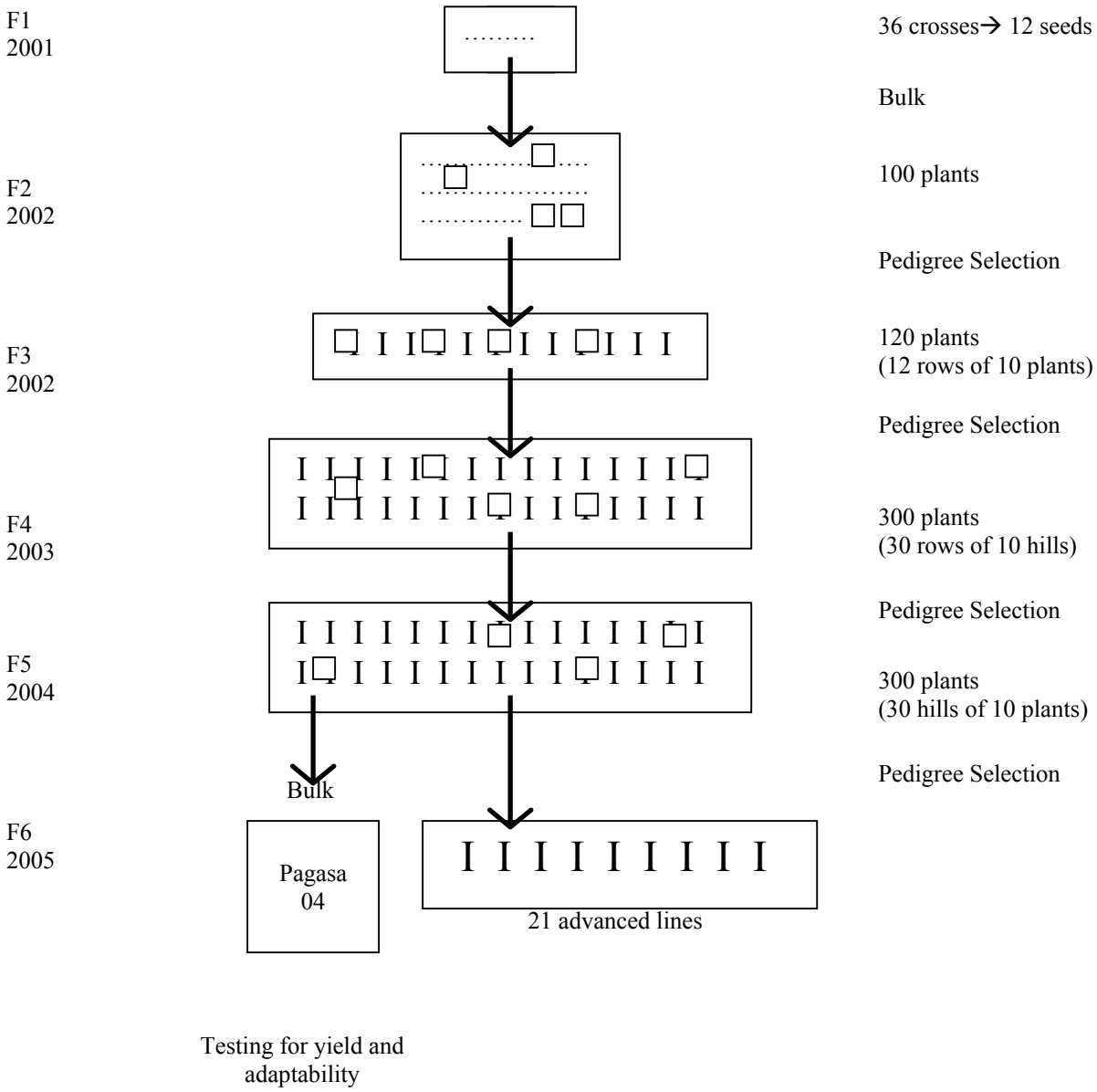


Fig 17.5 Rice Breeding Scheme (2nd breeding cycle) – used by farmer-breeder Florencio
(excerpts from a case study written by Hans Smolders, 15 March 2005)

17.13 Gourd breeding by FFS groups in Indonesia

Local vegetable production
Indigenous vegetables like ridge gourd and bitter gourd are very popular and widely used in the Indonesian kitchen. In Indramayu, these crops are grown as cash crops on poles in rice fields, in upland area, or on marginal strips of land along irrigation channels. Once harvested, the fresh fruits are sold on the local market via middleman; some find their way to the Jakarta market some 80 km away.

Vegetable genetic diversity
The breeding of indigenous vegetable crops like ridge gourd and bitter gourd thusfar have been neglected by national research institutes, as the government preferred to focus on crops with export potential like tomato, cucumber and chilli. Only recently more emphasize is laid on domestically marketed 'underutilized' vegetable crops. Seeds of commercial varieties, mainly F1 hybrids, are available through local seed retailers. This seed is only sporadically purchased by farmers. Most farmers in the Indramayu area rely on their own seed or obtain seed through social seed exchange mechanisms which is usually free of charge.

Baseline studies, farmer field schools and follow up studies have revealed that there is still a good diversity of ridge gourd and bitter gourd varieties cultivated in the Indramayu district. Each farming community seems to produce its own range of 2 to 3 varieties, although seed exchanges occur. Local varieties are often named after the community where it is cultivated, such as Emes Slyeg (a long slender type) and Emes Jenkok (a short thick but highly productive type). In the nine communities where FFS-PPB programmes have been established, 21 local varieties of ridge gourd and 12 varieties of bitter gourd have thusfar been identified and described by farmers.

Varietal crossing
During the FFS-PPB, about 25 female and male farmer participants have learned to evaluate varieties using participatory variety selection (PVS) and to cross selected varieties to combine desired traits for increased performance. On average 15 to 20 farmers per community have continued with follow-up field studies on selection and breeding.

The programme thus far has resulted in a large number of crosses: 16 varietal crosses in ridge gourd and 36 crosses in bitter gourd. By June 2005 this has yielded in segregating populations as follows: for ridge gourd: 2 x F0, 6 x F1, 6 x F2; for bitter gourd: 4 x F0, 30 x F1, 2 x F2. Some lines, especially in bitter gourd, have been lost because of seed dormancy and drought.

Breeding objectives
Breeding objectives are decided by the farmers during the baseline survey and FFS-PPB. For the Nunuk village in ridge gourd these are: high productivity, fruit not too long/not too short, good texture, thickness of skin, green fruit colour, long production period. Most crosses have been of the type local x exotic, indicating that the exotic varieties showed features that were not existing in the local types; mentioned features were: high productivity, good diameter, good shape and dark green colour of leaves. Negative features were: hard skin/ridge and thin fruit. In the Jenkok community, farmers made crosses of the type local x local, notably to combine the slender type (finding a better market in Jakarta), with the productivity and good taste of the short local type.

Breeding methodology
Selection procedures in both crops have been basically the same and can be typified as a modified bulk method. After crossing, the fruit is harvested and seeds are planted in the F1 field. In this field, which is already segregating, the first selection takes place among 40 to 50 plants. Farmers observe fruit appearance and plant production in the field after which the best plants are marked with a stick. Subsequently, crosses are made between the selected plants (full sibling cross) using the standard bagging method to avoid pollen contamination. No emasculation is needed as both in bitter gourd and ridge gourd (Cucurbitacae) have monocious flowers (either female or male). Manual crossing is done to consolidate the desired characteristics. About 10 crosses are made. After harvest the fruit is tested for good taste and texture, after which seed of the remaining fruits is harvested and bulked. A portion of the seed is retained for back-up. The same procedure is followed in the F2 and currently also in the F3.
Observations

Farmers in Indramayu have made the new learned skills their own by experimenting with whatever crosses they could feasibly make. Varietal crosses were thus made not only during the FFS but also during the follow-up field studies, whereas crosses are made also among full-sibling plants in the segregating population.

Considering these multiple crosses, the lack of land is the most limiting factor in carrying out the selection and breeding programme in these vegetables. For a highly segregating population, like the F1 and F2 the plots are much too small to make a good selection possible for desired plant types. Moreover, usually the entire breeding collection of lines and varieties is planted in the same field, which makes it difficult not only to prevent undesired outcrossing (by insects) but also to ensure large enough fields for selection purposes. A study field usually does not exceed 1000 m2 (30 x 30 m) or containing about 1000 plants. The result may not be satisfactory. Yet, the selection approach implemented by farmers to cross selected full-sibling plants is a modification of the bulk method which under the circumstances probably is the most viable, provided that the breeding objectives are strictly applied. This approach probably also prevents inbreeding and loss of desirable genes.

Farmers would do well to enhance the method by selecting or crossing more fruits and evaluate the selections row by row in the next generation. When the populations become more stable, probably in the F5 or F6, it would be advisable to switch to self pollination and after evaluation of individual rows, to bulk the good lines from stocked reserve seed to consolidate the desired traits (recurrent selection method).

Conclusion
On the whole, the on-farm breeding of indigenous vegetables like ridge gourd and bitter gourd is still new and in experiential learning stage. Practical experiences, like described above, are needed to guide farmers in a way that best suits their local circumstances. Based on case studies like this, farmers may learn to adjust their approaches, whereas breeders may advise farmers to improve their selection methods.

17.14 Breeding Pumpkin and Wax gourd by FFS groups in Cambodia

A new generation of breeders
Farmer Ith Pearun from Kehung commune in Tompung village, Kampung Speu province, Cambodia, was one of the first farmers to join the FFS-PPB programme on rice in 2002 and vegetables in 2003. Presently he is one of the senior farmer-trainers in the Kampung Speu province, and leads a farmer group of 10 farmers in follow-up field studies (FF) in rice, pumpkin and wax gourd. The group meets 8 to 10 times per season, about once every two weeks, to discuss the state of growth, observe insect and disease damage, review the selection criteria, and discus topics of general interest to farmers including problems in production and marketing.

Selection environment
The area is marred by drought and heavy rainfall. Whereas rice is grown on irrigated fields, vegetables like the popular pumpkin and wax gourd are grown on elevated rain-fed areas, in backyards or in paddy fields during the dry season. Recent drought and patchy irrigation facilities severely limits the village vegetable production capacity, especially for the popular wax gourd and pumpkin. This environment, characterised by occasional extreme weather stress, has had a significant impact on the traits that farmers have set themselves for their vegetable varieties. New varieties must be capable of high and stable production in both wet and dry environments, a characteristic which is referred to by farmers as ‘weather resistant’. Related to this trait are features like early maturity, which allows farmers to reduce irrigation needs and to plant multiple crops per year. Earliness also allows farmers to take advantage of residual moisture and to produce, for example, a decent crop of vegetables in the dry season. Once harvested, vegetables find their way to the local Kampung Speu market or to Phnom Penh, about 30 km away, via a chain of middlemen, wholesalers and retailers. Consumer preferences in vegetables are therefore also important.

Besides high production, farmers have selected for specific criteria like shape, size, color and taste in pumpkin and wax gourd, which they assume will fetch the highest price. In the beginning Ith Pearun and his group did not have very specific ideas about vegetable requirements in the market. Varieties like Tralach Srov (= rice wax gourd) and Lepeuh K’eik have been grown by farmers in the community

for years, and fetch a modest price in the market, but as the marketing is primarily done by middleman, they knew little about prices and market demands. A participatory market study initiated by PEDIGREA has helped them to shape the criteria and to identify main and niche markets.

Varietal evaluation and crossing
With alternating drought and wet conditions the growing conditions were rather extreme during the FFS-PPB vegetable course and field studies conducted in the community. This was particularly apparent in the varietal evaluation trial in the FFS field study, which contained 19 varieties of pumpkin and 16 varieties of wax gourd, most of which varieties failed to produce. Yet, some local varieties were fruiting well. Also some varieties introduced from the AVRDC (Taiwan) showed high productivity, but were less favoured by farmers because of the odd fruit shape. Farmers decided to make crosses with the AVRDC lines in pumpkin (6516 x 4270) and wax gourd (4270 x Tralach Srov). While crosses in wax gourd succeeded, crosses in pumpkin were not successful because of high humidity, which required crosses to be repeated in the dry season 2004.

Selection methods
Despite the scarce land and limited water resources, farmers continued with the selection in the F1 during the wet season 2004, which population was profusely segregating. It was decided to focus on three fruit selection characteristics per crop and to assign three farmer groups to the task under the leadership of a farmer trainer.

Farmers were grouped according to villages. Selection criteria were as follows:

Table 17.2 Selection criteria per farmer group

Farmer Group	Wax gourd	Pumpkin
1	Round and big	Coconut shape
2	Slender, long and waxy	Flat shape, rough skin, black colour (dark green)
3	Medium-short and non-waxy dark green	Long shape

The selection method applied by farmers was mass selection: from each field of pumpkin or wax gourd farmers selected, harvested and stored about 10 fruits in accordance with the above set of criteria. Prior to the time of planting the fruits were cut open to examine the flesh. The flesh was then examined for colour, volume and stickiness. Out of the fruits examined, one fruit was selected, the seed harvested, dried and re-planted in the field. The seed was enough to plant a field of approximately 30-50 plants. The rest of the seed was bulked and kept as back-up in stock. At the end of the season, field exchange visits were made by the three groups and the results of the selection shared between the farmer groups.

The selection approach continued by the farmer groups in the F2 (dry season 2004/05) and F3 (wet season 2005). From the F2 onwards, some of the criteria were discarded, namely 1 and 3 of pumpkin, and 1 of wax gourd, because farmers found that this shape was not well received in the market, where after the groups focused on one of the remaining criteria.

Selection progress
The farmer groups consider thus far to have made good selection progress. In pumpkin, according to farmer Ith Pearun, they have been able to select a new type of variety with rough skin (associated with stickiness), bright yellow color, high productivity, and fruits with a weight between 2-2.5 kg. Ith Pearun estimates that 60% of the plants have the desired fruit type. He hopes the population becomes more stable in the F4 or F5 after which he will start with self pollination to conserve the varietal characteristics.

Conclusion
Perhaps the most interesting part in the local vegetable breeding programme is the group dynamics; not only is the entire breeding programme split among three villages, the groups also apply different breeding objectives. The frequent exchange of information among the farmers allows for alignment of

the local breeding programme but also shows that farmers are genuinely interested in the other group's achievements. Farmers thus actively stimulate each other.

The bulk selection approach used by farmers in the villages may not be the best method, but considering the limited land resources and environmental stress conditions, the method at least allows for maximum segregation in the offspring population. The selection progress nevertheless is slow because of out-crossing with undesired plants. Moreover, the selection of a single fruit per generation is very strict and assumes that some desired genes may be lost. Results should be critically followed.

GLOSSARY OF TERMS, ABBREVIATIONS AND ACRONYMS

GxE	Genotype Environment interaction: the phenomena that two or more different genotypes react differently on a change of environment
grow outs	seed lots planted in the field for evaluation
inter racial	
local adaptation	the extend to which a genotype or variety is well adapted to the local conditions. Usually evaluated on the basis of yield
mass selection	a form of selection in which individual plants, inflorescence or seeds are selected from the total field, planting or harvested seed lot
negative mass selection	a mass selection in which individual plants, inflorescences or seeds are selected and eliminated from the field (i.e. roguing), planting or harvested seed lot
off-type	a plant differing from the variety in morphological or other trait.
positive mass selection	A mass selection in which individual plants, inflorescences or seeds are selected and combined to be used for propagation of the next generation
segregating materials	planting material that in the next generation produce plants with differing appearances, due to the separation of different alleles in the mother plant. Segregation frequently occurs in the first generations of a cross and less frequently later.
sib selection	a form of selection in which plants are selected from sibs, i.e. progenies from the same parents, but genetically different
sui generis	of its own kind (i.e. adapted for a specific purpose or situation)

BUCAP	Biodiversty Use and conservation in Asia Program
CCAP	Center for Chinese Agricultural Policy
CG / CGIAR	Consultative Group/Consultative Group on International Agricultural Research
EAP Zamorano	Escuela Agrícola Panamericana Zamorano (Honduras)
FFS	Farmer Field School
FIPAH	Fundación para la Investigación Participativa con Agricultores de Honduras
GMRI	Guangxi Maize Research Institute (China)
ICRISAT	International Center for Research in the Semi-Arid Tropics
IER	Institute d'Economie Rurale (Mali)
INTA	Instituto Nicaragüense de Tecnología Agropecuaria (Nicaragua)
IPGRI	International Plant Genetic Resources Institute
IRRI	International Rice Research Institute
LIBIRD	Local Initiatives for Biodiversity, Research and Development (Nepal)
PCI	Participatory Crop Improvement
PBR	Plant Breeders Rights
PRA	Participatory Rural Appraisal
SNV	A Netherlands-based international development organisation