PEDIGREA

Participatory Enhancement of Diversity of Genetic Resources in Asia

ENHANCING FARMERS' ROLE IN CROP DEVELOPMENT

Framework Information for Participatory Plant Breeding in Farmer Field Schools

Edited by Hans Smolders

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April 2006

Citation:

Smolders, H. 2006 (ed.). Enhancing Farmers' Role in Crop Development: Framework Information for Participatory Plant Breeding in Farmer Field Schools. PEDIGREA publication. Centre for Genetic Resources, the Netherlands. 60 p.

Published by:
Centre for Genetic Resources, the Netherlands (CGN)
Wageningen University and Research Centre
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Glossary

GENERAL TERMS	
FFS	Farmer Field School
FFS-PPB	Farmer Field School on Participatory Plant Breeding
NARS	National Agricultural Research System
NGO	Non-governmental organisation
PPB	Participatory Plant Breeding
PVS	Participatory Variety Selection (variety trial)

BREEDING TERMS	
Agro-biodiversity	Sub-set of general biodiversity found in agro-ecosystems
Allele	A series of genes that have the same function and occupy the same position on a specific chromosome. A single allele for each gene is inherited separately from each parent

Biodiversity	The variety of life on our planet, measurable as the variety within species, between species, and the variety of ecosystems
Breeding line	A group of plants from a common ancestry (e.g. a cross) used in a breeding programme
Bulk selection	Selection procedure in self-pollinated crops
Cross pollination	Transfer of pollen from anthers on one plant to the stigma on another
Emasculation	Removal of the anthers (male organs) from a bud or flower before pollen is shed to prevent self-pollination
F1 and F2	The first and second generation offspring of a varietal cross
Gene	Biological unit of heredity found in all cells in any living organism, consists of DNA
Gene recombination	Formation of new gene combinations as a result of cross fertilization between different individual plants
Genotype	The total genetic makeup of a plant or other organism

Germplasm collection	A collection of genotypes of a particular species from different sources and geographic locations, that may be used as source materials in plant breeding
Homozygote	Plant or organism carrying the same alleles of the same gene for a particular function
Heterozygote	Plant or organism carrying two different alleles of the same gene for the same particular function
Hybrid or cross	First generation offspring of a cross between two varieties
Inbreeding	Breeding of closely related plants or other organisms
Isolation	Separation of varieties in time, space or other barrier to prevent unwanted pollination
Mass selection	Selection procedure in cross-pollinated crops
Pedigree selection	Selection procedure in self-pollinated crops
Phenotype	External appearance of a plant or other organism

Plant character, trait or attribute	The expression of a gene in a plant phenotype
Progeny	Offspring of a particular plant or organism
Progeny or pedigree testing	Evaluation of a plant genotype by testing the progeny
Recessive gene	A gene which expression is suppressed
Recurrent selection	Selection procedure in cross-pollinated crops
Segregation	Separation of alleles from one another during the plant's reproductive phase. For self-pollinated crops the result is clearly visible in the F2 population
Self-pollination (selfing)	Transfer of pollen from an anther to the stigma in the same flower or other flower on the same plant
Variability	The amount of diversity in a population
Variety (cultivar)	A group of similar plants that can be identified from other varieties within the same species through genetically inherited structural features and performance

Acknowledgements

This publication is based on the experiences gained in farmer field schools held in Cambodia, Indonesia and the Philippines, and on the collective inputs of many contributors, including from the CBDC programme and BUCAP project. In particular, staff and farmer-breeders of PEDIGREA partners Srer Khmer, Field Indonesia, PPRDI, and Wageningen UR (CGN and LEI) provided major inputs.

Over the period 2001 - 2005 PEDIGREA has been funded by the Netherlands' Ministry of Agriculture, Nature and Food Quality and by FAO Headquarters.

In preparing this publication, special thanks to Arma Bertuso and Elenita Daño for overseeing the production, Myles Jamito for the cover design, Nemcy Cruz for the layout design, and Srer Khmer for the cover photographs.

The PEDIGREA programme

Established in 2002, PEDIGREA aims at strengthening the capacity of local communities to improve their own crop and animal germplasm, and to create a market for their community products. PEDIGREA has focused on Southeast Asia's main staple crop rice, and on local vegetables and local farm animal breeds.

PEDIGREA utilises the Farmer Field School approach and trains farmers to work as trainers of their farmer colleagues. PEDIGREA builds on the results obtained in former Integrated Pest Management programmes. Furthermore, PEDIGREA promotes an active collaboration between local communities and public institutions. Thus far, hundreds of farmers have been trained, of which many as farmer-trainers. Many communities have been reached in season-long trainings.

The PEDIGREA programme areas are located in Indramayu, Indonesia; North Cotabato, Mindanao, the Philippines; and Southeastern Cambodia. Local partners are Field Indonesia (Indonesia); Srer Khmer (Cambodia); and People, Plant Research and Development, Inc. (PPRDI, the Philippines).

Backstopping is provided by the Centre for Genetic Resources, the Netherlands (CGN) and the Agricultural Economics Research Institute, (LEI) in the Netherlands of Wageningen University and Research Centre, and by the International Plant Genetic Resources Institute, Asia and Pacific Office (IPGRI) Malaysia.

1. INTRODUCING THE CONCEPT OF PARTICIPATORY PLANT BREEDING

1.1 The importance of plant genetic diversity

Seeds and other plant propagating materials are essential inputs for agriculture. Grown into full plants they can feed people, provide medicines, and produce fibres and building materials for human use. Economies depend on products and by-products of plant genetic resources. Apart from the value in trade and consumption, it is the unique reproductive characteristic of plants as living organisms, and the re-combining ability of their genes, that has enabled farming communities for centuries to build and re-build their lives, and to produce food despite changing environmental and socio-economic conditions. Maintaining a broad diversity of plant genetic resources is essential to satisfy diverse present and future demands for products sustaining human life.

For thousands of years farming communities have grown wild plants, adopted some of them, and carried out selection in cultivated plants. By focusing on specific traits to improve plant performance and by growing crops in different and specific agro-ecosystems, gradually the combined human and natural selection pressure has altered the characteristics of plants to adapt to newly evolving farming environments. This process, called *crop domestication*, has provided the basis of the major food crops as we know them today.


Farmers retaining a key role in maintaining diversity

Crop domestication started about 8.000 years ago. Places where the first crops originally developed are known as *Primary Centres of Diversity*. These centres usually show a rich reservoir of both wild and cultivated plants belonging to the same or closely related species. The spread of agriculture in the past to other parts of the world by early colonists and traders resulted in a further increase in diversity of plant genetic resources, not only in the *Primary Centres of Origin* of specific crops but in additional areas as well, creating secondary centres of diversity.

Genetic diversity remains extremely important not only to individual farmers and farming communities but also to scientists and breeding institutions and humanity as a whole:


Genetic diversity supports future breeding efforts

- The availability of diversity enables farmers to grow crops under a range of varying conditions and adverse environments and allows them to better manage uncertainties, to spread their risks of production, and to sustain livelihood in marginal production areas. Such production areas are often exposed to stresses such as infertility, pest, disease and drought.

- Diversity assists both farmers and breeders to select and breed for better crops and varieties to satisfy present and future demands in production and consumer preferences.

- Diversity continues to satisfy the diverse demand by households and consumers in different cultural settings, for instance for taste, appearance, cooking quality, and by-products, and to suit niche markets as source for food, medicine, fibres and other uses.

This diversity is threatened, like all bio-diversity. The decrease in diversity in farming systems is called genetic erosion. Genetic erosion nowadays is considered one of the main threats to sustainable crop production and food security, especially in the mid-and long-term. Solutions to this end are being implemented, among which collecting genetic resources in genebanks, facilitating easier access to genebanks, as well as enhanced participation of farmers in managing their crop diversity and in the breeding process, and the appropriate training.

Fig 1.1: Primary Centres of Diversity (adapted to Vavilov, 1927); included are some major staple crops and vegetables

PRIMARY CENTRES	CROP
1 China	Rice, soybean, chinese cabbage, orange
2 India/Southeast Asia	Rice, cucumber, eggplant, pigeon pea, sugar cane, banana, jute
3 Central Asia	Pea, carrot, sesame, safflower, onion, garlic, apple
4 Near East (Turkey/Iran)	Wheat, barley, rye, pea, flax, lentil, chickpea
5 Mediterranean	Durum wheat, cabbage, sugar beet, olive, grape, almond, fig
6 Sub-Saharan Africa	Pearl millet, sorghum, cowpea, coffee, okra
7 Mexico/Central America	Maize, melon, tomato, pumpkin, cocoa, avocado
8 Andes, Brasil, Paraguay	Pepper, potato, rubber, cassava, sweet potato

EXAMPLES OF SECONDARY CENTRES OF GENETIC DIVERSITY

- The horn of Africa (Ethiopia) is a major secondary centre of diversity for barley, wheat and sorghum.
- Tomato was carried to Europe and subsequently to other parts of the world by Spanish traders some 400 years ago.
- Bananas originates from Southeast Asia and spread in ancient times to Africa to create a rich secondary centre of diversity.
- Southeast Asia is considered a secondary centre of sweet potato diversity, a crop that originated in South America.
- Sub-Saharan Africa can be regarded a centre of diversity of cassava, a crop that originated from the tropical Amazon region of South America.

1.2 Causes of genetic erosion

Modern crop breeding emerged in Europe after the discovery of Mendelian laws in the late 19th century, and started in the developing countries in the mid 20th century. Noteworthy are the establishment in the 1950's and 60's of many National Agricultural Research Systems (NARS) and the Centres for International Agricultural Research (CGIAR), such as the International Rice Research Institute (IRRI) and the International Plant Genetic Resources Institute (IPGRI). These institutes have been instrumental in the development of improved high yielding varieties in the food crops rice, wheat and maize, allowing millions of people to properly feed themselves. This development is also known as the Green Revolution.

Despite the benefits of these breeding efforts, modern plant breeding and the seed industry that evolved around it, turned out to have some negative effects as well, especially on the level of agro-biodiversity. For decades now, agricultural development has become almost synonymous with farming system intensification, monocropping, and high-input/high-output production systems, causing a dependency of farmers on external technologies, including a dependency on know-how and inputs like fertilizers and seeds, and often resulting in unsustainable practices. This concurred with a emerging views in which traditional know-how was regarded as inferior and backward and local varieties were linked with underdevelopment, low production and poverty. Because of such views, most of the transfer of know-how has focused on the application and adoption of modern technologies, resulting in a gradual loss of indigenous farmers' knowledge of production, selection and breeding. As a result, concurrent with farming system intensification, many traditional crops and varieties have been abandoned and lost by farmers.

Loss of genetic diversity caused by changes in consumption pattern

Even though the exact scale of this *genetic erosion* is unknown, it is clear that many valuable resources have been lost, a development which is still continuing. Fortunately, some local farmers still maintain traditional varieties in small pockets on-farm; others, mainly researchers, have collected and stored farmers' varieties in genebanks for conservation and use in formal breeding programmes.

Major causes of genetic erosion are:

- centralization of plant breeding into a limited number of public institutions and often multinational breeding companies;

- focus of modern agriculture on a few major crops and on mono-cropping practices causing replacement of many diverse farmers' varieties by few modern varieties;

- emerging markets and socio-economic conditions influencing consumption patterns favouring new farming systems and varieties with less diversity (globalization of food patterns);

- changes in climatic patterns and habitat destruction like deforestation and calamities, such as major new pests and diseases, drought spells, and civil war, causing gradual or sudden loss of agro-ecosystems;

- loss of the farmers' role as plant breeders.

Indirectly, genetic erosion is also linked with poverty. Thus far, modern plant breeding has been unable to generate sufficient benefits for many small and resource-poor farmers because of above-mentioned reasons. The low adoption of modern plant varieties in large areas of small-scale agriculture has both baffled and challenged scientists, development workers, governments, and others with a stake in agricultural progress and in the fight against poverty. Apparently, poverty also deals with a lack of access to resources and powerlessness such as dependency on external inputs, internalization of unjust structures, lack of know-how and confidence. Therefore, poverty can be seen as a historical product of structural problems, including those causing genetic erosion. Efforts to put a halt to genetic erosion must therefore also focus on social aspects, such as recognition and use of farmers' know-how and creative ability, and community empowerment.

1.3 Key role of farmers in genetic diversity management

Despite agricultural modernization, many farming communities, especially small farmers in developing countries, continue to maintain a dynamic process of crop conservation and development. Farmers participate in this development process consciously or unconsciously through the cultivation of crops in their agro-ecosystems and through the selection and exchange of seeds. This dynamic process consists of four interacting elements:

Natural selection

Natural selection acts as a selection force in the field through various mechanisms. Each farming system operates in a specific agro-ecosystem, where natural selection and farmer's cultivation practices create a specific environment. The genetic diversity of the cultivated crops results from these circumstances, for example:

- The way farmers prepare their soils, plant their seeds, irrigate their crops, use inputs like fertilizers and pesticides may favour or disfavour certain types and varieties.

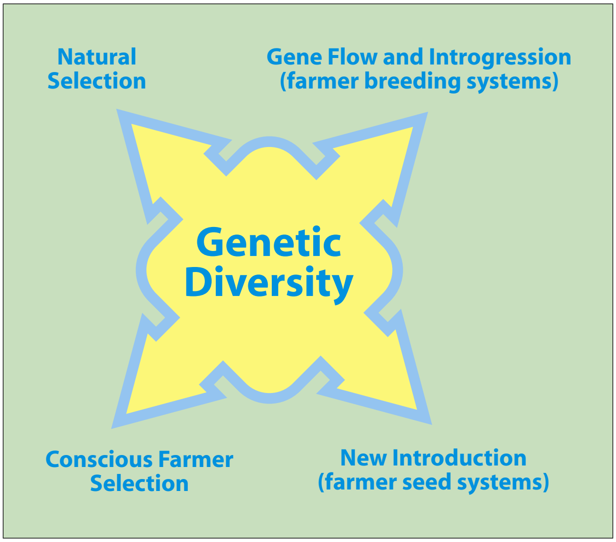

Fig 1.2: The four elements influencing genetic diversity at farmer's level

- External factors that are not controlled by farmers influence genetic diversity, including soils, climates and vegetation types. For example, the environment can be prone to a-biotic stresses like drought, heat/ cold, and salinity, or biotic stresses like weeds, pests and diseases.

The characteristics of these agro-ecosystems can be very location-specific, to the extent that breeding institutions can not afford to develop varieties for it, so that only local farmers can breed for better adapted varieties. Such specific circumstances do not only occur in climatically marginal farming systems but also in highly productive systems, such as the irrigated rice-based farming systems in Southeast Asia.

Conscious Farmer Selection

Farmers use many different plant characteristics to identify and select their crop varieties. The characteristics that farmers value in their varieties may relate to:

- agronomy (e.g. yield, pest resistance, and drought tolerance);

Farmers selecting in a rice field

- use (e.g. processing, cooking or fodder quality);
- markets (e.g. colour, taste, appearance, storability).

This type of conscious selection practices is called human selection, and is a major factor in the development of genetic diversity on-farm. Specific cultivation techniques, such as high density in the seed hole, elimination of unwanted plants during growth or elimination of unwanted male flowering plants, may act as selection forces. These practices may wield a selection force on the population or seed-lot, in favour or against certain characteristics, affecting the genetic base of the variety over time.

Gene Flow and Introgression

Farmers, who cultivate cross-fertilizing crops like maize, may choose to plant one variety next to another variety, which may serve to boost production or else to introduce new genes into the population. Farmers recognise that new diversity can be introduced into their varieties. They can encourage these processes, for example by using naturally occurring crossing like the above referred to method, or discourage them through isolation in time or distance. By cultivating crops in their natural habitat, genes from wild relatives may also be introduced into farmers' varieties. At the same time, through farmers' breeding systems farming communities have been able to keep the seed and maintain the characteristics of varieties even in centres of diversity where chances of admixture and outcrossing are considered high.

New Introductions

Seed flow is one of the primary mechanisms through which new diversity enters farming systems. Farmers may obtain their seed from neighbouring farmers, friends, relatives, local seed producing farmers and/or seed and grain markets, which all contribute to seed diffusion. Exotic varieties may be introduced through visits to other markets, seed retail outlets, and development projects. The strength of the farmer-to-farmer seed networks or social seed systems can form an indication of the degree of farmer involvement in the conservation and breeding of crops.

In many areas of the world, these dynamic processes of importance to the maintenance and development of diversity are now disappearing. To counteract this development and provide for a more sustainable basis of conservation and crop genetic improvement, we need to:

- restore farmers' knowledge systems and cultural practices in crop selection and breeding;
- strengthen farmer-to-farmers seed exchange and farmers' access to new genetic resources.

1.4 Participatory Plant Breeding

During the last two decades a breeding approach known as decentralised breeding or Participatory Plant Breeding (PPB)[1] has been developed. PPB promises a way of strengthening crop improvement within farming communities. The aims of PPB are (adapted from Weltzien et al., 2003):

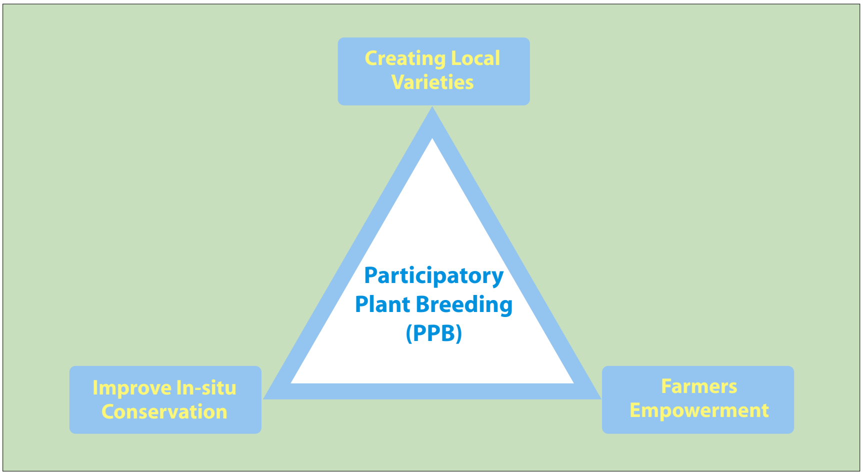

Fig 1.3: Objectives of participatory plant breeding in farmer's field schools

[1] The term PPB is used to cover all activities concerned with on-farm genetic diversity management. In other words, PPB includes crop genetic conservation, participatory breeding, as well as participatory variety selection.

- to develop locally adapted technologies for crop improvement and distribute them more effectively to and among farming communities;

- to improve the conservation and use of crop genetic diversity;

- to support local capacity development for generating such genetic resources, thus contributing to 'empowerment' or 'self-help' of farmers and other actors.

Each of these objectives reflects some limitations or shortcomings in the current system of centralised modern plant breeding. PPB promises to:

- Develop locally adapted varieties and materials that are better adapted to the farmer's local environmental conditions or give more attention to the diverse traits that farmers value in addition to yield, such as short maturity or market quality requirements.

- Improve the conservation and preserve the valuable genes and genetic resources *in situ*, which means that conservation is embedded in the dynamic on-farm environment. This is in contrast to *ex situ* conservation which preserves germplasm in cold stores or genebanks. *In situ* conservation has the capability of preserving more of the available genetic diversity than *ex situ* conservation in genebanks. As being part of the farmer's evolutionary environment, it ensures adding value to local diversity over time.

- Improve local capacities; as most of the know-how concerning crop improvement technologies nowadays has been confined to research institutions and companies, PPB ensures that farmers' capacities to manage genetic diversity are restored and improved; it seeks to support farmers in gaining more control over crop development and seed supply and enables them to pursue a different way of production than that which is currently offered by institutional breeding.

- Be more inter-disciplinary; since PPB is implemented in and around the farmer household, it covers much more than technology development and transfer of know-how to farmers; it entails a system of mutual learning by farmers, facilitators and researchers in a move to merge farmers' indigenous practices and knowledge with modern breeding technologies.

- Actively involve farmers, including women; it is important to make an impact and to ensure that the technologies are integrated in farmers' practices and owned by farmers; much more than institutional breeding, PPB makes a close link with other disciplines as well, such as social and economic disciplines, that may add value to PPB approaches within the context of the farmer household.

- Link farmers with research systems; participation of researchers in PPB is needed to make an impact on breeding technologies, and to make the approaches and products of professional breeding available to farmers.

1.5 Potentials and limitations of Participatory Plant Breeding

In general we could say that PPB is expected to benefit communities and to be of advantage in crops or geographic areas where conventional breeding efforts have been or are expected to be less successful, incomplete or absent. These conditions are generally fulfilled in the following situations:

- Marginal agricultural areas, where environments are highly variable, such as in semi-arid rain-fed or mountainous areas. These conditions usually preclude the widespread adaptation of modern varieties.

- Rural areas with little or no formal seed supply mechanisms and/or primarily subsistence-based farming.

- Minor crops important in local areas have not been the focus of plant breeding efforts.

- Major crops in highly productive ecosystems, where cultural preferences and biological challenges have not been (fully) met by the trait characteristics of modern varieties. For example red rice for use in special dishes, cultural ceremonies, or preferred use of secondary products like long straw for animal feed, flowers for vegetable soups etc.

The value of traditional varieties
Even though farmer communities have adopted modern varieties, many tend to keep their traditional cultivars, to cater for diverse consumer preferences at the household level and for niche markets, or to retain a backup crop in case of crop failure. Some communities deliberately include modern varieties to improve their local landraces (Dominique Louette & Melinda Smale, 1996). Varieties with build-in limitations for replication on-farm, such as hybrids, can be a major distracting factor for farmers. All these provide reasons why farmers have not (fully) adopted modern varieties and these reasons argue in favour of PPB.

Community empowerment
Social and equity issues can be a strong incentive and driving motive to establish a PPB programme. Community empowerment and the need in certain areas to provide explicit attention to the role of women or poor farmers is an exponent of this objective. Empowerment is a strong motive force for PPB leading to greater food sovereignty.

- Consumer preferences exist for local tastes and other crop characteristics that are lost in formal sector breeding products.

- Specific agronomic conditions where modern varieties have little impact, such as in mixed cropping systems and organic farming.

- Conditions of dramatic change such as after civil war and natural disaster.

Impact of PPB

Some argue that participatory plant breeding is likely to have negative impacts on diversity, especially landraces, because it intends to change local crop population structure, and replace it with higher yielding or better performing varieties. There is little evidence to support this theory. PPB aims at farmers' management of crop genetic diversity through a dynamic process rather than at the preservation of a static portfolio of crops. Although individual varieties may be lost at some occasions, through PPB farmers acquire the capacity to generate new varieties at all times, and are likely to jointly produce many more novel varieties than the formal sector. Only in cases where this dynamic process is damaged by enforcing farmers to adopt varieties and technologies through market forces, or in cases where communities have become reliant on compensation payment, PPB programmes may lead to a loss of local diversity. In the development and implementation of PPB programmes this aspect should be well monitored to certify that PPB indeed facilitates crop genetic diversity.

1.6 Parallel breeding systems

Two systems of plant breeding may be distinguished: the farmers' breeding system and the institutional breeding system. The farmers' breeding system is characterised by dynamic seed flows and continuous on-farm selection. The institutional or formal type of breeding system is characterised by strategic approaches and sophisticated selection methods. These two systems are in many ways complementary and need the other to become stronger. The farmers' breeding system can reach its full potential more effectively with the support from researchers of breeding institutions. Similarly, breeding institutions can gain considerable benefits in working together with farmer communities through PPB.

Improving local capacity through training of farmer-facilitators

General limitations in the farmers' system are:

- lack of (global) access to superior parent materials;

- limited capacity to perform cross breeding and to manage a high number breeding lines;

- lack of strategic goal setting processes how to best breed and select for identified traits;

- systematic documentation and management of PPB related information.

It is in these functions that plant breeding institutions can play a role to support PPB. On the other hand, institutional plant breeding also faces inherent weaknesses, such as:

- inability to capture farmers' real breeding objectives, needs and capacities;

- incapability of location-specific testing and selection for adaptation;

- limited number of varieties that can be produced and released at a given time;

- limited capacity to manage large numbers of breeding lines.

All of these weaknesses can be resolved by the farmers' genuine participation in plant breeding. Benefits for institutional plant breeding from integrating activities with the farmers' system of plant breeding, which otherwise would be difficult to achieve, include the following:

- testing for local adaptation in many different agro-ecosystems;

- direct participation of thousands of local farmers utilizing their creative powers in selection;
- access to vast resources of know-how including diverse consumer demands;
- faster adoption of new varieties at local levels;
- lower cost of farmer breeding systems.

1.7 Link with research

Varying degrees of interaction between farmers and scientists at different stages of the breeding process can be distinguished. Departing from extremes where plant breeding is carried out entirely by station-oriented research without interaction with farmers in the breeding process, breeding systems can be identified with increasing farmer-researcher interaction, until the other extreme is reached, where breeding is entirely done on-farm by farmers without interaction with scientists. In-between is a whole range of interaction of farmers and breeders possible in the breeding process. Collaborative approaches usually range from a 'Participatory Varietal Selection' (PVS) in which the initial stages of the breeding process are performed by scientists and farmer participation is restricted to evaluating finished cultivars, to a complete participatory breeding (PPB) model in which farmers and scientists collaborate throughout the breeding process in various ways. The latter can have many variants.

In developing these collaborative approaches, it is important to distinguish two categories of PPB, roughly defining the line between the two systems of breeding:

- formal-led PPB, where farmers participate and contribute to the breeding programme but researchers decide on the objectives and methodologies;

- farmer-led PPB, when researchers seek to support farmers' own system of crop development; in this approach farmers decide on the objectives and methodologies.

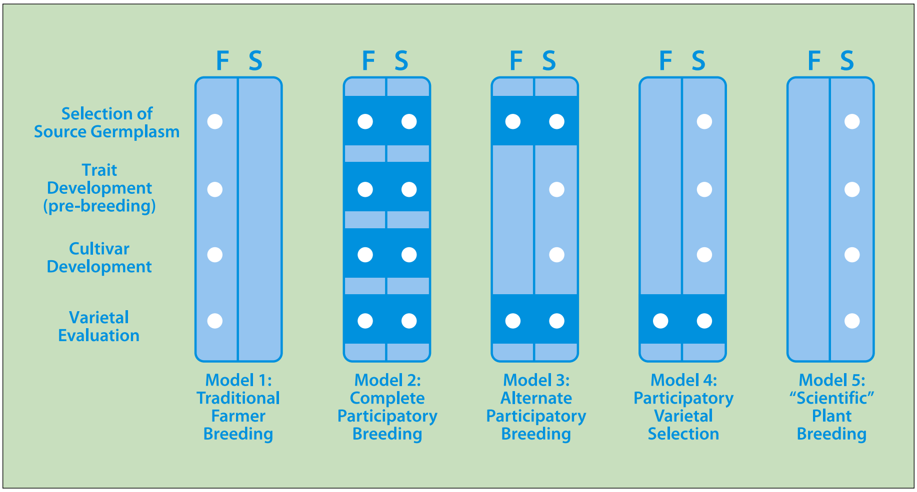

Fig 1.4: Some collaborative approaches in Participatory Plant Breeding (adapted from Moore & Bellon, 2004)

Overall, developers argue that the breeding process substantially gains in strength by facilitating decision making by farmers and/or breeders in different stages of the breeding process. In reality, it is sometimes difficult for local organisations to fully involve breeding institutions and scientists in farmer-led projects because of a variety of reasons, including a lack of funds, mandate, interest or political will. Often, scientist involvement is limited to the selection of source germplasm and the discussion of breeding methods.

1.8 The Farmer Field School

Early work with small farmers in the Philippines by FAO proved the feasibility of action-learning approaches with farmer groups, teaching farmers to apply what they had learned and let them use this again to develop new activities to gain greater control over local conditions. In response to increasing problems with pest management, particularly with brown plant hoppers in Indonesia, the training concept was adapted to introduce farmers to methods of Integrated Pest Management in rice. In 1988, this approach, which was dubbed the Farmer Field School model for Integrated Pest Management (FFS-IPM), was implemented in Indonesia, first at district level, later at regional level and soon country-wide. FFS then became the approach for IPM training in Asia and many countries of Africa and Latin America, and is currently applied in a wide range of crops, including vegetables and plantation crops (FAO, 2002). Most countries have also adopted national policies supporting FFS-IPM.

After the success of the FFS-IPM, it was just a matter of time to see the FFS approach being applied to other agricultural subjects than IPM. The universal learning concept (see box) applied in FFS makes the FFS suitable for virtually any topic, including for non-agricultural issues. Presently, FFS models have been developed for use, for instance, in community education, protection of human health, HIV prevention, soil management, natural resources management, and in the conservation of biodiversity, including participatory plant breeding.

In practice, the concepts of FFS translate into the following:

Farmers become experts. FFS does not apply a 'packaged technology' that should be 'adopted' by farmers, but a process of decision making in which farmers gradually improve their knowledge, experience and observation skills. The key is that farmers conduct their own field studies.
Their training is based on comparison studies (of different treatments) and field studies that they themselves design and conduct, and they do not form the extension or research staff. In doing so, they themselves become experts on the particular practice they are investigating.


Group activities in Farmer Field Schools

Principles of Farmer Field Schools

All Farmer Field Schools use the 'Learning Cycle' as the basic concept for learning. This method, which is well known among professionals teaching adults, uses participant experience for reflection and conceptualization, and experimentation for observation and analysis, again adding to experience and further learning. For example, in FFS-PPB, the participants go to the field early morning to collect data (experience) and return to the meeting place to analyse the data (reflection).

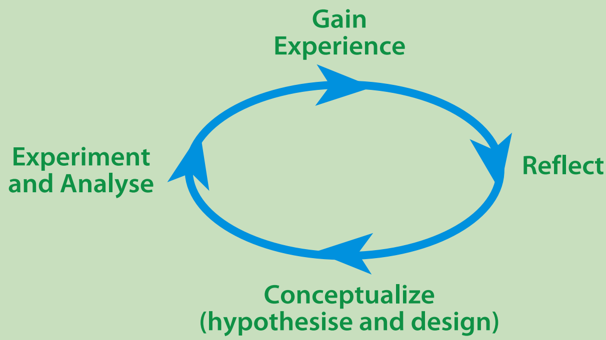

Fig 1.5: The Learnng Cycle

Farmers would then make use of the data to prepare a presentation regarding field conditions and differences between varieties, and then propose decisions for actions and observations (conceptualize). This decision is then implemented over the following week (experimentation) and the cycle begins again.

Facilitators, not Teachers. Trainers must not lecture, but should facilitate a process of learning. Trainers do not convince farmers, but rather provide structured experiences so that farmers can test methods and convince themselves about which methods are useful and which are not. Presentations during meetings are the work of the farmers and not the trainer. The extension worker may take part in the subsequent discussion sessions but as a contributor, rather than leader, in arriving at an agreed consensus on what action needs to be taken at that time.

The Field is the primary learning floor. Skills and concepts are best learned, practiced, and debated in the field. The field is the best teacher. Classroom lectures and presentations are not effective in itself. Working in small sub-groups collecting data in the field, and use these data for action decisions are the best way for farmers to learn.

Season-long training courses. Training should be related to the seasonal cycle of the practice being investigated. For annual crops this would extend from land preparation to harvesting. For fodder production this would include the dry season to evaluate the quantity and quality at a time of year when livestock feeds are commonly in short supply. For tree production training would need to continue over several years for farmers to be able to see for themselves the full range of costs and benefits. FFS-PPB offers both short-term and long-term benefits to farmers.

Regular group meetings. Farmers must be allowed to actively participate and share their experiences at agreed regular intervals during the training to achieve maximum interest and effectiveness. For annual crops such meetings may be every 1 or 2 weeks during the cropping season. For other farm management practices the time between each meeting would depend on what specific activities need to be done, and be related to critical periods of the year when there are key issues to observe and discuss in the field.

Group dynamics and team building. Training includes communication skill building, problem solving, leadership, and discussion methods. Farmers require these skills. Successful activities at the community level require that farmers can apply effective leadership skills and have the ability to communicate their findings to others.

Learning materials are learner generated. Farmers generate their own learning materials, from drawings of what they observe, to the field trials themselves. These materials are consistent with local conditions, are less expensive to develop, are controlled by the learners and thus can be discussed by the learners (and used by farmer-trainers) to teach others. Learners know the meaning of the materials because they have created the materials and/or reflect local cultures and environments.

1.9 A new challenge

Participatory plant breeding programmes in farmer field schools (FFS-PPB) can greatly benefit from the widespread and often country-wide development of FFS-IPM such as the accessibility to a strong and skilled cadre of facilitators, both within government and NGOs, and the numerous tools and exercises developed for farmers to gather, systematize and expand their knowledge. Moreover, hundreds of thousands of farmers have already participated in IPM courses and have become familiar with the FFS approach. Despite these advantages, the FFS-PPB requires innovative approaches because of some fundamentally different conditions:

Duration of FFS-PPB. In IPM all plant, insect and environment interaction as well as management practices can be studied and learnt in one season. Beyond this season farmers are basically on their own and expected to apply the learned concepts in their fields. In FFS-PPB farmers learn the basics, such as variety comparison (PVS) and crossing, but there is a range of other topics that farmers can learn to improve their skills beyond the initial FFS course. Moreover, farmers cannot see yet the results of their breeding work, let alone benefit from it. Achieving these outcomes may take much more than one season, which is why the FFS-PPB training is more long-term in nature.

Relationship between genetic diversity and ecosystem

Crop failures are seldom the immediate result of a loss in genetic diversity. Most are associated with practices of monocropping or a breakdown of pest or disease resistance. Only a few cases are known where pest infestations were the result of a narrow genetic base:

- The potato crop failure in Ireland in the 19th century due to Phytophtora disease infestation was due to a very narrow diversity of the potato crop in Europe causing starvation and the reduction of the Irish population by one fourth through deaths and migration.

- Another example of crop failure due to lack of genetic diversity is the rice crop failure in Asia in the early 1970s due to the Tungro virus, destroying all rice areas planted to only one variety: IR-8.

Germplasm management. The availability of local and exotic varieties, including segregating materials, products of pre-breeding and breeding lines, is extremely important for the success of the FFS-PPB. Farmers need to learn to gain access to new germplasm and breeding lines to make progress. Development workers, plant breeders and their institutions often need to be involved to search for and acquire exotic germplasm. Once introduced, this germplasm needs to be multiplied, maintained and stored. Finally, once a farmer-bred variety is released, the variety may be registered or not, and maintained.

Agro-biodiversity, not agro-ecosystem. Unlike FFS-IPM, which teaches farmers to better manage their agro-ecosystems and to produce crops in a more environmental-friendly and cost-efficient way, the management of plant genetic resources entirely focuses on the genetic aspects of crop production. Generally the link between plant genetic resources management and the ecosystem is weak. Instead of agro-ecosystem analysis (AESA) like in IPM, special tools (GEAN) assist farmers in genotype identification and performance analysis that strengthen this link.

2. KEY ELEMENTS OF FFS-PPB

2.1 What motivates farmers to participate?

Participatory plant breeding can only be effective when it meets the needs of the local farming community and provides practical solutions to local constraints. Constraints in farming communities can be of the following nature:

- a lack of access to superior genetic material;
- a narrowed genetic base for the major crops in the community (few varieties available, specific demand for traits that the seed market cannot supply);
- a reduced number of crop species available to the community;
- limited individual skills to manage genetic resources;
- lack of collaborative efforts to manage plant genetic resources.

Farmer Field Schools generally work on the premise that farmers themselves can manage and develop the tools needed to resolve constraints related to genetic resources management. To be successful, the FFS-PPB, therefore, must create a farmer-friendly environment where farmers can work to improve their skills and resolve their constraints by delicately matching local and external (scientific) knowledge, resources and skills to their own benefit.

Farmers' expectations may focus on one, two or more of these constraints. They may expect to increase their income by selecting better varieties, to find ways to explore new markets or to increase product value. Some may be intellectually challenged by the subject matter and excited to learn the 'science' of breeding, or else they may be motivated by environmental and biodiversity issues. For others, the main attraction is the group interaction, the discussions and the debates that are an important part of every FFS, which is expected to result into community empowerment.

Compared with FFS-IPM, farmers may perceive less economic benefit from the FFS-PPB in the short term. Organisers, therefore, should demonstrate the benefits of PPB in the long term through initiating discussions, showing photographs and videos of more advanced projects. The challenge in the development of the FFS-PPB is to build sufficient income generation and other short-term benefits into the curriculum to motivate farmers to continue with follow-up activities, thus supporting the long-term goal of sustainable agriculture and local management of plant genetic resources.

MOTIVATION TIPS

- Let farmers motivate other farmers; use 'experienced' farmer-breeders to reach out to other communities and local farmers to reach out to their neighbours
- Involve the community; conduct more than one type of FFS-PPB, and on more than one crop; engage school children in the FFS, let the community select their participants and report back; arrange Farmer Field Days for feed back
- Use visuals like farmer field days, demonstration plots, displays and videos
- Obtain institutional and political support; involve local officials, researchers and establish farmer forums and organise seminars

2.2 The breeding cycle

Breeders select and breed in their crops to create new and better performing varieties. This activity is rooted in a process called the *breeding cycle* which involves five sub activities:

1. Setting breeding goals
2. Generating variability
3. Narrowing down variability
4. Testing for adaptability
5. Variety adoption and diffusion

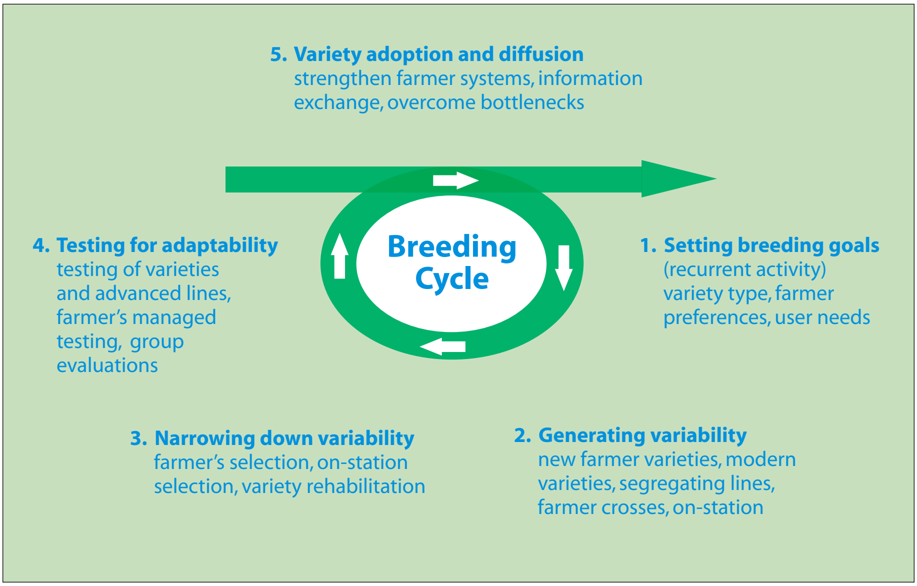

Fig 2.1: The Breeding cycle

The breeding cycle is a recurrent activity and is essentially the same for farmers and scientists. A breeding cycle usually begins with setting proper goals describing what type of variety is needed, followed with the introduction of germplasm or with a crossing between two varieties, and ends with the release of a new improved variety and distribution of its seed. This new variety can again be used for comparison or crossing with another variety to start a new breeding cycle.

DURATION OF A BREEDING CYCLE

It may take 1 season for variety selection or up to 8 or more seasons for crossing and selection to complete one breeding cycle. The latter can be long especially for farmers, however, a (farmer) breeder can manage several crop breeding cycles at the same time, which allows him or her to continually produce new improved varieties. In addition, farmers and breeders can exchange segregating materials and other germplasm for further selection and testing under local conditions, which significantly reduces the number of seasons to produce a new variety.

Setting breeding goals

Plant breeding is a time consuming activity. To be effective a (farmer) breeder, therefore, must develop his or her own breeding strategy, which means that he/she must plan ahead of time which traits s/he wishes to bring together in the new variety emerging from the breeding programme. The success of a breeding programme depends on how good the (farmer) breeder is able to define these goals. Strategy development in the traditional farmer breeding system is generally poorly developed, as most farmers have a set of preferred characteristics in their mind, but rarely work together to set well-defined goals and objectives for their breeding programme. Setting breeding goals has many implications for the activities in the breeding programme: for the search for germplasm, in the screening of varieties, in the selection of parent varieties for crossing, and in the selection process throughout the breeding cycle, and should therefore be regularly reviewed and adjusted.

Generating variability

Farmers are normally limited in their options to generate variability. They may introduce new varieties from neighbouring farmers or families, friends, local seed producing farmers and/or seed and grain markets. In addition, variability may be increased through spontaneous natural outcrossing in the field or through mutation. This process, however, is generally slow. Professional breeders have more options

Generating variability through crossing varieties available. They may generate variability through the introduction of new germplasm kept at other research stations or genebanks or through varietal crossing. Especially the latter is very effective. The crossing intends to re-combine desired characteristics that are anchored in the original parent varieties.

Narrowing down variability

After increasing the genetic variability, farmers and breeders need to select for suitable plant types. In PVS, farmers evaluate the different (stable) varieties for performance over one or two seasons. In PPB, farmers select in the progeny of the cross, which is normally profusely segregating. This selection process may take eight or more seasons. Gradually, through rigorous selection, the number of suitable populations and/or individual plants is reduced, until only a few advanced populations or lines become available for yield and adaptability testing. Breeders may use many different selection techniques to optimize the selection process.

Testing for adaptability

At the end of the breeding cycle, superior lines and advanced populations emerging from the programme may be tested for productivity and adaptability under a range of different growing conditions, such as for different farming systems, soils, and altitudes. They can also be tested for specific traits like taste, appearance and cooking quality according to the preferences of farmers and consumers. Farmers and breeders can use the superior lines and advanced populations to start another breeding programme in an attempt to recombine desired characteristics.

Variety adoption and diffusion

Once a farmer or breeder has produced a new variety, s/he would like to see that the variety is adopted and disseminated to as many farmer end-users as possible. In most countries formal policies and systems are in place for the testing, release, multiplication and distribution of such varieties, finally to reach farmers through seed retail shops. New varieties produced by farmers usually do not have such elaborate distribution systems and are generally diffused through farmer-to farmer exchange mechanisms.

2.3 The FFS-PPB curriculum

The basic question in the development of the FFS-PPB curriculum is how to squeeze a long-term activity like on-farm crop improvement into one or a sequence of short-term training programmes based on FFS principles of experiential learning. There should be enough substance in the curricula to attract farmers to participate. Related to this issue is the question how to get farmers emotionally involved in the FFS, so that they will continue and not quit halfway the FFS-PPB programme. In PEDIGREA the following combination of approaches works well:

- ***Long-term training focus.*** The FFS-PPB curriculum is spread over a number of seasons, and consist of a baseline survey, an intensive start-up course in the first season, and a number of less intensive follow-up field studies over a period of minimum 2 and maximum 8 seasons (the duration of a breeding cycle).

- ***Enhancement studies.*** The FFS-PPB is supported by so-called FFS enhancement studies, usually of broader scope, such as on marketing.

- ***More than one crop or topic.*** One community focuses on two or more crops. After FFS-PPB on rice, the community may focus on vegetables, and even on animal genetic resources. In this way, the farming community remains active, and gradually becomes a centre of knowledge, which is soon recognized by farming communities in the vicinity.

Additional ways to get farmers emotionally involved are:

- ***Selection process.*** Ensure the right farmers participate in the FFS;

- ***Genetic resources.*** Facilitate the access and introduction of germplasm meet the expectations of farmers;

- ***Self-learning focus.*** Give participants the power to shape their own curriculum;

- ***Farmer group exchanges.*** Ensure dynamic group interaction within and between farming communities.

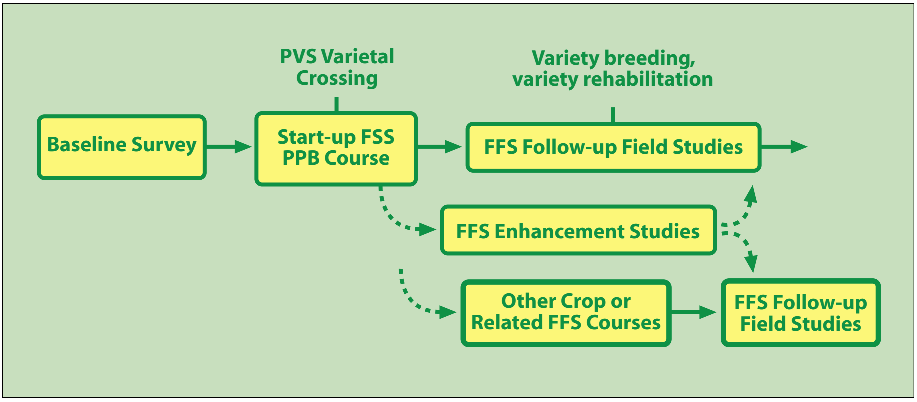

Fig 2.2: Strategic elements of the FFS-PPB programme and curriculum

2.4 The start-up FFS-PPB course

The initial or start-up FFS-PPB course marks the beginning of the community's PPB programme. In this first course farmers are introduced to the various elements of crop genetic diversity and plant breeding. The curriculum focuses on one, for example rice, or two crops, like vegetables. Emphasis is laid on field studies, where farmers learn to observe, record, and practice what they have learned in the field school. Activities, exercises and field studies touch upon the various elements of the breeding cycle:

- identification of strategic breeding goals based on local knowledge and collected market information;

- introduction of new farmer varieties, other cultivars and genetic materials from genebanks and research stations;

- varietal evaluation and selection (PVS);

• crossing of selected varieties;

• selection in early or advanced segregating populations.

The start-up FFS-PPB curriculum additionally includes special topics on biodiversity and plant breeding providing the participants the necessary information to understand activities during the follow-up field studies and enhancement studies.

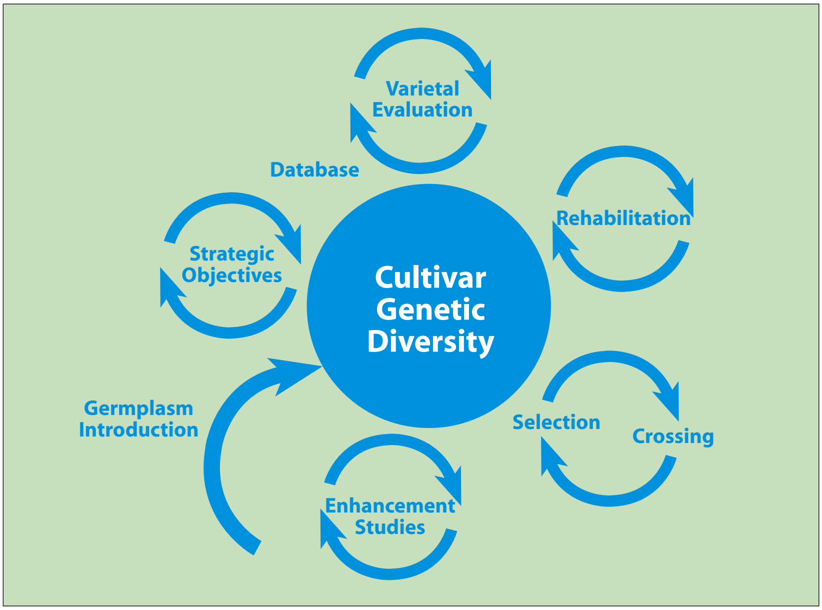

Figure 2.3: Study topics in the FFS-PPB (Note that the diagram reflects a flower with stem and five petals, reflecting the six key elements of FFS-PPB. This diagram can be used to help farmers remember more easily what PPB is about)

2.5 Field studies for FFS-PPB

Farmers learn best when topics are practiced and debated in and around the field. Field studies, therefore, are important tools in the transfer of know-how and skills to participants. In the field, farmers work in small sub-groups to observe, collect data and report the results back to the plenary for discussion and analysis. In this way, farmers share in the action learning process and contribute to the analysis and decision making in the FFS-PPB. A typical start-up FFS-PPB course may include the following field studies:

Variety evaluation

Variety testing and selection or PVS (Participatory Variety Selection) is one of the primary learning activities in the FFS. Farmers learn to compare a number of varieties for performance-based criteria meeting the requirements of the local producer, consumer and/or markets. Usually the variety testing involves a simple partially replicated trial layout, composed of 10 to 15 varieties including at least one local control. In the variety evaluation study farmers learn the skills of how to set strategic goals, and how to collect, compare and analyse their data against pre-set goals.

Farmers conducting field studies in the FFS-PPB

Plant growth and reproductive morphology

This activity concerns the study of the plant's morphological and growth characteristics, as well as the study of the plant's flower and reproductive system. Farmers learn to distinguish between self-pollinating and cross-pollinating crops, and learn to draw and describe the different pollination and fertilization mechanisms. They also learn to identify male and female flower parts, and the optimal time for emasculation and fertilization.

Varietal crossing

Varietal crossing is one of the field studies farmers are normally very enthusiastic about. The field study is a follow-up on the study on the reproductive morphology and prepares farmers to perform crosses between two plants of different varieties. Farmers learn the technique of emasculation, bagging, fertilization, and the right timing for successful crossing. By doing so, farmers learn the necessary basic skills to start a local breeding and selection programme. Depending on the crop the crossing technique applied can be easy or difficult.

Selection in segregating populations

In this field study, which focuses on unstable segregating populations, farmers learn to apply various selection techniques. This may include selection techniques like the bulk pedigree method, and backcrossing for self-pollinating crops, and mass and recurrent selection for cross-pollinating crops, as well as modifications thereof. Advanced farmers may learn about topics such as genes, genotype and heritability. However, for most farmers attending the start-up FFS course, the field practice is sufficient; theories are usually learned and internalised by farmers during the follow-up studies.

2.6 Follow-up field studies

Follow-up field studies are conducted in the season immediately following the completion of the start-up FFS-PPB course. This allows participants to observe and study the results, whereas the freshly harvested seed of selections and crosses can be replanted. All field studies are season-long, which means that they start before the planting season and finish with an evaluation after harvest. The duration of the follow-up studies generally ranges from two to eight seasons, depending on the type of study. Common FFS approaches are followed such as facilitation of group dynamics and field studies. Farmers meet every week or every other week for the duration of the course. In PEDIGREA, farmers generally focus on more than one crop at the same time.

Variety rehabilitation

The field study on variety rehabilitation aims to restore a local variety to its original or desired level of performance. Varieties tend to deteriorate because of accidental admixtures, natural selection, cross pollination with non-desired plant types or varieties, and sometimes mutation. This causes varieties to loose one or more of their characteristics such as yield, appearance of plant or fruit or pest and disease resistance. In this study farmers learn to improve their selection skills by identifying the 'lost' traits and selecting for desired plants in their populations. This field study is generally conducted immediately following the start-up FFS-PPB course, simultaneously with varietal breeding studies. Variety rehabilitation studies generally take two seasons to complete.

Varietal breeding

This is the main follow-up field study in the FFS-PPB course. Commonly farmers work with segregating populations from different origins: seed may be harvested from varietal crosses made during the start-up FFS-PPB course, other seed may be derived from selected breeding lines. Breeding lines may be own selections, selections exchanged with other farming communities, or segregating materials obtained from research stations. During the study farmers learn to apply the various selection techniques for the crop under study and practice it in the field. The study on varietal breeding generally takes up to eight seasons to complete.

Farmer with a selected fruit

Village seed banks

In this follow-up field study farmers address the problem of storage and record keeping in the local FFS-PPB programme. A key problem for farmers in PPB programmes is to ensure the safe storage of the varieties and breeding lines introduced and generated by the programme. Difficulties also occur as a result of low quality packaging and inadequate identification and labelling, resulting in seed admixtures an accidental loss of seed lots. In this study farmers learn to use low-tech storage facilities and simple record keeping systems for reference and material exchanges among communities, and learn to reproduce material in the field. This study takes approximately one season to complete.

2.7 Enhancement studies

Enhancement studies are follow-up field studies that are conducted after the start-up FFS-PPB course and aim to strengthen the FFS-PPB programme. The scope of enhancement studies goes well beyond the PPB programme, such as studies on vegetable marketing. They may be short or long. Examples of enhancement studies are:

- vegetable marketing;
- farmer breeder's rights.

Vegetable marketing

This enhancement study aims to strengthen the farmers' knowledge of their product markets and develop a realistic market strategy and action plan to diversify marketable farm products. Farmers first focus on the internal aspects, investigating their main problems in the production and marketing of their crops and capacities to change the current production and market strategies. Then, teams of farmers, traders and other stakeholders will study the external aspects, exploring existing and alternative markets. They will research the crop's success factors for the current and future markets, including an analysis of products, the potential for novel diversity within a crop, the features of customers, market chains, competitors and a macro-economic analysis. Subsequently, the combined information of the internal and external market analysis will lead to determine the strengths, weaknesses, opportunities and risks for the development of an action plan. This enhancement study is not explicitly season-bound, the main activities in this study are interconnected and are implemented over a period of 6 to 12 months.

Link between markets and genetic diversity

Farmer breeder's rights

This short study can be conducted at any time during the follow-up studies, but is usually conducted towards the end of the breeding cycle. At this time farmers are ready to release their newly bred varieties. The purpose of this study is to make farmers aware of the potentials and pitfalls in gaining recognition for the released variety, and the regional, national and international policies regulating this issue. Farmers will learn topics of local variety listing, licensing to seed companies and plant breeder's rights. This study is still under development.

3. DEVELOPING THE FFS-PPB PROGRAMME

3.1 Overview: steps in the development of a FFS-PPB programme

Developing a FFS-PPB programme requires several steps in order to build the necessary know-how, cadre of trainers, resource materials and political/policy support. The following steps are deemed necessary for establishing a successful and sustainable FFS-PPB programme:

Start-up phase

- pre-select crops and areas;
- establish contacts with research stations;
- recruit and train a core group of senior FFS facilitators.

Implementation phase (repeated steps)

- train local farmer trainers;
- develop or update the FFS-PPB curriculum;
- conduct village baseline surveys;
- arrange and manage germplasm for use in the FFS;
- conduct start-up FFS-PPB courses in selected farming communities;
- carry out follow-up field studies;
- conduct enhancement studies.

Cross-cutting issues

- ensure sustainability of the FFS-PPB programme at community level;
- build political/policy support;
- monitor developments.

The start-up phase is essential to establish a good foundation for the FFS-PPB programme. Only a selected group of experienced people, including development workers, scientists, local extension officers and senior farmer-trainers, who are familiar with the local situation, are involved in this early process. The involvement of an existing local organisation can form a major advantage, especially when this comes with farmer field school experience and a good local network.

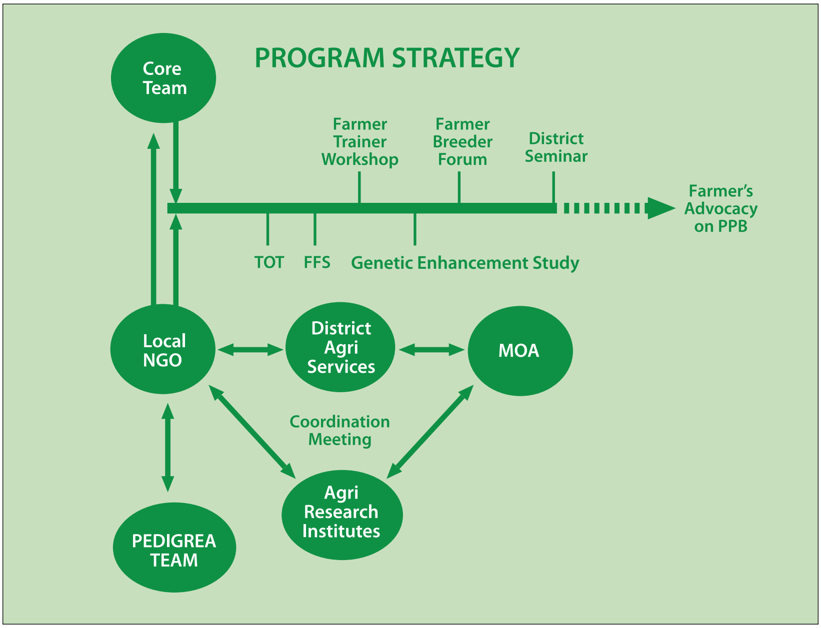

Fig 3.1: Development strategy for a local FFS-PPB programme

In the implementation phase the focus is on the establishment of FFS-PPB programmes at community level. It is advised to concentrate the FFS-PPB on a few crops of economic importance to the community, and to limit the programme to a distinct area in order to build 'local centres of knowledge'. When the programme expands, gradually more farmer-trainers will be involved.

Eventually the aim is that the entire local organisation of the FFS-PPB community programme is in the hands of a core team of farmer-trainer/breeders.

Cross-cutting elements like community and policy/political support as well as monitoring are becoming important especially when the FFS-PPB programme gains in size and strength.

In the current chapter we will describe, based on the PEDIGREA experiences, the different steps involved in the development of the FFS-PPB programme throughout the start-up and implementation phase. The cross-cutting elements will be discussed further in chapter 4.

3.2 Pre-selection of crops and areas

A FFS-PPB development programme generally starts with identifying the most suitable crops and areas. A common approach to support area selection is to conduct a survey investigating the farming system patterns in the region by using secondary data from government agencies. This provides a clear indication of the major crops grown by farmers in the region and the location of the production areas. As explained in chapter 1, there are many different situations where PPB potentially can be successful. Strategies for selection of crops and areas therefore depend on the focus of the FFS programme, which can be one or a combination of the following:

Table 3.1: Strategies for selection of crops and areas

FOCUS OF FFS PROGRAMME	SUGGESTED SELECTION
Breeding for low input and stress related conditions	Marginal production areas, areas with variable growth conditions
Broadening of local crop genetic diversity	Areas and crops with clearly reduced diversity, such as intensive farming systems close to urban markets
Initiating crop improvement in neglected crops	Anywhere where the particular crop is popular and in high demand
Breeding for niche markets	Farming areas near possible niche markets such as large cities
Conservation of genetic resources	Areas with a high level of crop genetic diversity, mostly remote areas

The scope for expansion can also be a major reason for the selection of a particular crop or area. For example, rice in Asia has excellent prospects in PPB approaches, as it is grown by many small farmers. In Africa, similar situations exist for crops like maize, sorghum and millet. Minor crops, such as indigenous vegetables or finger millet, can be of significant local importance to farmers, but the scope for replication is more limited. The choice for these crops is often motivated by conservation goals as well.

From a genetic resources perspective, some crops can be identified that are grown by many farmers at larger acreages, usually rendering these crops less vulnerable to genetic erosion. In a second category, some crops are grown by many farmers but at small acreages or by a small number of farmers at larger acreages. These crops and their varieties might be sensitive to genetic erosion, and still attract sufficient interest to warrant their improvement through PPB. A fourth category is formed by crops grown by a small number on small acreages only. For the conservation of such crops and their varieties probably other methods than FFS are more suitable.

Upon selection of crops, a validation is required to confirm the importance of the selected crop(s) in the selected farming communities, which is done during the village baseline survey. Experience has shown that each location is unique, and that specific information concerning farming systems and seed systems, as well as the potential for local participation, apparent during the survey, can be a major factor in the area selection process.

3.3 Establishing links with research

Establishing links with national agricultural research stations and individual scientists is a deliberate strategy in FFS-PPB to enhance local capacity development and the sustainability of the FFS-PPB programmes. Main benefits for farmers in linking up with researchers or research institutes, and, reversely, for researchers in establishing links with farmers are:

Table 3.2: Benefits for farmers and researchers in partnerships in plant breeding

BENEFITS FOR FARMERS	BENEFITS FOR RESEARCHERS
• better access to germplasm	• 'free' testing of varieties and breeding lines in diverse farming environments
• exposure to new breeding approaches	• selection for stress-related conditions in target or marginal production areas
• obtaining skill and know-how through expert teaching	• structured information concerning producer and consumer preferences, using farmers' knowledge
• gaining political/policy support for FFS-PPB development	• new opportunities to write research papers on a variety of subjects

Benefits are primarily based on the comparative strengths and weaknesses of both breeding systems, the farmer and institutional breeding systems as explained in chapter 1.

Links with researchers can be established either on an individual basis or through a Memorandum of Understanding (MOU) with the research institute. The latter may describe the concept for collaboration and determine the role and involvement of researchers and farmers in the FFS-PPB programme. Though preferable, experience in PEDIGREA shows, that the MOU is not always within reach.

Variety evaluation study in yardlong bean

The success of establishing a research link varies per country. In some countries research institutes may already implement PPB activities and react positively; in other countries, scientists are suspicious of the FFS-PPB approach and feel threatened by it. In these cases collaboration may be difficult to establish. Overall, farmer-breeder partnerships still face many bottlenecks which includes such issues like property rights (who obtains the right on the newly bred varieties?), research funding (who pays for the researcher involvement?), and scientific recognition (is this truly a scientific result?). Usually it is up to the local organisation to find the best time and ways to establish a research link for the FFS-PPB programme.

3.4 Recruitment and training of FFS facilitators

The first step towards establishing the FFS-PPB programme is the training of a core group of trainers and facilitators by experienced development workers and trainer-researchers. Once trained, this core group of facilitators will be responsible for most aspects of training and for the management of the FFS-PPB in their region. Recruitment of this core group often comes from IPM programmes, which has the advantage that they already master the FFS concepts, including methods and theories of non-formal adult education, and that they manage relevant networks and have experience with policy aspects.

Core facilitators should be farmers who know how to grow crops. They must be ready to become experts in PPB methods and able to spend a large amount of time in the field with trainees and farmers. Also they should be ready to meet frequently to assist in planning work, budgets and strategies for improving the PPB programme, and should provide full time input for at least 4 years or eight seasons.

Once a core team of FFS facilitators is developed, they should be able to conduct a Training of Trainers (TOT) to train new (farmer)-facilitators. It is advisable to also invite agricultural extension officers to participate both in the TOT and the FFS-PPB. A TOT typically lasts 1-2 weeks and has 10-12 participants. Different resource persons, including researchers and guest core

Impressions of training of trainers for farmer field schools facilitators from other FFS-PPB programmes contribute to the TOT. At the end of the TOT, farmer-facilitators should be able to:

- conduct a village baseline survey;

- adjust the FFS-PPB curriculum in accordance with crop and location specifics;

- know how to organise and implement the start-up and follow-up FFS-PPB;

- prepare and manage the budget for the FFS-PPB.

Core trainers may eventually become senior facilitators and resource persons in their region.

3.5 Village baseline survey

Once the area, communities and priority crops have been selected, a village baseline survey is conducted in order to prepare for the FFS-PPB main course. A village baseline usually takes place one month before the start of the FFS-PPB. The purpose of the village baseline survey is to validate crop choices, to map the available genetic diversity in the community, to elaborate on the strengths and weaknesses of the varieties cultivated in the village and to set breeding objectives. The survey, which is a farmer-driven and not a research-driven activity, uses group exercises to allow farmers to discuss the various topics and to choose the crops and criteria for breeding in the FFS-PPB programme.

The baseline survey usually takes 2-3 days to complete and involves approximately 30 resident farmers. The pace and depth of the survey may vary with community and, although a short and focused survey is preferred, it should be guided by the time farmers can invest in the exercises and the ability of the community to decide upon their own goals for breeding. Occasionally, the baseline survey takes more than the three days set apart. Some organisations, like in Indonesia, have decided to establish the baseline survey not before but at the beginning of the FFS, to enable participants to focus and to set enough time apart for the goal setting process, although this approach restricts the time to collect and introduce good germplasm.

3.6 Introduction of germplasm

The next step in the preparation of the FFS involves arranging for necessary germplasm to increase the variability in the community's variety pool and to allow farmers to select for valued traits. The quality of the collected genetic resources greatly determines the success of the local FFS-PPB programme. When farmers observe that the material shows improved traits, they are more motivated to continue. For example, in Indonesia, the introduction of brown hopper resistant varieties has led farmers to extensively cross this material with their own varieties.

Once breeding objectives are established, it is necessary to start searching for suitable germplasm as early as possible in order to be on time for the planting of the FFS field trials. Depending on the crop and region, germplasm can be accessed from different sources:

Exotic varieties. In many countries, large seed collections of major staple crops are available at national and international genebanks. For minor crops, like indigenous vegetables, usually only a small collection is retained in genebanks. This material, collected from various countries and regions, is usually diverse and little adapted to the local farming environment, and often little characterised. Introduction of exotic varieties is primarily recommended in case specific characteristics such as pest resistance or drought tolerance not found in the local varieties are required.

Collecting germplasm from neighbouring farmers

Segregating populations. Introducing segregating populations into the FFS-PPB programme provides a shortcut in the breeding cycle, which – assuming that the material is suitable – saves farmers a lot of time producing new varieties. Early populations like F2 or F4 or advanced lines like F6 may be introduced from nearby research stations or from FFS-PPB programmes in neighbouring communities. The latter has specific advantages, since the cross and selection is already based on the local production and consumer preferences, whereas the farmer-breeder himself may also have a stake in the selection.

Commercial varieties. Commercial varieties can be purchased from local seed outlets or from city markets. Most of this seed, especially in vegetables, is of hybrid origin and few farmers tend to purchase it, instead relying on their own or on seed exchanged with their neighbours. In countries with a less development seed supply mechanisms, the experience is that the quality of commercial varieties is less reliable.

Date of collection: ________________	Production cycle (in days): ____________
Name of collector: ________________	Appearance of fruit: ________________
Address of farmer-producer: __________	Pest & disease resistance: ____________
______________________________	______________________________
Source of seed: ________________	Production capacity: ________________
General description: ______________	______________________________
______________________________	______________________________
Strengths: ______________________	______________________________
______________________________	______________________________
Weaknesses: ____________________	______________________________
______________________________	______________________________

Fig 3.2: Sample of a variety characterisation listing by farmers

Farmer varieties. Varieties grown in the vicinity are well accessible by farmers but tend to be not very different from the farmers' own varieties. Farmers may travel to other regions with similar farming systems to collect more exotic varieties, but since these field trips are expensive they must collect enough seed or fruit to plant a number of field trials (as a rule of the thumb at least five times more). Good timing of this collecting mission is important, preferably coinciding with the harvest so that farmers will be able to see the crop in the field before selecting. At the time of collection, or afterwards, it is important to characterise the varieties based on data provided or collected during the field trip.

3.7 Implementation of start-up FFS-PPB course

Each FFS-PPB course is carried out by a facilitation team consisting, in principle, of three facilitators: two farmer-trainers and one district extension officer-trainer, all preferably living in or near the target farming community. Facilitators should be of opposite gender. In preparing for the main FFS-PPB course, the facilitation team works closely with the participants in order to arrange for necessary germplasm, make a layout of the seed bed and field trials, and raise seedlings for planting in the field.

The main FFS-PPB course generally takes 4-5 months (18 weeks), which covers a full planting season, from 2-3 weeks before planting of the field studies to final evaluation after harvest. Farmer participants in the FFS-PPB meet on a weekly basis to follow-up on the field exercises and topics. Field exercises are conducted in small groups of farmers, which groups are formed at the beginning of the FFS-PPB. Small groups share responsibilities and tasks in the field studies and at the same time facilitate necessary discussion and interaction among farmers. Each course group consists of 25 farmers approximately with a right balance of male and female, young and elderly farmers. Participants in the FFS are selected usually by consensus from the farming community using a set of selection criteria after the completion of the village baseline survey.

Group of farmers during an FFS exercise

The course contains four inter-related field studies: 1) variety evaluation, 2) plant growth and reproductive morphology, 3) varietal crossing and 4) variety breeding (selection in segregating populations). Although less preferred, farmers may decide to combine study 1) and 2) because of lack of space in the field. The variety evaluation trial generally contains minimum 10, maximum 30 varieties, and includes at least one local control variety. In the case of vegetables like pumpkin the variety evaluation study rarely contains more than 7 varieties because of the large planting area required for such trial. The study on varietal crossing is generally performed on varieties planted in a separate plot. Performing this on plants in the variety trial may interfere with the results of the trial, especially in vegetables. In the case of rice, plants are generally transplanted to pots and transferred to a shed near the FFS meeting venue for demonstration and practice of varietal crossing. Line selection studies (selection in segregating populations like F2 or F4) are always planted in separate plots; fields may contain from 50 to 2000 plants. To facilitate selection one seedling per hill should be planted.

Farmers performing varietal crossing in vegetables

In addition to the field studies, various topics are discussed during the course to support the knowledge base of the farmers participating. Firstly, farmers review the breeding objectives, discuss how to observe and record the different criteria, and set the time of observation. Secondly, they familiarise themselves with the weekly GEAN observation sheets (Genotype by Environment Analysis) which supports them in their field activities, data analysis and final evaluation. Thirdly, they study the plant growth and reproductive systems during the flowering stage and practice varietal crossing. Also they discuss the different selection techniques for the crops under study. Finally, at the end of the course, they conduct an eating quality evaluation and sit down to discuss the results, evaluate the course, and plan for the next season.

Just before the end of the season, a Farmer Field Day is conducted to celebrate the successful completion of the FFS-PPB course. During this day the results of the field studies are shared with invited guests including village leaders, fellow farmers and officials. This venue is also used to generate awareness in the community on issues of genetic erosion and PPB. At the end of the course, successful farmers generally receive a small reward (T-shirt) and certificate.

GENOTYPE by ENVIRONMENT ANALYSIS (GEAN)

Genotype - Environment Analysis, or in short GEAN, is a weekly activity conducted during the FFS-PPB course(s) to guide participants in their field studies, especially on aspects of data collection, analysis and decision making. Activities start as soon as the first seedlings emerge and end at harvest time. The weekly GEAN exercise involves two parts: field activities and data analysis.

In GEAN, farmers focus on three kind of observation:

1. Genotype: these are observations on variety traits and attributes and form the most important element in GEAN. The activity provides a direct link with the breeding goals and the observations set by farmers at the start of the FFS course (see 4.2)
2. Environmental: this element focuses on environmental factors in the study field and involves data collection on environmental aspects of biotic origin (pest and disease prevalence, weeds), a-biotic origin (weather, water), and human origin (fertilizer application, spraying)
3. Genotype by Environment interaction: in this last section, farmers determine whether or not there is an influence of the environment on the observed attributes or traits in the field. This analysis is necessary as interaction may distort the result of the variety comparison.

At the end of each GEAN session, participants discuss the results and decide on the following issues:

1. What variety has performed best? Limit the decision to two or three observations per week
2. What further action is required? Elaborate on the field activities needed for preparing the next week's session.

A day in the farmer field school on participatory plant breeding

7:00	Review of last week's activities Explanation of this week's topics and field activities Preparation of GEAN data sheet Expectation setting
7:30	Field work and data collection
9:00	Farmers and groups reconvene to compile and analyse results Groups present and discuss their results Participants discuss and finalize the key decision points
10:00	Introduction to special topic
10:30	Start with group activities on special topic Reconvene, analyse and discuss the results Summarize the group findings
12:00	Wrap-up of this week's activities Levelling of expectations Preparing for next week's activities

Example of a FFS Curriculum on PPB in Rice (Indonesia)

Week 1	Opening ceremony Baseline study (varieties cultivated)
Week 2	Baseline study (breeding objectives)
Week 3	Baseline study (decision varieties for trial) Layout of field studies
Week 4	Seedling preparation Study on plant morphology and growth stages
Week 5	Planting method Planting of study field
Week 6	Observation and scoring methodology
Week 7	Plant observations and presentation Genotype & environment (GEAN)
Week 8	Flower morphology*
Week 9	Crossing method*
Week 10	Crossing practice (2 days)*
Week 11	Crossing results*
Week 12	Line selection and selection methods*
Week 13	Seed banking*
Week 14	Variety rehabilitation*
Week 15	Biodiversity*
Week 16	Final evaluation
Week 17	Farmer Field Day
Week 18	Follow-up planning

* includes GEAN

3.8 Implementation of Follow-up Field Studies

On completion of the FFS-PPB training course participants and facilitators evaluate the results of the field studies and discuss how to continue in the next season(s). Participants then discuss what field studies should be conducted during the next season, who will be responsible for seed storage during the off-season, and who is going to participate in the next season's activities.

The main follow-up field study is the study on line selection or variety breeding; other posible follow-up field studies are: variety rehabilitation, genebank, and variety evaluation (PVS). The latter, a replication of the previous FFS study, may be required when farmers have more varieties to evaluate. Occasionally, farmers decide to again perform varietal crosses, this time more targeted.

Proud farmer-breeders showing their selections

In the Follow-up Field studies farmers can concentrate on one crop or on more than one crop. The norm is that farmer focus on more than one crop, for example on rice and one or two vegetable crops, which of course each need their specific expertise and preparation.

In PEDIGREA this has now become feasible. Follow-up field studies are conducted by groups of farmers with minimum 8 to maximum 25 participants. All participants should have completed the start-up FFS-PPB course. Farmers and facilitators meet every week or bi-weekly to observe the field, make notes and discuss progress and special topics in very much the same fashion as in the main FFS-PPB course.

As the FFS-PPB programme expands, more communities in the area become engaged in PPB. This creates a rich source of information, breeding materials and experiences. In PEDIGREA, the feed-back and exchange of information and material between same-crop farmer groups and farmer-breeders has become a major force motivating farmers to continue with their PPB activities. Venues for regular exchange of information and material like farmer-breeder workshops, network meetings and local seed fairs may be organised by the core team to support the further development of the PPB programmes.

Group dynamics in follow-up field studies

In Cambodia, almost all the participants in the FFS-PPB start-up course on rice and vegetables have signed up for follow-up field studies. Groups have been subdivided in three sub-groups of 8-10 farmers, one group per village, each under the leadership of a farmer-trainer. Each group is responsible for its own field studies, and continues to do so during the entire breeding cycle (8 seasons). They meet once every two weeks. Although the crops are the same, the breeding activities and breeding objectives are different.

In Ta Pech village, Kandal province, three small farmer groups are formed, of which two focus on variety breeding in rice and vegetables, and one on variety rehabilitation. Out of the two groups on variety breeding in rice, one group focuses on short maturity, the second group on mid and long maturity. Farmer groups within the same commune closely work together and regularly make exchange visits to share the results of breeding and selection work during the season.

In Kok Rom Lech village, Samrung Thung district, also three small farmer groups are formed; they focus simultaneously on three crops: rice, pumpkin and wax gourd. In rice they apply the same, in pumpkin and wax gourd different breeding objectives.

In Indonesia, like in Cambodia, promising breeding materials is exchanged among the groups. A field coordination team consisting of three senior farmer-trainers meet regularly with resident farmer-trainers in the field or in workshops to discuss progress in the PPB programmes, and initiate farmer group exchanges and seed fairs. Other initiatives by the team comprise seed bank management, and a news bulletin.

3.9 Implementation of Enhancement Studies

In addition to follow-up field studies, farmers can choose to participate in so called enhancement studies. Enhancement studies support the PPB programme, can be short or long, and range from workshops addressing specific development issues in the PPB programme to full-fledge FFS training programmes. In PEDIGREA, currently two enhancement studies are under development: vegetable market strategy development and farmer breeder's rights.

Farmer-adapted approaches

Breeding in small farmer communities can have constraints which are not or in less proportion found in on-station breeding. For example, in farmers' fields there is generally a lack of space for studies in the field, a lack of isolation in the case of cross-pollinating crops. Also seed storage may be a problem and the lack of administrative capacity. Unlike research stations, there is no employer-employee relationship. Monetary compensation is minimal (per community on average 100 USD per year), which, in the absence of other stimulation packages (community empowerment, germplasm, group interaction) there can be a lack of responsibility and sharing of results. In this situation the lesson is that one should not attempt to make farmers adapt to the breeder's environments; rather breeding methods should be adapted to the farmer's situation. In PEDIGREA different concepts are applied and are presently closely monitored:

Modified selection methods. For cross-pollinating vegetable crops like bitter gourd, pumpkin and loofah, a modification of the standard selection method is applied which can be typified as modified full-sib bulk selection. Instead of bulking the F1, F2 etc good performing plants are selected in the population, hand-crossed among each other and the resulting seed bulked for next season planting. This approach avoids the need for isolation and, provided enough crosses are made, prevents that valuable genes are lost.

Meta-breeding populations. These are decentralized small field units of breeding lines, essentially derived from the same cross, that are managed by individual farmers or small groups of farmers. Groups are responsible for the planting, selection, harvest and storage. Different farmer groups have the same or different breeding objectives and regularly share results. Meta populations aim to resolve issues of lack land and responsibility.

Strong farmer-led coordination. In Indonesia, the FFS-PPB programmes are coordinated by a core farmer team, which run the day to day activities of the FFS-PPB programme in the Indramayu district. This team plans for new FFS-PPB, meet with the leaders and farmers in the new community, arrange for baseline surveys and timing of the FFS-PPB, select new farmer-trainers, organize Training of Trainer workshops and Farmer breeder fora and support the development of the curriculum. Farmer-led coordination leads to a great sense of ownership of the FFS-PPB programme.

4. ENSURING IMPACT, UPSCALING AND MAINSTREAMING

4.1 Beyond the pilot phase

Eventually FFS-PPB programmes will expand beyond the pilot areas and develop into major on-farm breeding systems. Such expansion generally coincides with the completion of the FFS-PPB manual in the local language, the availability of a strong team of facilitators, and a well established local farmer-based organisation to coordinate the programme.

In order to advance from pilot phase to major FFS-PPB programme, each step needs to be carefully planned. For this to happen, three cross-cutting activities must be pursued from the beginning of the FFS-PPB programme.

4.2 Making PPB an integral part of farming communities

As the entire FFS-PPB programme takes place in the farmer communities, all segments of the community need to be involved, farmers and traders, children and elders. In other words, PPB needs to become an integral part of the entire farming community. In order to reach this, four elements are essential:

- building a cadre of experienced farmer-facilitators, who can train other farmers;
- creating forums and opportunities for farmers and trainers to interact;
- documentation and dissemination of successful experiences of farmers in the application of the knowledge gained from PPB;
- development of FFS-PPB in other crops and related topics.

Building a cadre of farmer-facilitators

Building a strong cadre of experienced FFS facilitators is crucial not only in the initial development but also in the further expansion of the FFS-PPB programme. Core facilitators should be primarily made up of farmer-facilitators. Farmer facilitators are familiar with all aspects of the local community and, frequently being farmer-breeders themselves, they are best placed to assist fellow farmers in their crop breeding programmes, often at minimum or no cost. Moreover, building a core of farmer-facilitators is an effective mechanism to build confidence among farmers and empowering communities. Other facilitators and supporting staff may assist in aspects where farmer-facilitators generally are weaker, such as in administration and monitoring, in order to enhance programme development as a whole.

Creating farmer forums

Farmer forums enable farmers to exchange information and experiences and discuss issues related to the PPB programmes. At village level, farmers can meet on a monthly basis with farmers in neighbouring PPB communities to share the results of the FFS-PPB courses, or keep each other informed on crop-based activities in follow-up field studies. These village level forums may also create focus groups to share plans and ideas. At the district level, representatives of the different PPB communities may establish a farmer-breeder and trainer forum to evaluate on a quarterly or half-yearly basis the different PPB crop programmes, review FFS curricula and activities, and create liaisons with local authorities. Apart from crop-related issues, farmer forums may also cover the discussion on farmer breeder's rights and socio-economic issues relevant to the community. Senior farmer-trainers may be elected to coordinate the forum and FFS activities, creating effective farmer networks and leadership for discussion of relevant topics and activities as the FFS-PPB programme continues to develop.

Documentation and dissemination of successful experiences

In order to develop the FFS-PPB programme, and to adapt it to fit the local farmers' environment, the programme should become a learning organisation. Documentation of local farmer practices and other experiences on the breeding of crops, training and organisation, community empowerment and relevant policy/political aspects are needed to enhance the FFS-PPB programme and curriculum. This can be done, for example through simple case studies, describing farmer's experiences, advanced case studies, studying particular farmer's practices, workshop papers, news bulletins and other publication forms. By sharing this information via local and international forums, other experiences are integrated, through which it is possible to regularly review the FFS-PPB curriculum, contributing further to more successful farmer experiences.

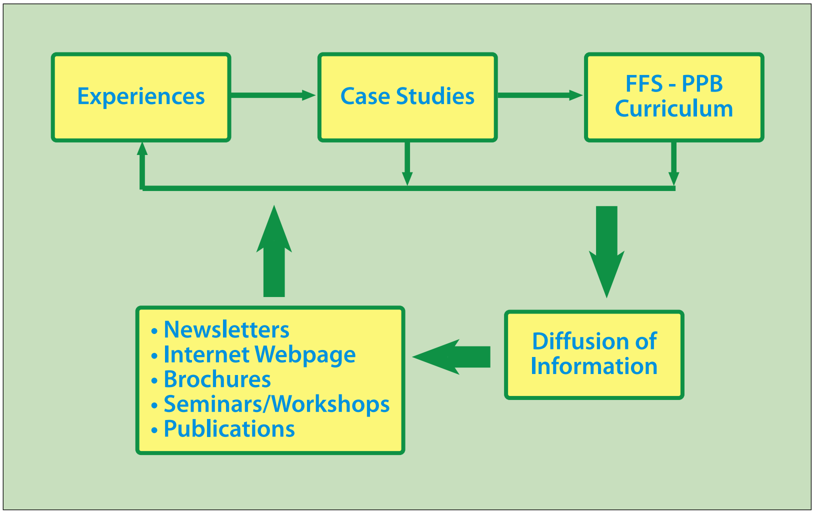

Fig 4.1: Integration of farmer experiences into the FFS-PPB curriculum through regular review and documentation

Further development of FFS modules

FFS approaches need to be developed for other crops as well, especially for important food and cash crops, to ensure that all major crop segments in the local farming system are covered, and to motivate other farmers in the community to participate. Generally farmers are eager to expand their gained knowledge to other crops. Further development of FFS is not only limited to crop-related issues, but could actually expand to other related topics such as livestock, or even socio-economic issues relevant to the community.

FFS building community awareness

4.3 Political and policy support

Experiences in the FFS-IPM programme show that political and policy support is essential when moving from the pilot phase to a larger scale. Although support from the local authorities may be required to obtain approval for the initial development, once the programme expands beyond the pilot phases, additional support should be sought from the provincial or central government, with may bring in the research institutes, based on successful demonstration of FFS-PPB in farmer's fields. This may form a major boost in the subsequent development of the FFS-PPB programme.

In PEDIGREA, agricultural extension agents closest to the respective farmer communities are invited to participate in the TOT and FFS-PPB main course. This is an essential link to the district extension agency and local authorities. In addition, local officials are invited for farmer field days and seed fairs or to attend special workshops or seminars on FFS-PPB experiences.

Although much research on participatory plant breeding approaches has been conducted in developing countries, especially by international organisations, until now few initiatives have been undertaken by national research institutes along the same lines as FFS-PPB. Most of the national institutions opt for the safer option of "on-farm management" of their own breeding programmes, which would not require them to work with farmers as equal participants. Obviously, farmer-led breeding programmes like FFS-PPB, where farmers manage their own breeding programmes, is threatening to some in the national research institutions. Most national research institutions also lack the funds, mandate, interest or political will to venture into FFS-PPB.

There is a need for institutional and political changes at the level of national agricultural research stations (NARS) to enable researchers to effectively participate in PPB activities, and for farmers to have equitable access to available information and germplasm material. Currently, the most contentious issues are related to the introduction of Plant Breeder's Rights (PBR) and Material Transfer Agreements (MTA). With the trend that MTAs are getting stricter, the possibility of national institutions sharing their germplasm held at research stations is becoming less likely. Research institutions, fearing that farmers may use their material to obtain breeder's rights, may be willing to provide breeding materials to FFS-PPB programmes but at the same time do not provide details on the cross and the selection background of the materials.

Farmers, on the other hand, find it increasingly difficult to use this material as they perceive that this may obstruct farmer-to-farmer seed exchanges and trade, and also, that they cannot receive recognition for their breeding work. The options for multi-location testing and registration of farmer varieties are limited, although in some countries (e.g. the Philippines) there are signs that local authorities are willing to consider local variety listings.

4.4 Monitoring and evaluation

Expansion of the FFS-PPB programme necessitates a good monitoring and evaluation process to track developments and achievements in the different FFS-PPB programmes. This process should be transparent, participatory, and understandable for the relevant farming communities involved, and should serve to:

- help build the capacity of stakeholders to reflect, analyse and take action;

- contribute to the identification of lessons learned that can lead to corrective action or improvements by the programme recipients.

Key Characteristics of Participatory Evaluation

- Draws on local resources and capacities
- Recognises the innate wisdom and knowledge of end-users
- Demonstrates that end-users are creative and knowledgeable about their environment
- Ensures that stakeholders are part of the decision making process
- Uses facilitators who act as catalysts and who assist stakeholders in asking key questions

Monitoring and evaluation in the FFS-PPB can be done at four different levels (McAllister, 1999):

1. The first level is that of the participatory process development, which refers to the methods and tools used in the FFS-PPB curriculum, the follow-up studies, and enhancement studies. Monitoring this process development is very important as it tracks the documentation of experiences that can be used in further development of the FFS-PPB curriculum. Studying process development may determine how participative the programme is conducted, how effective the tools are in transferring know-how to farmers, and whether these are understood by the target groups and increase self-confidence. The best venue for monitoring of participatory process development is at the end of the FFS-PPB training season by FFS-PPB facilitators and participants, or else during the training of trainer workshops or farmer discussion forums.

2. The second level is that of outputs, which describes the concrete and tangible results of the FFS-PPB programme. Examples of outputs are:

- the number of people participating in the FFS-PPB;
- the skills and know-how that have been learned by the participants;
- number of crosses made and lines evaluated;
- number of superior lines or varieties selected by farmers during the season.

Farmer-trainers and participants can monitor outputs at the end of the season, when they sit down to discuss the results of the FFS-PPB, which can then be compiled by the core farmer facilitators for necessary action.

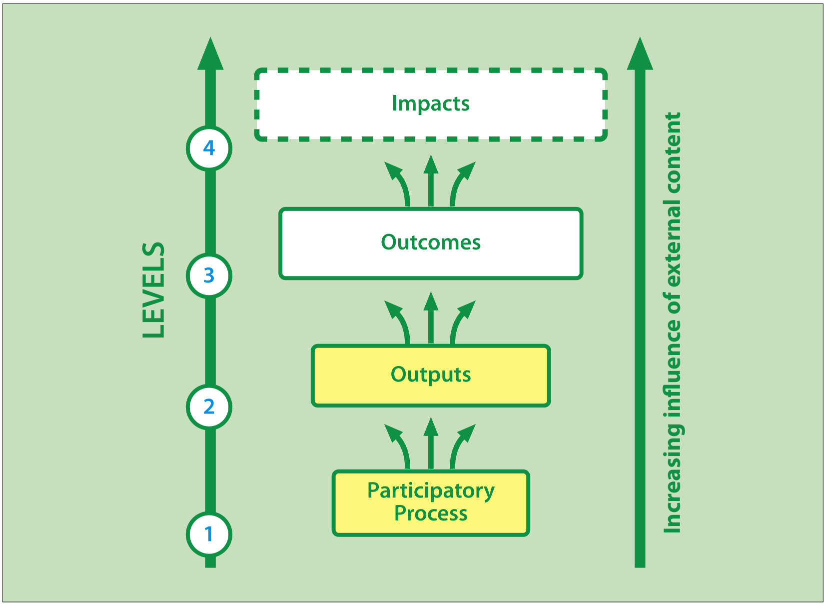

Fig 4.2: Four levels of monitoring and evaluation

3. The third level is that of outcomes, which are short-term impacts or effects and describe the intermediate impact that can be attributed,

at least in part, to the FFS-PPB programme. They can be negative and positive, expected and unexpected. Examples of outcomes in FFS-PPB are:

- improved ability of farmers to solve problems
- improved community confidence and self-esteem
- development of superior farmer varieties
- changes in farm management practices, such as the adoption of new varieties, diverse use of crops and varieties

Monitoring of outcomes can be trickier than that of outputs since it is more difficult to pinpoint what really has changed as a result of the FFS-PPB programme. Outcomes can be monitored by farmers with the assistance of staff of local organisations or by experts every other year. In Indonesia, farmers have experimented with the monitoring of outcomes by taking pictures in their communities (see box).

Farmers demonstrating results of the FFS-PPB during a farm field day

4. The final level of monitoring is that of impact, which describes overall changes in the community and may include wider social and development goals. Examples are:

- the improved sustainability of livelihoods;
- empowerment of communities;
- decreased poverty (e.g. the extent to how these varieties improve the farmer's income).

Monitoring of impacts of FFS-PPB programmes at community level and beyond can be measured only after a substantial number of years. With each higher level of monitoring, the influence of external factors increases. For example, development impacts such as rural poverty and livelihood are often significantly affected by external factors, such as climatic conditions, and changes in the socio-economic environment (market prices).

In PEDIGREA, different approaches for the monitoring and evaluation of FFS-PPB programmes are presently implemented, mostly at the participatory process development (level 1) and outputs level (level 2). Some of the tools, like ballot box, T-chart and piling up, measuring the quality of the FFS-PPB course and the improved skills and know-how of participants, have been adapted from regular FFS programmes, but other tools like the 'picturing tool' have been developed anew. Tools at the higher levels evidently need a longer time to develop, especially so when the PEDIGREA programme, established only in 2002, is still relatively young.

PICTURING IMPACT

In this evaluation method, developed by Field Indonesia, farmers or farmer groups receive a photo camera and are asked to take pictures on evidence of changes that has occurred over the past period in their community as a result of the FFS-PPB programme. After finishing, photographs are displayed, categorised, and presented to the other groups explaining the reason for choosing it. Results can be positive or negative, planned or unplanned. The evaluation is primarily meant for feedback on outputs, outcomes and impacts from the farmer's point of view, and will thus contribute to lessons learned and improve the FFS-PPB programme.

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