The Quality of Science in Participatory Plant Breeding

Maccarese, Rome, Italy,
IPGRI Headquarters
September 30 - October 4, 2002

Workshop co-hosted by:
CGIAR System-wide Program on Participatory Research and Gender Analysis in Technology Development and Institutional Innovation (PRGA)
and
CGIAR System-wide Genetic Resources Programme (SGRP)

Prepared by Louise Sperling
2003

PRGA: The Consultative ´Group on International Agricultural Research (CGIAR) works to promote food security, poverty eradication, and the sound management of natural resources throughout the developing world. The purpose of the CGIAR Program on Participatory Research and Gender Analysis (PRGA Program) is to assess and develop methodologies and organizational innovations for Gender-sensitive participatory research and to mainstream their use in plant breeding and in crop and natural resource management. The PRGA Program is cosponsored by the International Center for Tropical Agriculture (CIAT), which serves as the convening center, and by the International Maize and Wheat Improvement Center (CIMMYT), International Center for Agricultural Research in the Dry Areas (ICARDA), and International Rice Research Institute (IRRI). PRGA Program activities are funded by the Canada's International Development Research Center (IDRC), The Ford Foundation, and the governments of Norway, Italy, Japan, the Netherlands, and New Zealand. Switzerland, and Canada. The program's members include international agricultural research centers, national agricultural research systems, non government organization, and universities around the world.

SGRP: The System-wide Genetic Resources Programme (SGRP) joins the genetic resources programmes and activities of the Future Harvest Centres in a partnership whose goal is to maximize collaboration, particularly in five thematic areas. The thematic areas - policy, public awareness and representation, information, knowledge and technology, and capacity-building - relate to issues or fields of work that are critical to the success of genetic resources efforts. The SGRP contributes to the global effort to conserve agricultural, forestry and aquatic genetic resources and promotes their use in ways that are consistent with the Convention on Biological Diversity. IPGRI is the Convening Centre for SGRP. The Inter-Centre Working Group on Genetic Resources (ICWG-GR), which includes representatives from the Centres and the Food and Agriculture Organization of the United Nations, is the Steering Committee.

CONTENTS

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Context
The practice of Participatory Plant Breeding (aka 'PPB') has known a remarkable growth in the last ten years. Characterized by explicit collaboration in plant breeding among (*inter alia*) farming communities, formal breeders, and development personnel, about 120 PPB projects exist worldwide (with about 80 of these well documented of the PRGA website: (see **www.prgaprogram.org**).

This particular workshop emerged from a key recommendation of the panel of the System-wide Review of Plant Breeding Methodologies in the Future Harvest Centers (October 2002) which suggested that Participatory Plant Breeding (PPB) approaches be considered among the core breeding strategies within the international agricultural research centers. To move forward the practice, the panel suggested that a workshop be convened to compare and contrast varied PPB practices and to assess 'state of the art' to date.

Quoting the report, Recommendation 18:
***Centres should evaluate the use of PPB as an organic part of each Centre's entire breeding programme,* rather than isolated endeavour [emphasis added] ….The workshop could devise ways to systematically evaluate the utility of different kinds of PPB as an integral part of conventional plant breeding…."**

The Quality of Science in Participatory Plant Breeding workshop was subsequently held in Rome, Italy (at the headquarters of the International Plant Genetic Resources Institute, IPGRI), September 30 - October 4 2002. Though a small meeting of 35 participants, it brought together some of the leading practitioners in PPB within the Future Harvest Centers and representatives of the genetic resources area (scientists from some 7 different centers). However, recognizing that important innovative and creative work in PPB has been unfolding within regional and national networks, and among civil society groups, the Workshop also drew expertise from: the MesoAmerican PPB networks, the South and South Asian Using Agricultural Diversity Network, SEARICE, CIRAD, FAO, US Universities (University of California), the DFID-supported plant science programs, and from a range of National Agricultural Research Systems (China, Malawi, Cuba, Solomon Islands, Brazil).

Somewhat unusually for the Future Harvest Centers, the meeting was co-hosted by two different 'system-wide programs': the System-wide Program on Participatory Research and Gender Analysis for Technology Development (PRGA) and the System-wide Genetic Resources Programme (SGRP). This joint endeavor was to encourage that a diversity perspective, and a farming/natural resource management systems focus would be linked to plant breeding concerns in an integral, rather than *ad hoc* fashion. Such a holistic perspective is, of course, the base, from which farmers themselves manage their household, farming plots, and wider land, water (etc) resources.

Overview of Content and Select Recommendations

The overall brief of the workshop was to assess critical advances in the social and biological science shaping PPB practice, evaluate the breadth of its impact to date, and identify key next scientific challenges. A multi-institutional Organizing Committee debated long and hard and focused this broad brief into six key topics (listed below—and for more detail see full sub-list themes in Proceedings). Plenary Sessions and subsequent working groups were organized around these issues: what do we know, what don't we know, how should we design research and development work to move the issue forward.

Key broad themes identified by the Organizing Committee for moving 'PPB' forward

I. How to conduct rigorous and predictive diagnostics and priority setting with farmers in PPB (at various scales)
II. How to construct research design and analysis of results which balance researcher needs and farmer needs in PPB (how it is done and what it means)
III. How to compare the impact of classic versus participatory plant breeding as well as compare the impacts of different types of PPB
IV: How to shape PPB-conducive research and development policy (what can be done, or not; institutionalization)
V. Putting PPB in a more holistic and integrative context to promote increased production and systems sustainability
VI. Future horizons; (Wild Cards!) (focus on biotechnology and PPB)

Working Group Discussions

Working Group discussions were as important as the plenary presentations (the latter being limited to 17, to allow for maximum group interchange and 'thinking' together). These discussions have been reported in full (see section in Proceedings), and we highlight here a few of the working group salient points, to suggest their flavor. (Notes from Working Group discussions can be found in Annex 1)

Priority Setting

- Joint priority setting was judged as a continuing weak point in PPB methodology and emphasis was put on the need to start the process which the joint setting of 'goals' (eg. higher production, production and diversity enhancement, skill building) and to negotiate careful between biological and social goals.
- Participatory methods to work at multiple scales need to be explored more systematically and the issue was debated of whether local methods can be scale up or very different ones have to be used for priority setting at larger scales.

On-Farm Testing and Evaluation

- In PPB, the group deemed it essential that trial design is agreed upon by all partners and that it is interpretable by all partners. Trial designs take very different forms and structures as they are designed for different breeding goals, different agro-ecological systems and different social and economic conditions: lots of choices are available and the flexibility is very big.
- For evaluation at all stages, it is essential to use primarily farmers' criteria for evaluation, and add other criteria in consultation with them. Initial research may be needed to determine these key criteria. Determining the possibly differing needs of different stakeholders (ethnic groups, women, poor farmers) can be essential for success.

Scaling Up

- A prime issue was raised of whether scaling up of PPB should be primarily supply-driven (policy or project-led) or demand driven (stakeholder-led). In terms of the latter, the following conditions could be favorable to demand-driven scaling up: systematic work with Farmer

Research Committees, channeling part of the research funds through FRCs or facilitating ways for PPB products to better reach the market

- Many approaches are being tested or implemented for scaling up the process of PPB, among others: through capacity building of NARS and regional agricultural network alliances, by developing partnerships with Farmer Field Schools, through farmer-breeding clubs.
- In terms of having wider impact, the group stressed the critical need to document more clearly the complementarities between conventional and participatory plant breeding.

Impact

- Two of the first comprehensive analyses of the impact of PPB programs were presented: for rice and maize work in India (DFID, Plant Science-led) and for barley in Syria (ICARDA).
- To enhance impact, the group sensed that much more work needs to be effected (and attention given) to developing seed systems which are compatible with specific PPB program strategies, and which can maintain production and wide/fast distribution.

Shaping development policy: IPRs

- Given the vagueness of international and many national laws on what might constitute 'joint products' in the absence of formal contracts (breeding products, written products as well as innovations), the group supported the development of a Code of Conduct to a) recognize various partners contributions, b) promote 'fair practices, and c) ensure broad access to products and processes emerging from PPB collaboration.
- It was recommended that the group work not only to improve their own practice (eg immediately considering joint authorship more broadly), but also to work at the legislative level to influence law development which may discriminate against or not recognize products emerging from various stakeholder collaboration.

PPB and diversity approaches

- More than 10 different methods and were identified, already in use, to link PPB and diversity concerns
- More systematic linking of *ex situ* and on-farm work was stressed, and several test cases were sketched. These included ideas to bring PGR and PPB/crop improvement networks in: West Africa/ Sahel to look at diversity and supporting local seed systems for the millets and sorghums; Uganda to address concerns of cassava varietal narrowing (and lack of CMV resistance) ;in Western Kenya to counteract decline in beans production due to root rot prevalence; in Rajastahn, India to recreate local varietal needs for the poorest of farmers.

PPB and Biotechnology

- The few practical examples presented focused on linking molecular markers to farmer-preferred traits, and tissue culture for more rapid micropropagation at the community level.

Action Plans

Finally, the group outlined an explicit agenda for action of 'Priority Areas in PPB'. Interestingly, this agenda is very different from the one outlined by the core of this group five years ago (in the base document for the PRGA—see plant breeding group on PRGA website). Moving beyond precise technical and social breeding concerns, the group expressed the need to *maintain and strengthen a critical mass of PPB researchers to ensure scientific credibility.* In this vein, broader development of training materials was cited as one immediate thrust (for, eg University courses and, equally, to enhance the skills of farmers and farming communities in breeding and seed management). A second major action emphasis was put on *influencing policies and policy change,* with work particularly recommended on seed policy and regulatory reform—to ensure that the products of PPB actually reach the intended –end users. The third major thrust mapped out for

action focused on strategies for *capturing (new) finances and building new partnerships.* Substantial efforts were recommended to expand the use of PPB in time and space *per se* (eg through alliances with regional agricultural networks and educational institutions) and particularly to expand its breadth of inquiry—to include new crops, to extend beyond breeding to an inclusive seed system and marketing focus, and to embed the work in a more holistic farming systems, genetic diversity and natural resource management (NRM) context.

The very high quality of formal presentations, the working group recommendations on precisely how to move the science forward, and the strategic action plans on 'crucial next steps' go beyond analyses of technical and social aspects of PPB *per se*. These elements themselves attest to how fast and how far the scope of participatory plant breeding has been moving in the last 5-10 years. The issues are no longer focus simply on 'how to' or 'does it work'—but how can we design implement participatory plant breeding to ensure that the process and its benefits can be expanded more widely--- and for still greater positive effect.

The full workshop proceedings is available on the PRGA and SGRP Websites (www.prgaprogram.org and www.sgrp.cgiar.org).

ACKNOWLEDGEMENTS

This workshop drew on the talents of many. First and foremost, the co-hosts would like to acknowledge the vision of their mutual 'systemwide programs' (The PRGA and SGRP) for recognizing that more user participation in plant breeding and more varietal and crop diversity-enhancing approaches need to be intimately linked if research is to have positive impacts among the poor, in marginal areas, and in heterogeneous production areas.

Though restrained in number of participants (n=35), this meeting aimed to identify gaps and move forward the field of participatory plant breeding (PPB), particularly at its plant genetic resource (PGR) interface. As such, the voice and insight of each participant proved unusually important and we thank those who made the time, and intellectual commitment to joining this Quality of Science in PPB exchange.

Equally, setting a focused a agenda in what is becoming a widely practiced and thematically vast field proved a basic challenge. In this vein, the efforts of the Organizing Committee (OC) proved formidable. The OC worked together to select the most compelling 'key themes', screened abstracts, finalized the program, and maintained unusual good humour when against some time-pinching deadlines.

Organizing Committee Members (in alphabetical order):

Jacqueline, Ashby CIAT/PRGA
Gary Atlin, IRRI
Salvatore Ceccarelli, ICARDA
Wania Fukuda Maria Goncalvez , EMBRAPA
Barun Gurung CIAT/PRGA
Larry Harrington, CIMMYT
Janice Jiggins , independent
Jacques Lancon, CIRAD
Rodomiro Ortiz , IITA
Eva Weltzien-Rattunde, ICRISAT
Louise Sperling, CIAT/PRGA
Bhuwon Sthapit, IPGRI
Jane Toll IPGRI/SGRP
Ronnie Vernooy/IDRC (advisor)

A vital product of this workshop was the joint work accomplished together, during the meeting itself. The productive interchange was greatly enhanced by the skills of two facilitators, Ronnie Vernooy (IDRC) and Janice Jiggins (independent) who lead the group through a reflection of what might be accomplished better collectively or in sub-groups, , why, for whom and how. The Summary Charts sketch resulting insights here. (Annex XX). It is an impressive and provoking agenda

Needless to say, this workshop simply would not have happened without the logistical backbone of the SGRP Secretariat. Oonagh Darby graciously took the brunt of an incredible workload, with Layla Daoud and Samy Gaiji exerting extraordinary efforts at particularly critical times. Their work was supported by IPGRI's administration, travel and visitor services, and our thanks go to the many colleagues at IPGRI Headquarters who helped in ensuring the smooth running of the workshop.

Finally, we would like to mention the roles of two very different types of contributors for offering inspiration and important insights into 'the way forward'. First, both Director Generals of our host institutions have been instrumental in insisting that that narrowly focused disciples stay out of their boxes. Joachim Voss, Director General of CIAT, Acting Chair of the PRGA (and a former PPB practitioner himself) , continues to push for PPB work to take a more 'holistic perspective---, not just to fully embrace the notion of diversity, but to unfold consciously within a more integrated natural resource management perspective. Similarly, Geoffrey Hawtin, Director of General, maintains that crop and variety diversity remain vital, and relevant only through through their active, creative and evolving use. Both have promoted

vigorous user perspectives in research--- and for research to anticipate dynamic and holistic development needs. Such themes should lay at the core of successful, integrated PPB/PGR programs.

We end by the acknowledging the obvious. It is individual men and women farmers, and farming communities who have led the way in collaborative efforts in plant breeding and plant genetic resource management.. And come what may, it is they who will continue to lead the way.

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Louise Sperling, PRGA
Jane Toll, SGRP

ACRONYMS

CIAL	Comites de Investigacion de Agricultura Local
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
DFID	Department for International Development, United Kingdom
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
FAO	Food and Agriculture Organization
FFS	Farmer Field Schools
FRC	Farmer Research Committees
GIS	Geographic Information Systems
GRM	Genetic Resources Management
ICARDA`	International Center for Agricultural Research in Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
IITA	International Institute for Tropical Agriculture
IPGRI	International Plant Genetic Resource Institute
IPR	Intellectual Property Rights
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
M&E	Monitoring and Evaluation
MV	Modern Variety
NGO	Non-Governmental Organization
NARS	National Agricultural Research System
NRM	Natural Resource Management
OC	Organizing Committee
OF	On-Farm
PM&E	Participatory Monitoring and Evaluation
PPB	Participatory Plant Breeding

PRA	Participatory Rural Appraisal
PRGA	CGIAR System-wide Program on Participatory Research and Gender Analysis
PVS	Participatory Varietal Selection
PROINPA	Programa de Investigacion de la Papa
R&D	Research and Development
REML	Restricted Maximum Likelihood
SEARICE	South East Asia Regional Initiatives for Community Empowerment
SGRP	CGIAR System-wide Genetic Resources Programme
WARDA	West Africa Rice Development Association

Annex 1

Key Themes for Moving Forward the PPB Field

Workshop:

Quality of Science in Participatory Plant Breeding

Key themes identified by Organizing Committee

Below find list of themes identified as priority areas for research and action by the Organizing Committee (OC) of this Quality of Science in PPB Workshop. The OC felt that these are areas in which significant methodogical and organizational research still needs to be done--- in order to realize the full effectiveness of participatory plant breeding approaches. It was these 'key themes' which structured the original 'call for papers' and the organization of working groups during the actual workshop sessions (see Annex II).

I How to conduct rigorous and predictive diagnostics and priority setting with farmers In PPB (at various scales)

- Needs assessment and breeding priority setting with farmers: (developing methods meaningful and useful for farmers and breeders)
- Farmers roles and degrees of decision-making in setting priorities (trade-offs between community-level work and that with wider extrapolation)
- Integrating in a more meaningful way social analysis to shape PPB work at all stages (how does social differentiation shape the farmer/breeding process; how does resource access and tenure shape farmer breeding)

II. How to construct research design and analysis of results which balance researcher needs and farmer needs in PPB (how it is done and what it means)

- Experimental designs and methods to bring PPB to small farmers (both in early generations and with stabilized materials)
- Evaluation and manipulation of information from OF trials: quantitative and qualitative (would include statistical methods, software issue, comparisons of farmer ratings and researcher-obtained measurements; and reliability of different sorts of data)
- PPB science on a large scale: challenges: (trial design, data collection designs, and methods—(GXE issue; use of GIS).
- Types of participation and participatory methods for the large scale: challenges
  .

III. **How to compare the Impact of Classic versus Participatory Plant Breeding as well as compare the impacts of different types of PPB**

- Comparing Process and Products and impacts of Classic breeding versus the different forms of PPB (would incorporate the issue of participation as means/end; as well as the link of the quality of participation—with the outcomes)

- Costs and benefits of participatory PB (and different forms of PPB) vs. conventional methods

IV.· How to Shape PPB-conducive research and development policy (what can be done, or not) (institutionalization)

- Designing PPB programs to recognize mutual obligations and benefits

- Assessing the value of and Incorporation of participatory data in national release decisions (How/When)
- Strategies for linking PPB to various kinds of seed system innovations

V. Putting PPB in a More Holistic and Integrative Context to Promote Increased Production and Systems Sustainability

- Linking PPB with crop and agro-ecosystem analysis
- Linking genebanks and genetic resources management (GRM) more directly to support PPB work – and diversity for farmers? (how, where, what levels) (information, germplasm…))
- Linking Genetic Resource Management and PPB within Integrated Natural Resource Management approaches to better target diversity and improvement efforts in heterogeneous environments - G x E interactions and addressing the specific climate, soils, water, production and marketing parameters. (How/where/ what designs, what evidence of effectiveness)

VI. Future Horizons; (Wild Cards!)

- Linking DNA marker technology and PPB
- Farmer –participatory gene discovery
- Participatory evaluation of functional genomic products
- Identifying PPB opportunities as private sector R&D expands (how and can the goods remain public?)

Annex 2

ABSTRACTS

1. Farmer participation in priority setting for breeding programs: methodologies and experiences.

E. Weltzien

Like in other domains, one of the key motivations for pursuing more farmer participation in plant breeding research has been to facilitate a paradigm shift from technology driven research to demand driven variety development, and germplasm enhancement.

Priority setting for plant breeding involves not just decisions about traits and adaptations, but also issues such as type of variety, i.e. lines, hybrids, open pollinated varieties, the level of intra-varietal diversity, and the targeted varietal diversity.

Most published accounts of involving farmers in this initial stage of the variety development process address the need to prioritize between traits and adaptations, to identify selection criteria and targets. Methods used for this purpose have largely relied on results from farmer variety evaluations. Descriptions of farmers' own varieties and their shortcomings, and assessments of introduced materials, using different ranking tools, and encouraging discussions among farmers are commonly used.

Key needs for variety development may be missed, if researchers do not already have a profound understanding of farmers' production systems, and their production goals. Different approaches have been used. Divers PRA tools are available for revealing key patterns in the development of production systems, and farmer decision making.

Decision making with farmers regarding variety type, and diversity considerations requires a common understanding of these concepts, and the current practices of variety and seed management.

The paper will provide an overview over the published literature on methods and experiences of working with farmer on identifying priority traits for further selection. Advantages and disadvantages of working with farmers on station and on-farm will be evaluated, and will be related to the understanding of production systems constraints.

Key contrasting examples for working with farmers on issues regarding variety type and diversity issues will be presented.

2. Role of Farmers' Research Committee (FRC) in Participatory Maize Breeding Program in Gulmi district of Nepal

[1] Sanjaya Gyawali, Pratap Shrestha, Anil Subedi and [2] Bhuwon Sthapit

[1] Local Initiatives for Biodiversity, Research and Development, [2] International Plant Genetic Resource Institute (IPGRI)

Most participatory researches attempts to integrate and capitalize farmers' knowledge into rigorous science, however, there is a lack of efforts to institutionalize the process. Farmer-led participatory maize breeding project implemented by LIBIRD in collaboration of *"Krishak Anushandhan Samuha"* Farmers' Research Committee (FRC) in Gulmi district of western hill of Nepal has shown very interesting results. Farmers in the area are institutionalized for population improvement of maize and seed production of farmers' preferred varieties.

The objective of this paper is to describes the role of *"Krishak Anushandhan Samuha"* Farmers' Research Committee (FRC) in institutionalization the process of integrating local knowledge of maize improvement in the farmer-led maize breeding program in Gulmi. The farming communities have formed FRC, the *Krishak Anushandhan Samuha*, which has a vital role for planning, implementation and evaluation of maize breeding activities in the project area. The working mechanisms has facilitated ensured leadership of FRC in the project, empowered the farming community and farmers have gained skill in population improvement of maize. The paper also explains the process for the formation of FRCs, and seed production and management committee in the area. We also describe the identification of institutional roles and establishing the working mechanisms in the farmer-led maize breeding program in Gulmi. Also the FRC's and farmers' role in mass selection, crossing and maize improvement programs, participatory variety selection and establishment of community based maize seed production activity in the project area is described. The FRCs work as a bridge between farmers and researchers. We elucidate process of farmer bred *"Resunga Composite"* maize population development that is resulted from a random cross of five elite maize varieties obtained from National Maize Research Program. We discuss FRCs role on access of *Resunga Composite* population to different institutions to demonstrate farmers' awareness to their property right.

Key words: FRCs, *Resunga Composite*

3. Methods for understanding farmers' knowledge about genotypes and environments: Exploring the basis for enhanced collaboration with plant breeders in Mexico, Syria, Nepal, and Cuba.

Daniela Soleri (Center for People, Food and Environment and University of California, USA), David A. Cleveland (University of California, USA), Flavio Aragon Cuevas (INIFAP, Mexico) Salvatore Ceccarelli (International Centre for Agricultural Research for Dry Areas [ICARDA], Syria), Stefania Grando (ICARDA, Syria), Ram B. Rana (Local Initiatives for Biodiversity Research and Development [LI-BIRD], Nepal), Deepak Rijal (LI-BIRD, Nepal), and Humberto Ríos Labrada (Instituto Nacional de Ciencias Agricolas, Cuba). Steven E. Smith (University of Arizona, USA).

The paper describes the development of research methods for understanding farmers' knowledge of their crops and environments, and how the results of this research can be used to facilitate collaboration between farmers and plant breeders in PPB programs, with potential benefits in terms of both efficiency and empowerment. The paper directly addresses several topics under themes I and II set for this Workshop: a) developing meaningful and useful methods for assessing needs and setting priorities, b) farmers' roles and degrees of decision-making in setting priorities, and c) experimental designs and methods to bring PPB to small farmers.

The methods were originally developed in Oaxaca, Mexico for understanding farmers' knowledge as the basis for collaboration with plant breeders, and further developed in work with PPB projects in Syria, Nepal and Cuba. We begin by identifying key issues for PPB (e.g., genotype x environment interaction, heritability, response to selection), and framing them in terms of the basic biological model of plant-environment relationships. We then translate these issues into scenarios using situations familiar to farmers, but introducing some important concepts with which they are not familiar, such as uniform, very low stress growing environments as opposed to highly variable, unpredictable, stress environments. Farmers' responses to these scenarios are then analyzed in terms of the basic biological model, and compared with plant breeders' understanding of the same issues. Results to date suggest that farmers and plant breeders often understand the interaction between crop genotypes and growing environments in very similar ways that are congruent with the basic biological model, and that differences can often be explained in terms of specific differences in the genotypes and environments they are familiar with, and do not appear to result from different theoretical understanding. Results suggest a conceptual basis for farmer-scientist collaboration, a method by which researchers can be introduced to farmers' knowledge that supports greater mutual respect, and a means for identifying key variables important for PPB efforts including novel factors or processes.

We have developed a generalizable methodological approach that permits inclusion of farmers' conceptual knowledge in research design and execution, and can form the basis for enhanced farmer-scientist collaboration for crop conservation and improvement.

In Mexico we worked directly with maize farmers in two communities in the Central Valleys of Oaxaca, not participating in a PPB project. In the other three countries we worked with on-going PPB projects, and different crops and institutions were involved: Syria (barley, CGIAR Center), Cuba (maize, national agricultural research institute) and Nepal (rice, regional NGO). Two communities were sampled in each country with the exception of Nepal where the work is ongoing.

The research methods described here can also be used to understand other issues important for PPB. For example, we are now exploring with farmers in Oaxaca the use of scenarios for evaluating the potential effects of transgenes introgressed from genetically engineered maize varieties on farmers' traditional crop populations in Mexico, and farmers' knowledge and values concerning these effects.

4. Linking the Formal and Informal Systems: Exploring the Potential for Crop Development and Biodiversity Enhancement

Yiching Song*

The Participatory Plant Breeding (PPB) Project in SW China started in January 2000 in Southwest China. This project is a follow-up to an impact study carried out from 1994 to1998 by CIMMYT to assess the impact of CIMMYT's maize germplasm on poor farmers in Southwest China. The study addressed the processes of technology development and diffusion by both the formal and the farmers' seed systems and the impact of the introduced germplasm at different levels. One of the key findings of the impact study is the systematic separation and conflicting operation of the formal and farmers' seed systems, which resulted in poor adoption of formal bred MVs, increasing narrower genetic base for breeding and decrease of genetic biodiversity in farmers' fields. Therefore, the current project aims to identify possibilities, mechanisms and arrangements for developing more effective linkages and mutually beneficial partnerships between the two systems which will enhance crop development, in-situ/on-farm management of genetic resources, and farmer capacity building in the specific context of China.

The main perspectives guiding the research are Agricultural Knowledge Systems, and Participatory Research and Gender Analysis. The main methods used are main stakeholders identification and network mapping, comparative field trials between conventional professional breeding, farmer traditional seed selection, PPB, and participatory monitoring and evaluation.

This paper intends to present the case by first describing the research methodologies, main research activities, and the achievement so far. Then, emphasis will be given to the analysis of the social and institutional aspects of the technology development and diffusion process and the related emerging issues in the social transition period in rural China now. A discussion on the confronting challenges, future directions and institutionalization will bring a close to the paper.

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5. Evaluation of data from participatory selection in segregating material of sorghum in two villages in Burkina Faso

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Sorghum is the staple crop of Burkina Faso. It is grown in a range of cropping systems and with various production objectives. Until to date little success has been obtained by the national breeding program in diffusing modern varieties. There are various reasons for this, amongst others, that breeding has been too centralised with low representative growing conditions, and that farmers' needs and preferences have not been taken into sufficient consideration.

The approach of an in-situ preservation and variety enhancement sorghum project recently initiated in Mali and Burkina Faso is to focus on local landrace-based population improvement through recurrent selection, participatory selection of segregating materials and early decentralised yield testing. The project involves national and international scientists, development organisations and farmer organisations. Farmer organisations and other local relevant actors are involved in all stages of the research activities.

Our text will provide preliminary results of on-farm breeding work carried out in 2001. Two on-farm trials were conducted in different agro-ecological zones in Burkina Faso (villages of Some and Zikieme), each comprising 64 sorghum cultivars sown in a 8 x 8 lattice design with two replications. The cultivars were F3/F4 sorghum lines derived from: crosses between guinea and caudatum types, previously released varieties and local landrace varieties.

Workshops for 20-40 farmers, 3 scientists (2 breeders, one agronomist) and a local NGO were organised at both experimental sites in order to discuss and to identify farmers' needs, as well as to rank farmers' criteria for selecting a new sorghum variety. In a second working session, the trials were evaluated by groups of 4-6 farmers (male and female, and from different areas).

At the Some site, all 64 entries of the trial were scored by two male and two female groups as well as one senior sorghum breeder for the three most important criteria identified in the first working session. The farmer groups and the breeder next selected for the better appearing panicles in the best preferred lines. At the second site of Zikieme, farmer groups from different areas within the zone selected their preferred lines and panicles in both repetitions. Agronomic data was collected by technical staff. Selection, following the habitual procedure of pedigree selection, was also carried out in the same F3/F4 lines on-station by the national sorghum breeder.

To assess these evaluation methods and to develop perspectives for participatory pedigree selection for the above mentioned project, the different sets of collected data were analysed and compared by using simple correlation, Kendall coefficient of concordance (multiple correlation) and comparisons of means. Some of these results were discussed and then compared with previous PVS results done in the same areas. Finally, the efficiency and quality of the participatory selection method is discussed and compared to the conventional method.

6. Comparing and integrating farmers' and breeders' evaluations of maize varieties in East Africa

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Over the last 15 years, seed companies in Kenya have not been able to increase their maize seed sales, and new varieties were not able to beat old favorites. Most popular varieties are more than 15 years old, the favorite for the dry areas even 24 years. To address this problem, CIMMYT has started a breeding program in East Africa where, farmers are engaged early on in the selection process, leading to the evaluation of many entries by a many people in many locations. The approach requires a more systematic and quantitative methodology then the classical participatory approach, where farmers are only asked to evaluate varieties at the very last stages. Farmers and multidisciplinary teams have now collaborated for more than 3 years, trying different approaches and updating the methods continuously. Currently, sufficient material is available to begin a critical review, pertaining to three key questions: i) are the methods appropriate and appreciated by all partners involved, ii) is the information gathered complementary to classical breeders' selection data, and iii) does the method improve the selection and increase the adoption rate?

The participatory approach combines the identification of farmers' selection criteria, scoring of the new varieties for the different criteria, and an overall farmers' evaluation score. The results are combined with and compared to breeders' evaluation, synthesized in the breeder selection index. For the present paper, we reflect on the subjective impressions of the different participants, we analyze and decompose both farmers' and breeders evaluation, and end with a statistical analysis of their relationship.

Three years of experience with participatory breeding show that:

1. Farmers are very interested in the process, but breeders far less so. The method of soliciting selection criteria and using them to score varieties is very convenient, although proper briefing is very important. To engage farmers and breeders in discussion on the same day of evaluation, tools to quickly synthesize the results still need to be developed.
2. The experiments and evaluations generate large data sets, in a format and of a nature few scientists are trained to analyze. Appropriate software as well as sufficient resources is a problem.
3. Farmers' and breeders' evaluations show little correspondence: usually, only half of the farmers' and breeders' selections overlap (for the first three or five selections of each group). Moreover, no statistical correlation was found between breeders' index and farmers' overall evaluation. Farmers' evaluation was further decomposed, indicating for example that the score for yield accounts for about half the overall evaluation. In the breeders' evaluation, yield is given much more importance.
4. The breeders index is not very indicative of the breeders' selection process. The functional form does not express the observed selection behavior, in which varieties are rejected if they do not pass a certain resistance levels. This process would be better described with a multiplicative function. Moreover, the weights that are attached to different criteria are very subjective and not related to farmers' preferences.

We conclude that substantial progress has been made in soliciting and quantifying farmers' preferences, as well as involving them in the selection process. Still, the dialogue between farmers and scientists remains underdeveloped. It is most important to continue analyzing both breeders' and farmers' evaluations and to improve the communication between the groups, not only by narrowing the gap between the quantitative indices but also by improving on the way the groups interact. Since the methods developed are beginning to be applied in other regions and countries, it is important to keep track of both farmers' and breeders' variety selection and follow the varieties through their release and, hopefully, adoption. In the process we hope to identify suitable indicators and predictors of adoption.

7. Scarlng up of Participatory Cassava Breeding in Brazil : A Case Study from Northeast[1]

Wania Maria Gonçalves Fukuda[2], Chigeru Fukuda[2], Nadine Saad[3]

Abstract-The participatory cassava improvement has been developed in Brazil since 1993 in four states of the Northeast. This methodology was introduced and adapted initially in the semiarid Northeast. Further, this research was expanded to another conditions of the Brazilian Northeast. Northeast Brazil is characterized by low-fertility soils and adverse climatic conditions. There are long periods of drought that can last up to eight months. The annual rainfall ranges from 400 to 750mm, distributed over a 3 to 4 month period. The main objectives of this work consisted on the establishment of a reciprocal feedback system between farmers and the improvement program, to elevate the probability of adoption of improved cassava clones, and to enlarge the genetic diversity of cassava farmers. This work was development based on the active participation of farmers in the entire process from evaluation and selection of clones on advanced phases of selection in community areas and farmer' properties. More than 70 communities were involved, and the number of participating household was estimated at nearly 1500. A trial was established on each farm, in plots consisting of 50 plants per clone, without replicates. The best nine varieties selected in advanced phases of the improvement program were used in all trials, in addition to a locals varieties. The participatory cassava improvement in the Northeast of Brazil has made a profound change in the way of breeding is conducted in this region. They can be summarized as follows: the general organization of the regional improvement program changed as result of the adoption of participatory methodologies; changes in the orientation of the traditional improvement program by including extension workers and farmers in the clones evaluations during advanced phases the improvement program, establishing trials in farmers' fields, and by providing feedback including farmer' criterias selection in the program; stimulating the interest of farmers in conducting research; identification of several clones with a high probability of acceptance by farmers, adoption and multiplication in the farmer? proprieties; increased genetic diversity in farmer's proprieties; increased number of participatory tests by demand of extension agents and farmers; and expansion of participatory research projects in Northeast Brazil because of the demand of extension workers, communities, associations, and agrarian reform (Settlement) project, in addition to the financial support provide by new donors. The localities and criteria used to select new cassava clones were expanded and diversified. The process works functions as an efficient tool for the transference and diffusion of the selected varieties as well as feedback for the cassava improvement programs with the farmers' criterias selections. To maintain the quality of work in such a large project including the evolution of ongoing trials and the new demands these are presenting for the project team; the quicker definition of the farners'selection criteria; to promote farmer interest to work with segregation material ; to explore ways of recognizing farmer ways of recognizing farmers input in the development of varieties that are officially release; and the adoption and impact study of participatory research should be conducted.

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8. Correlations among farmer trait ratings, agronomic measurements, and overall preference in rainfed rice PVS trials: implications for scaling up

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Rainfed rice breeding programs are usually small, and serve target environments that are highly variable. This variability has a large random component that cannot be controlled by breeding for small niches (Atlin *et al.*, 2001). Potential varieties must therefore be evaluated over many farms and several seasons. Because farmers' environments and preferences often differ from conditions and selection criteria used on research stations, evaluation must be conducted under farmer management, and by farmers' own criteria. Rainfed rice breeders are recognizing that PVS is critical to their ability to produce products preferred by farmers. Several variations of the Mother-Baby model are being tested by breeding programs collaborating with IRRI in India, the Philippines, and Laos.

The precision of PVS trials is determined by the level of replication across environments. However, small breeding programs have limited capacity to manage on-farm trials. Researcher time is the main constraint. Usually, if Baby trials are laid out as formal experiments, with plots of equal size and shape, fewer than 20 can be handled by one research station, because for trials to be informative, they must be planted when the farmer plants the rest of the crop. It is impossible for researchers to assist with layout, planting and harvesting of many trials in the narrow window for these activities. If 3 cultivars are evaluated per farm, a network of this size consists of only 60 plots. This will not give sufficient power if more than 3 or 4 cultivars are included, or if interactions with environmental or management factors are to be estimated. Some PVS programs have linked effectively with extension networks or NGOs to scale up, but this can involve high transaction costs and may not be feasible in areas where partners are not effective. Robust methods for scaling up are needed that minimize researcher involvement, require little training of farmers, and generate high-quality data. Designs in which each farmer tests only one to three varieties, and in which farmer ratings rather than quantitative measurements of yield and other traits are collected, fulfill these requirements. The use of yield ratings eliminates the need to lay out plots on equal areas, and consequently the need for researchers to be present at planting. Ratings in which farmers compare performance of the new variety with their expectation of the performance of their current variety may permit farmer knowledge to be integrated in the assessment of new lines. The effectiveness of a selection strategy based on farmer ratings depends on the repeatability of measurements versus ratings, as well as on the correlations among trait ratings, measurements, and overall ratings of preference. These relationships have been studied in PVS trials conducted in eastern India, the Philippines, and Laos. Both yield measurements and farmer yield ratings were highly repeatable, and highly correlated with farmer preference. These results indicate that PVS protocols based on farmer ratings may be as effective as those involving agronomic measurement, but with much less researcher involvement. These designs constitute a simple yet powerful method for small programs to achieve the high levels of replication needed to make gains in variable environments.

Atlin, G.N., Cooper, M. Bjornstad, ?. 2001. A comparison of formal and participatory breeding approaches using selection theory. Euphytica 122:463-475.

9.. Impact of Participatory Barely Breeding in Syria

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There is growing perception in the research and development community that research without some kind of farmer involvement in technology development and evaluation has limited value to the poor people in developing countries. This has resulted in a major change in research approach. For the last five years, farmer participatory research has significantly gained importance in the CGIAR centers, particularly in plant breeding. This change is induced by the perceived benefits from increased relevance of research results as result of participatory research. ICARDA has used decentralized participatory barley breeding in Syria since 1996, and this paper assesses the benefits and costs of ICARDA's participatory barley breeding approach as compared to the "conventional" breeding approach, both at the farmer level, and as returns to research.

The farmer-level impacts were assessed through a survey conducted in 2001 of 86 farmers who participated in ICARDA's barley evaluation research, and 106 non-participating farmers. The methods used included conventional economic methods of measuring benefits from adoption of technology, but we also used non-conventional approaches to impact assessment and tried to capture a wider scope of impacts, including "process impacts" which occur as a result of the participation itself rather than as a result of the technologies developed via participatory research methods. The type of interaction between scientists and farmers directly affects the kinds of process impacts that occur, and indirectly affects the nature of resulting technology as well as types of beneficiaries. The process impacts assessed in this study include effectiveness of targeting the users and human social capital changes. We also calculated the value of farmers time in research.

Using an economic surplus model, we estimated the benefits of ICARDA's barley breeding to Syrian agriculture. We compared two scenarios: conventional vs. decentralized participatory breeding. The higher estimated benefits to participatory breeding are mostly due to reduction in research and development lag. The participatory barley breeding program has developed lines which are more acceptable to farmers than the varieties they currently cultivate, and these lines have been developed 3-4 years faster than if they would have been developed using conventional on-station method. However, extending the benefits of the new barley lines at larger scale, and hence realizing the potential gains from participatory breeding, the national agricultural extension and seed system have to function well, especially the seed system.

Our results show that the largest share of the cost of the breeding program in an international center is the infrastructure (overhead) and personnel. The given breeding approach (e.g. conventional, decentralized, participatory) or breeding method (bulk, pedigree) used mostly affects the operational costs that constitute a relatively small share of the total breeding budget. Moving from conventional breeding to participatory breeding has an impact on the allocation of the total operational costs, and the biggest change is due to the decentralization of breeding (moving from station to on-farm), and adding participatory trials increases the operational costs slightly, but relative change in total cost structure is insignificant.

The main purpose of this study was to provide empirical evidence of the impact of farmer participation technology development as compared to conventional breeding approaches. This paper also offers some conclusions about future agenda for institutionalization of participatory breeding. The analysis of the benefits and costs of ICARDA's participatory barley breeding program to Syrian agriculture indicate that one of the key success factors for realizing the gains is the participation of the national programs. Currently there is not enough knowledge about the alternative scenarios and organizational structures of participatory plant breeding at the national program level, nor about the benefits and costs of these alternatives at the national level.

10. The impact of PPB in maize and rice in India and a comparison to classical breeding programmes

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We summarise the results from three participatory plant breeding (PPB) programmes in India. Two of these were on maize - one targeted at tribal farmers in eastern India in Panchmahals district, Gujarat and the other at tribal farmers of Chhotanagpur Plateau, Jharkhand. This led to the farmer-accepted, released maize varieties GDRM-187 (GM-6) in Gujarat and BGM-2 in Jharkhand. The other PPB programme was for rice. This was targeted at tribal farmers in Chottanagpur Plateau, Jharkhand, and led to the release of two farmer-accepted rice varieties Ashoka 200F (Birsa Dhan 109) and Ashoka 228 (Birsa Dhan 110). The length of time and the cost of producing the maize and rice varieties were compared to those for the conventionally bred varieties that were released, for the same agroecological situation, as coincidentally as possible to the PPB varieties

Overall the financial costs of the PPB were considerably lower, but the institutional arrangements for PPB were more complex and involved outside experts. Hence, the comparison is not straightforward. However, in all cases PPB was considerably faster and generated a substantial increase in returns because of reduced discount on benefits as a result. (Benefits now are more valuable than benefits later, so economists discount later benefits.) Moreover, in all cases, the PPB was more equitable since it produced varieties of early duration that particularly meet the needs of resource-poor farmers.

The adaptability of the PPB upland rice varieties was not more specific than for conventionally bred upland varieties so potential benefits are as great as for classical breeding. Moreover, the potential area served by the PPB programme is substantial (there are 0.7 million hectares of upland rice in Jharkhand alone), particularly when spillovers into similar agroecologies in other states are considered.

For maize, the extreme earliness of the PPB varieties probably results in a more specific adaptation to marginal conditions. However, the area directly served by the released maize PPB varieties is less than for rice, but still substantial. For example, there is 0.29 million ha of rainfed maize in Gujarat and there may be spillover benefits in adjoining states of Rajasthan and Madhya Pradesh where there is considerably more rainfed maize. The more specific adaptation of early maize varieties may reduce overall benefits, but their adaptation may not be as specific as their earliness might suggest. The maize PPB variety from eastern India has performed extremely well in formal multilocational trials across states in India.

For PPB to be more widely accepted a logical connection has to be made. The impact of these success stories has to influence decision makers to adopt decentralised methods of plant breeding. Whether this institutionalisation will take place will depend, in part, on careful monitoring of impact and on how many more successes can be demonstrated for PPB.

11. Impact of participatory plant breeding: an overview

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Over the past three years, in collaboration with many institutions and individuals, the Systemwide Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation has systematically collected scientifically credible empirical evidence of the impacts and costs of participatory research in natural resource management research and plant breeding. This paper provides a synthesis of three areas of program-funded work: 1) conceptual framework for assessing the impacts of participatory research and gender analysis; 2) analysis of the inventory of 153 participatory plant breeding projects; and 3) major findings from the detailed impact case studies on participatory plant breeding in West Africa, Syria and Brazil.

Even if participatory project successfully achieves its set objectives, without an explicit impact analysis framework no basis exists for understanding how and why it worked or for reproducing its effects on a broader scale, in other sites, or with other target groups. The impact assessment framework summarized in this paper illustrates that the expected impacts of incorporating stakeholder participation in research are contingent upon the nature of approach used, and how farmer participation at different stages of innovation can have different impact on the technology or innovation design, as well as on the potential adoption or acceptance among the intended users. Similarly, who makes the decisions at different stages of innovation (farmers or scientists) may lead for example to different priorities being identified for different beneficiaries.

In order to understand the state-of-the art of the participatory research in plant breeding, an inventory of 153 projects was collected by 2001. This paper presents the summary of results such as projects specifics (location, length, scale and size), types of organizations involved in participatory plant breeding (IARC, NGO, NARS etc.), crops that were targeted, breeding methods used, type of participatory approach used, as well as perceived impacts and costs of using participatory methods in plant breeding.

Outcomes of participatory research include both product and process impacts. Hence, the first objective of the each of three participatory plant breeding impact cases studies presented in this paper was to identify and characterize the benefits and costs associated with the participatory plant breeding. Secondly, what we sought to evaluate in these case studies was not the overall impact of a research project that used participatory techniques, but rather the incremental effect on impacts and costs that can be attributed to incorporating farmer participation in plant breeding. Therefore, the impacts were assessed against an appropriate conventional research counterfactual.

*This paper is synthesis of several PRGA program funded impact studies that the editor has co-authored or collaborated with the following people: Nancy Johnson, Elske Van Der Fliert, Sieglinde Snapp, Olaf Erenstein, Nadine Saad, Wania Fukuda, Aden Aw-Hassan, Hisham Salaheih, Slavatore Ceccareli, Stefania Grando, Louise Sperling, Jacqueline Ashby, Pascal Sanginga.

12. Participatory Plant Breeding and Property Rights

Louise Sperling and Dan Leskien

Participatory Plant Breeding is today being practiced in a wide range of crops and locales: about 120 cases have been inventoried worldwide, with the number of new ones increasing steadily. Despite this expansive growth of interest in the techniques of participatory plant breeding', attention to the ethical and legal rights and obligations resulting from the various forms of collaboration has been unusually scant, although practitioners routinely access funding using claims that 'joint' or 'participatory' work is indeed being undertaken (among scientists, farming communities, development and extension personnel, rural cooperatives, and others involved in the plant breeding enterprise).

Collaborators should jointly benefit from their collaboration. Joint collaboration should be linked to joint benefit-sharing. At this point, there are no ready-made arrangements or "best practices" to suggest for the processes and materials that emerge from PPB collaborations. Most of the PPB work to date has simply skirted the issues of property rights with two very diverse strategies: materials jointly developed by formal breeding and farming communities have been fed into the formal system for variety release and seed multiplication (completely ignoring farmers' input), or the PPB-developed materials have been "released," "let go" into farming communities—with no official launch of any kind.

Attempting to address this gap, this paper emerges from a legal and ethical analysis of varied types of PPB currently being practiced. Focusing on 'intangible' property—that is, intellectual contributions, it suggests how existing legislation may help (or not) PPB participants for dealing with authorship, inventorship and breedership issues. Different concepts of current IPR laws are reviewed with regard to collaborative research, drawing mainly on the legal situation in the United States, United Kingdom and Germany (but also consulting select legislation in some 30 countries). The paper details and compares the legal requirements of joint inventorship and employee inventions, joint authorship and 'works for hire', and finally the elements which could establish joint breedership and 'employee varieties'.

The legal analysis ultimately serves to highlight that existing legal regimes may not be sufficient for ensuring that PPB collaborations unfold fairly for all partners. A formal contract or rigorous process of 'Clarification of Expectations' may be warranted to ensure transparency and equity. The paper ends by suggesting concrete elements to be included in a collaboration agreement. The Advisory Board of the PRGA is currently reviewing both these elements and process suggestions for adoption as standard practice by grants funded in the future.

13. Role of participatory plant breeding in understanding and supporting farmer management of local crop diversity for livelihoods enhancement

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This paper describes the participatory methodology for on-farm management of local crop diversity in Nepal that links community based genetic resources management more directly to support PPB work and diversity for farmers.

The study was initiated in 1998 and is part of the value addition activities of the IPGRI global project, *Strengthening the Scientific Basis of In situ Conservation of Agricultural Biodiversity* in Nepal. It was jointly implemented by the Nepal Agricultural Research Council (NARC), an NGO-Local Initiatives for Biodiversity Research and Development, (LI-BIRD). It aimed to strengthen capacity of local community-based organisations (CBO) for management of genetic resources for food and agriculture.

Participatory method is developed to understand the rationale of extent and distribution of local genetic diversity at community level for analysing reasons for farmer's decisions. This method has been useful for setting breeding goals and consolidating farmer's role in community-based crop diversity management. CBOs were encouraged to exchange information and materials through diversity fairs.. Few good practices such as diversity fairs, diversity blocks, diversity kits, diversity songs and drama, community biodiversity registers and participatory plant breeding (PPB) have been considered to be the ways of building local capacity to maintain traditional cultivars and to ensuring that these are available when needed.

Information is shared with farmers to strengthen farmer's role as researchers, managers and development workers in managing genetic diversity. Social seed networks provide insights of who maintain local crop diversity and how farmers conserve and maintain crop diversity. It was found that social system played key role in access to genetic resources and transfer of local knowledge associated with specific diversity. Informal system is not always perfect in all cultural contexts and therefore, deep understanding of the process is required before the management interventions are planned. In Nepal, it was found that some social networks are weak in exchange of information and, hence materials and diversity fairs and diversity kits are important intervention that can promote exchange of seed and information as well as raising community awareness. Farmers group can manage such development activities. This also strengthens farmers understanding and use of ecological science and use value. Periodic diversity fairs managed by local institutions, where exchange of genetic materials among farmers also takes place, encouraged farmers to maintain high diversity as the number of farmer-named cultivars has increased over the years. The ownership to maintain inventorying of local diversity has been developed slowly leading to farmers genetic resource database. This record is known as community biodiversity register. The system is seen to monitor local diversity over time and create opportunity to develop options for managing local diversity under changed context.

PPB has been used as a strategy to enhance skills of farmers and local institutions in searching diversity, selecting, assessing and maintaining interested materials for socio-economic and genetic benefits to humankind. Farmer's interest in plant breeding is enhanced if farmers are aware about the importance of genetic diversity and how they can utilise them for their benefits. Landraces having economically valued traits are marketed in local brand name such as *Jetho Budho*, *Pahele* and *Jerneli* of rice landraces. Quality seed production, better processing and packaging of culturally valued rice landrace *Anadi* is linked to market for enhancing consumer demands. PPB process is being used to improve eating quality of *Mansara* rice for its locally adapted traits in the marginal environments. Niche specific cultivars will have better chance of survival on-farm if participatory varietal choice is given for similar niche environments. The paper also describes the process by which farmers have selected 8 crosses and three segregating bulks from *Mansara* x

Kumal-4 cross according to grain types. Farmer selected bulks were sub-divided and distributed to all the interested and nodal farmers for *in situ* evaluation. Spread of bulks and selection history will be monitored in 2002 harvest season. This work will continue for further few years to test 1) whether landrace *per se* be conserved, or (2) if PPB contributes to the enhancement of biodiversity in terms of broadening genetic base that provides benefits to community. The key issue in future is to explore strategies for linking PPB within broader genetic diversity enhancement and livelihood enhancement framework by developing capacity of community to manage local biodiversity *in situ*.

14. Understanding farmers' seed management: Starting point for future breeding activities and sustainable seed supply

Anja Christinck, Kirsten vom Brocke and Eva Weltzien-Rattunde

This presentation will address key theme number V, and particularly how PPB and genetic resources management could better be linked in order to target diversity and improvement efforts in heterogenous environments with unpredictable growing conditions.

The research was conducted as part of the ICRISAT/ICAR pearl millet improvement project for Rajasthan with support from the University of Hohenheim and financing by the German Ministry for Economic Co-operation and Development (BMZ). It aimed at enhancing quality, diversity and productivity of farmers' pearl millet genetic resources in Rajasthan. NGOs and farmers were involved in an informal capacity.

The work included fifteen months of field research by a social scientist, using a participatory and gender-sensitive approach. More than 900 farmers participated in interviews, PRA exercises and on-station workshops. The diversity and performance of farmers' pearl millet seed was assessed in field trials and with the help of molecular markers.
Rajasthan is a semi-arid state in the North-West of India, which is situated at the edge of the Thar desert. In western Rajasthan, mean annual rainfall ranges between 250 and 400 mm, with high variability from year to year. Pearl millet is the staple crop, grown on 4-6 million hectares annually. Rajasthan is considered to be one of the "less developed" states of India. The caste system divides the society into distinct groups with different status, professions and access to resources.

Farmers in western Rajasthan use seed of modern varieties in many different ways, but seldom to simply "replace" their traditional landraces. Instead, they prepare seed mixtures, use small amounts of modern variety seed as "breeding material", or purposely use advanced generations of hybrid seed. Traditional practices were developed further in order to incorporate the new seed technology into the farming system, which is otherwise not compatible with the situation of many farmers. Understanding this situation gives plant breeders the opportunity to develop seed material which would support the farmers' own crop improvement strategies, rather than replacing them. Furthermore, these results indicate that plant breeding should be oriented towards specific user groups.

The farmers' seed management led to a slow process of variety replacement. The potential benefits are not evenly distributed, because the "modified" farmer populations show superior yield potential under favorable conditions, but have no advantage under drought stress. Therefore, the traditional landraces of the region are the most secure option for the poorest people working under most marginal conditions. We can state a clear need to take conservation measures, which should be organized in such a way that the poor farmers' access to this seed is ensured.

Besides drawing practical conclusions that take the traditional patterns of co-operation between the villagers into account, we will also bring our methodological approach up for discussion, as a contribution to the future agenda.

15. How to Improve the Efficiency of Conventional and Participatory Breeding in Open Genetic Systems? A Model based on "Creolization" of Maize among Poor Small-Scale Farmers in Mexico.

Mauricio R. Bellon[I] and Julien Berthaud[I, 2]

In the development of their products, do participatory and conventional breeding schemes take farmers' management of improved germplasm after adoption into consideration? In the case of outbreeding crops and small-scale farmers who recycle seed and rely on local seed networks, the impact and efficiency of breeding, either conventional or participatory, depends not only on the adoption of the germplasm, but on what happens to it once adopted and under farmers' management. The conventional adoption model for improved germplasm—developed either through formal or participatory methods—is that a variety once adopted should stay unchanged. If it does change, the changes are likely to be negative; therefore would require replacement of the seed. This could be done either with new seed of the original variety or of one that is even "better." A growing body of evidence, however, suggests that the conventional adoption model is especially inappropriate in the case of small-scale subsistence oriented farmers growing crops with high rates of outcrossing such as maize—an open genetic system. Many of these farmers have taken up improved varieties (in addition to other local landraces) and through their management transformed them to better suit their needs. This process has been termed "creolization" or rustication and can be seen as "middle way" by which scientific technology is adapted to local farmers' conditions, thus serving as a vehicle by which the poor benefit from improved germplasm. This presentation introduces a model to link breeding—conventional and participatory—and farmer management of improved germplasm after adoption. It presents evidence of creolization of improved maize germplasm among small-scale farmers in very poor regions of Mexico. This type of farmer is an important target for participatory breeding efforts. Based on the model and the evidence presented, we discuss the implications of taking creolization into consideration for breeding, particularly in the case of participatory breeding schemes for outcrossing crops. The presentation concludes that taking farmer management of improved germplasm after adoption into consideration would increase the potential impact and hence efficiency of any breeding effort aimed at small-scale farmers that recycle seed in open genetic systems.

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16. Combining PPB and marker-assisted selection: strategies and experiences with rice

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Our hypothesis is that participatory plant breeding (PPB) does not preclude the use of modern biotechnological techniques. We postulate that they can be effectively combined to enhance one of the advantages of PPB - improved adaptation to stress conditions through selection in the target environment. Marker-assisted selection (MAS) can improve the efficiency of selection for stress tolerance traits that typically have a low heritability. For example, we combined the approaches by using MAS to increase the initial frequency of favourable alleles in bulk populations which farmers then selected in their own fields.

The PPB is co-ordinated through a local NGO in India and a local NGO in Nepal. Overall we are using three strategies to combine MAS with PPB for rice. In one we use bulk populations, in the second pure-line breeding, and in the third we are using markers to evaluate the results of selection to optimise the next cycle of selection. The MAS has targeted QTLs associated with improved roots that should result in better drought resistance. MAS backcross breeding methods have transferred QTLs for selected root traits from variety Azucena to the upland variety Kalinga III.

The first strategy used modified single large-scale marker-assisted selection (SLS-MAS) to generate four bulks each with a different root QTL present, one bulk with a marker for aroma as well as a root QTL, and a control bulk from the same generation with no QTLs. These bulks, which were segregating for many background genomic regions, were given to upland farmers at the $BC2F_3$ generation. Farmers selected within the bulks over two seasons. While some of these original participating farmers will continue with farm-saved seed, we have added new farmers to the PPB programme using seed we multiplied in the off-season. To compare consultative and collaborative methods of PPB a consultative approach is also being followed in the same set of bulks. Drought resistance will be compared in the bulks having different QTLs and in the bulks derived from consultative and collaborative breeding.

The second strategy has used MAS to generate pure lines with combinations of root QTLs or root QTLs and aroma. These are to be tested on station in consultative PPB and should evaluate the value of the root QTLs both individually and combined in pure lines. Comparison of bulk and pure-line breeding will identify which is most efficient for speeding the selection for drought tolerance.
In a third strategy, marker evaluated selection (MES), the products of PPB from a number of different crosses are evaluated with molecular markers to identify farmer-preferred genomic regions. These are likely to be QTLs influencing any trait of agronomic benefit to farmers. PPB products are derived from at least 4 different rice ecosystems, two different countries (India and Nepal) and two growing seasons. Results will be used to design a breeding strategy that combines all the best characteristics for a particular ecosystem into one ‘ideotype’ variety using MAS.

17. Use of molecular markers in participatory plant breeding with small-scale cassava farmers

Jonathan Mkumbira, Linley Chiwona-Karltun, Hans Rosling and Urban Gullberg

This contribution could be aligned to the theme 'Linking DNA marker technology and PPB' under 'Future horizons'. However, it could also apply to a number of the outlined themes.

We are exploiting the possibilities of using molecular markers as a tool for PPB with small-scale cassava farmers in Africa, as opposed to use of morphological markers that may vary due to plant age and environment. We work in a multidisciplinary team with expertise in anthropological approaches/interviewing, social studies, traditional breeding, chemistry and molecular markers. Scientists involved in the studies are from institutions both in north and south including: the Ministry of Agriculture and Irrigation in Malawi, University of Malawi, IITA/SARRNET, Karolinska Institute, Sweden, the Swedish University of Agricultural Sciences and The Royal Veterinary and Agricultural University, Denmark. We are also collaborating with CIAT and IITA in a project named "The Cassava Molecular Diversity Network (MOLCAS)". Most of the studies were conducted in the main cassava growing area in Malawi and some work has started in Uganda.

We have used SSR markers, developed at CIAT, in combination with various interviewing techniques (Molecular anthroplogy), chemical and agronomic measurements, to understand the farmers' knowledge on the genetic diversity of cassava. So far we have learnt the following.

- Farmers have high ability to distinguish plants with specific genotypes as belonging to named cultivars.
- The commonly grown cultivars are mostly maintained as single genotypes.
- The least grown cultivars seem to be kept for bio-diversity and are more genetically heterogeneous than the common cultivars.
- Farmers' distinction of "bitter" and "cool/sweet" cultivars appears to have influenced the genetic pool of cassava in this area since the genotypes of the two groups separated into two clusters in a principle component analysis.
- Micro-environmental variation on farm level, due to uncontrolled as well as controlled factors, cause considerable G x E interaction amongst the commonly grown cultivars.

Thus, in addition to marker assisted breeding, the advances in molecular genetics also provide new tools for understanding the complex farming and food systems of poor small-scale farmers. Consequently, the combination of molecular genetics with farmer participation provides a research tool that is a useful addition to the methodology needed to improve food security in sub-Saharan Africa.

On-going and proposed future studies using a combination of tools are:

- Broad adaptation of cassava genotypes in Malawi
- Identification of morphological keys used by farmers to identify their varieties
- Trace the spread of new varieties among farmers and market outlets
- The role farmer breeding/seedlings play in preserving genetic diversity.

Annex 3

Working Group Notes

Working Group Notes
Priority Setting with Farmers
(to take place at various scales)
(synthesized by D. Soleri and Y.Song)

Minimum standards
Must identify common or shared interests of stakeholders at different levels.

Before engaging in priority setting, need a stakeholder analysis as well as discussion with stakeholders regarding their roles.

Before engaging in priority setting, need in depth understanding of basic production/farming systems (including germplasm and seed systems), social process and marketing constraints. (process may need to be built in).

The processes for making assumptions regarding breeding and seed system need to be made explicit----with discussion of these among stakeholder. Diversity, stability, risk, etc.

Need to define participation and by whom. Aim for balanced inclusion of stakeholders in the whole process.

Need negotiation/understanding between social and biological goals

Need to be explicit with stakeholders regarding whether the work emphasis is on research or development or both ----and appropriate compensation.

Common goal setting
Key research areas

Must develop objective indicators for priority setting in PPB. Donors want this.
This may need to be done at multiple levels. (what are conflicts, commonalities?)
Biological (diversity, genetic gain, trait changes), social (equity, economic or other well being), other

Methodologies for priority setting need further methodological development—e.g., identifying conceptual knowledge, needs assessment, participation expectations etc.

Participatory methods for priority setting at multiple scales need to be explored further
Can local methods be scaled up?
Do priority-setting methods explicitly need to be developed for large scale?
Does larger scale (spatial coverage in this case) necessarily imply the need for more or diverse PPB activities? Depends on the distribution of diversity of material, needs, environments etc.

Goal setting should be reviewed, iterative, not a one time event. Should allow for adjustment, adaptation, and responsiveness.

Working Group Notes:
On Farm Testing and Evaluation
(Synthesized by D. Cleveland and E. Weltzien).

1. **Trial designs for on-farm testing**. Trial designs take very different forms and structures, as they are designed for different breeding goals, different agro-ecological systems, and different social and economic conditions. Lots of choices are available and the flexibility is very big. This allows that the design for PPB activities can be negotiated with specific participating farmers. It is important that sufficient understanding is reached of both partners' concepts and skills in plant breeding, testing etc before taking decisions on trial design, and evaluation criteria, and their application. It is, however, also common experience that the mutual understanding of concepts and skills improves iteratively. Trial design, criteria for evaluation and methods for assessments may change over time, as a result of improved mutual understanding of skills and knowledge, and as growing conditions are changing. In participatory plant breeding it is essential that the trial design is agreed upon by all the partners, and that it is interpretable by all partners. Farmer learning about different options for variety testing, plant breeding, and seed production does not need to come only from the breeder associated with a specific project. How to facilitate learning from other farmers also emerged as an issue. There are powerful examples, mostly through the work of NGO's and well-organized farmers, e.g. SEARICE. Examples are the farmer presentations of results and achievements at the regional symposia of the PPB group of the PRGA (Nepal, 2000). Handbooks for farmer training, are in progress, and can be a powerful tool for farmer learning (SEARICE, PROINPA, and LiBird). Less formal handbooks exist already, from different countries, prepared by eg. development organizations or missions, which may not reach the formal sector, CG or NARS.

   Variety trials on-farm may have a minimum of only one test variety per participating farmer, who compares the new variety with a control variety, either her/his own choice or a commonly chosen check. Usually a larger number of replications is required to arrive at sound conclusion about the relative performance of a small set of new varieties (3-5). It facilitates the participation of many farmers, and varieties get exposed to a wide array of growing conditions. Another extreme would be to test a large number of segregating lines (300 -325) in farmers' fields, with replication, with a trial design that allows the estimation of quantitative characters with sufficient precision to expect genetic gain from selection. Statistical analyses resemble those for on-station trials, the best for the specific conditions. Particular advantages were recognized for using alpha lattice designs, analysed using a REML procedure for estimation of effects and variance components. If the aim is genetic gain for a qualitative trait, precise assessments, usually involving appropriate statistical tools are required. However, if the aim is primarily to enhance adoption of preferred varieties by farmers, it is essential that many farmers are involved, that they are confident about making the appropriate comparisons; detailed statistics may not be required for farmers' decision making. It is essential to discuss the trade-offs between different design options with farmers. Statistically analysed results could be used more convincingly to spread the results and conclusions of farmers' trials to other non-participating farmers.

2. **Criteria for choosing parental material for the creation of new genetic diversity**. Parental material can only be chosen after joint breeding goals have been identified by the project partners. Farmers' knowledge about the advantages and disadvantages of specific local varieties and breeders' knowledge about other sources of germplasm usually allow the identification of promising and complementary parental material. Even if not all partners contribute to the final decision-making, it is important that all partners agree that the chosen approach for the identification of parents is optimal. The ceiling for expected genetic gains is determined by the choice of parental materials. (What are farmers and plant breeders each doing in terms of creating new genetic diversity: choice criteria, choice methods, evaluation data? How many crosses are optimal? Balance between farmers and plant breeders? What types of sharing of roles and responsibilities?).

3. **Criteria for selection/choice**. The group agreed that for evaluation at all stages, it is essential to use primarily farmers' criteria for evaluation, and add other criteria in consultation with them. Initial research maybe required to determine these key criteria. Determining the possibly differing needs of different stakeholders groups (ethnic groups, women, poor farmers) can be essential for success. How to balance criteria for pre-harvest and post-harvest traits; yield and yield components (e.g. phenology grain

yield, and stover yield) yield and quality traits? Are trade-offs necessary? What may happen when different farmers in household, community, have different criteria? Can scientists help farmers to increase selection efficiency by suggesting/incorporating new criteria? Is variability for a specific trait a criteria for evaluation/selection? This may affect the way that data are recorded, analyzed and presented.

4. **Methods for applying criteria in evaluation and selection**. A wide range of options exist and are used: from scoring systems with three categories to measurements of quantitative traits, and taste panels with a large number of participants to assess organo-leptic differences. Discriminating genetic, environmental and interaction effects can be essential, and may require statistical analysis. Different criteria are important in early segregating populations versus stabilized materials. Farmers may use syncretic ad hoc methods: e.g. in Syria, highly variable plots are liked by some farmers because they allow all at once the assessment of a genotype's across a range of growing conditions. In PPB, micro-environments emerge as a source of G x E interactions that can be addressed specifically through participatory approaches. Documenting, and analyzing this type of result remains a challenge. All partners in the evaluation and selection process should keep their copy of the evaluation data. Specific effort may be required to help a farmer with recording his/her observations (or as a group).

5. **Data, results and conclusions**. Evaluation data from all participants, statistical analyses of quantitative traits from the joint evaluations, should be shared with all partners in the selection process, before making the final choices about the next year's trials. How and at what points do farmers and breeders generate and share data? (e.g. in ICARDA program farmers are given scientists' evaluation data).

Working Group Notes
Scaling Up PPB
(synthesized by J.Lancon)

1. Why and for whom scaling-up?

- For farmers, especially women and poor, because the group sense that PPB will help plant breeding to become more efficient and effective in providing either: narrowly adapted varieties that meet a mosaic of needs and opportunities, or varieties with broad adaptation. This will be made easier by giving farmers broader access to genetic diversity, by improving the system of plant breeding and research management, and by strengthening the seed system.
- For farming communities, because the group senses that PPB will facilitate the improvement or recognition of farming communities' rights.
- For donors also, because they need to get impact "accountability" to justify their funding and they consider scaling up as an indicator of process sustainability (from supply to demand driven)
- And for NGOs because scaling up is part of the community development

2. What and how scaling-up?

Preambula: we don't want scaling up through pyramidal structures, but rather scaling up through replications

Stakeholders' and more specifically poor farmers' and women' participation to plant breeding may be either supply-driven (policy or project-led) or demand-driven (Stakeholders'-led). The following conditions could be favourable to demand-driven scaling up: systematize work with Farmer Research Committees (FRCs), channel research funding in part through FRCs or facilitate ways for PPB products to better reach the market. Ways for stimulating more specific scaling up are numerous.

2.1. For products or technologies

- Through informal diffusion (best technology) with entry points where farmers can be systematically reached
- Through formal diffusion by putting farmer-bred and products of farmer – scientists collaboration into formal release
- By strengthening farmer sharing seed systems (perhaps through Farmer Field Schools ?)
- By producing enough seeds at an early stage for the potential demand
- By stimulating NGOs and organisations (commercial or non commercial) to get systematic feed back from farmers and establishing mechanisms to communicate feed back
- By proposing a policy enabling farmers to produce and distribute "farmer improved seed".
- Through small machinery to enable farmers to produce seed in bulk

2.2. For processes

Preambula : there are issues of power - who controls the scaling up process? Particular issues are: allowing access to diversity held by others, farmers' rights, legal issues

- By developing explicit complementarities between conventional and participatory breeding
- By helping NARS to take up PPB approaches
- By bringing in more actors (more plant breeders learning from PPB experiences, other stakeholders)
- Through experiential capacity building (farmer to farmer training: we then need to adapt method derived from FFS for PPB or PVS) with local or provincial support
- Which organisational forms? Couple smaller units (FFS) with multi-stakeholders institutional formation to make FFS effective for PPB or PVS
- Can we scale up through education system (such as new university courses?) or Do we need different educational processes / opportunities to learning?
- By supporting regional networks and grants
- By linking PPB with governmental or other extension agencies
- By developing partnerships with development projects on the basis of FFS
- Through farmer – breeders clubs where universities could send students to "home" communities

3. How to measure scaling up

Indicators of scaling up could be extension to a region, a nation or micro-niches, among different farmers, other institutions (and level), other crops or cropping systems, from crop to natural resource management (NRM), more integrated or holistic designs.

Social science may be needed to analyse the social structure of farm communities and organisation of the poor to ensure they have access to PPB processes and products.

Working Group Notes:
The Impact of PPB
(synthesized by K. Steele)

Achievements
- Demonstrated the success of PVS – varieties have been adopted.
- There is increasing evidence of success with PPB.
- There are several examples in some countries where policy makers have been influenced (LI-BIRD, WARDA).
- There is evidence for farmer empowerment.
- Genetic diversity has increased. (in both low productivity and high productivity systems)
- There has been reduction in "research-lag".

Disappointments
- Still huge institutional resistance to PPB. (PPB tends to be project-based, rather than institutionalized in the mainstream; variety release procedures and seed regulation also hinder spread of PPB and PPB products)
- Few conventional plant breeding programs have incorporated PPB into their strategies and successes have not been widely adopted.
- Few policy makers have been influenced.
- Still not always clear how PPB can enhance the livelihoods of the "poorest of the poor".
- Lack of momentum.
- Donor policies change.
- Re-labeling of projects to make them appear 'participatory'.

Comparisons between conventional and participatory approaches
- Few examples exist of studies which have compared the approaches, these include
  Beans CIAT- Rwanda
  CIALS- Latin America
  Barley- Syria
  Maize and Rice: India and Nepal
  Maize-CIMMYT- Oaxaca
- Comparisons can be made of individual components of the two approaches.
- Direct comparisons are difficult to make because there are many variables and the methods used vary – e.g. comparisons between pedigree and bulk breeding methods.

Measurable indicators (and methodologies)
Adoption rate
% adoption = % farmers interested x % farmers satisfied
Remote sensing

Economics
Overall livelihoods – Participatory Monitoring and Evaluation (PM&E)
Farmer (individual or group) income by Participatory Rural Appraisal (PRA)

Empowerment
individual or group level skills
Leadership skills gained
control of own seed systems; greater access to germplasm

Genetic gain/diversity.
Molecular markers to analyse diversity

Seed supply
Seed demand
Efficiency of seed system to satisfy demand (genetically and quality-wise).

Not all impacts are quantifiable

Mimimum set of factors for holistic measurement of impact

- Technology- products/numbers, varieties and type
- Developmental factors (livelihoods)
- Process developments (partnerships, institutional changes, methodology development, policy changes
- Diversity (increase on-farm)

Themes for prime further consideration: (impact)

- Guidelines for good practice principles and use this to measure impact
- Use of more participatory M&E tools
- Regulation and reform issues. (influencing variety release and seed regulation procedures to accommodate PPB products)
- Seed systems – much improvement needed.—to speed seed increase/distribution of PPB products (and ensure maintenance of seed supply)
- Comparisons of conventional and participatory PB.
- Strategies to address conflicts between PPB products (variety diversity) and market concerns or pressures (to have a few varieties grown widely). Allied to this: How to use PPB and encourage commercial uptake.
- Development of holistic impact assessment methods--- from the viewpoint of different stakeholders

Plenary Discussion
PPB and Intellectual Property Rights

This plenary discussion followed an overview presentation Participatory Plant Breeding (PPB) and Property Rights. It reviewed how current legislation (international and select national) informs (or not) joint collaboration ('joint breeding', authorship' and inventorship), and presented a sketch 'Code of Conduct' for helping to fill in legislative deficits or ambiguities.

The plenary discussion which followed raised the following points:

- Intellectual Property Right (IPR) systems *per se* should not be the sole focus when considering various rights implied by joint collaboration in plant breeding. We need to broaden our perspective and consider possibilities for *sui generis* systems.

- The idea of a "Code of Conduct" for PPB work (engaging the range of stakeholders) was supported by the group. The scope for 'non-recognition or 'abuse' of stakeholder contributions has been identified as a real threat (to immediate and future collaborations).

- The aims of such a code would be to a) recognize various partners contributions; b) to promote 'fair practices; ' and c) to ensure broad access to the products and processes emerging from PPB collaboration.

- The group identified the need to improve our own practices immediately! To consider community (and possibly other stakeholder inputs) in authorship. Plant breeders Rights (PBRs) decisions/applications, etc.

- It was recognized that there is an evolving policy environment:
    - Contracts may indeed be needed for such collaborative work; and
    - Issues such as 'product liability' will likely become more important--- eg if farmers involved in PPB start producing seed- commercially
- It was also recommended that work be carried out in terms of PPB/Property Rights at the legislative as well as 'practical' (project and field implementation) level. . It would be useful to influence law development which may discriminate or not recognize products emerging from varied stakeholder collaboration (incl. farming community collaboration), and laws which may not be able to address adequately the complexities of products and processes resulting from PPB (eg. final breeding products which are heterogeneous).

- It was also highlighted that local as well as exotic views, norms, practices need to be taken in account (and incorporated/negotiated) when considering issues such as 'ownership, property, intellectual contribution—in any given participatory plant breeding context.

Working Group Notes
PPB approaches with a diversity perspective-enhancing biodiversity and production
(synthesized by B.Sthapit)

Theme I: Linking PPB with diversity maintenance

- PPB in India and Nepal bulks (mixture of lines) are used, and there is variation within the bulks.
- In PPB in India, also, crosses are made between the better local adapted materials and improved ones.
- Another approach is to improve locally adapted landraces.
- In the IPGRI project in Nepal, landraces selected according to varied uses provide the base material for improvement.
- In maize, population breeding rather than hybrid breeding is used.
- PVS can be a vehicle to bring "exotic" variation into a place.
- It is important to facilitate farmers' access to useful diversity.
- Enhancing the selection skills of farmers can be also an important way of linking diversity and crop improvement.
- It was pointed out that the aim is not to conserve genotypes—with changing conditions and needs of farmers—but to conserve gene combinations.
- In common beans in East Africa, farmers use mixtures. These mixtures are made up of different components. However, some components may be lost due to pest, disease of climatic stress, decreasing the usefulness of the mixture to farmers.

  One can screen materials to provide farmers' choices for them to select components for their own mixtures. Particularly if the loss of the component due to disease, one can provide resistant components.

- In terms of the limitations of PPB and diversity, it was noted that managing diversity can be difficult and management intensive. Predicting what is useful or interesting may also be difficult.
- Also discussion is needed to define the scale at which we are looking at diversity. Diversity changes with change of scale.
- Core collections also have a role to play.

Theme II: Linking PPB with diversity maintenance

1) Describing/mapping local diversity
   - Do this before PPB starts and with genetic resources and farming systems experts
   - Use farmer characteristics
   - Identify history of varieties - instances of introduction of modern varieties
   - Document as farmer's "passport" data - encourage farmers to document their diversity (community biodiversity registers)
2) Sample varieties and put into collection – responsibilities of GR specialists/genebank specialists
3) Approaches of combining PPB and a diversity thrust
   - Strengthening of popular local varieties with introduced MVs
   - Base broadening by intercrossing local and introduced MV
   - Reintroduction and raising awareness of local varieties that have been lost from community e.g. diversity blocks, fairs etc
   - Identifying and reinforcing varieties with particular market traits
   - Exposing farmers to large PVS trails
   - Exposing varieties to range of environments to "uncover" diversity

Effects of PPB on diversity

a) country level - increase in diversity in terms of numbers of varieties
b) farm level - risk of genetic erosion/replacement of landraces

Document cases in progress where roles of genebanks and PGR management are demonstrating potential outlets of genebank for community benefits

Synthesis:

How can we maintain or enhance diversity in farmer's fields

1) PPB methods

- Modified bulk method
- Cross between local and introduced exotic materials
- Testing and selection variable materials by farmers
- Promoting mixtures
- Exposure of large number of varieties to wide range of environments to "uncover" diversity
- Create new options of use

2) Linking –on-farm and *ex situ* and production units

Understanding local context before PPB initiates

- Understanding, describing and mapping local diversity before PPB starts
- Collection of local diversity, assessing value of diversity and uses
- Understanding local institutions and farmer's seed systems

Providing access of local, locally adapted, and new diversity and knowledge

- Providing access of locally adapted seed to local community by fairs, blocks, kits, PVS and information
- Exposure of large number varieties through PVS, Diversity kits are key methods for bringing new variation in the system
- PPB may be used for broadening genetic base by intercrossing local and MV for managing both biotic and abiotic stress
- Re-introduction of lost traditional cultivars and crops from genebank or other villages through diversity blocks and fairs can be useful practices

Improving materials to make them more competitive

- Creolization of open-pollinated landraces
- Improvement of local landraces by incorporating useful genes under farmers' target environments (gene-combination)
- Use of marker -assisted PPB

Consolidating farmer's role in diversity management and uses

- Strengthening plant breeding concept, principles and skills to local community is important strategy for creating and maintaining diversity
- Strengthening capacity of social seed networks for market incentives and linking to genebank and FFS
- Strengthening capacity of community to farmer information database – biodiversity registers

Gaps for further work

- Document the impacts of PPB on genetic diversity –positive or negative changes
- Directly link genebank with community based PGR program or community and vice versa
- Explore biodiversity enhancement in the context of dietary diversity/nutritional aspects, farming systems, mitigate intervention problems
- Effect institutional roles-change in traditional mind set of plant breeder, genebank, development workers (toward combining production and quality WITH greater diversity)

Plenary Discussion
PPB and Biotechnology
(synthesized by R. Buruchara)

Presentations and discussion illustrated:
Practice and potential:

Molecular tools currently applied in PPB.

- Few tools are applied (in general)
- Fewer practical examples (in general)
- Presentation and discussion illustrated application of the following tools
    - Molecular markers
    - Tissue culture

Molecular markers is allowing:

- Identification of parental materials in crosses
- Linking markers to farmer preferred traits
- Linking molecular markers to phenotypic traits which farmers use in selecting
- Understanding farmer knowledge
    - Basis to support the PPB approaches and value of farmer contribution in selection - to influence policy and colleagues – potential to understand this better and validate farmer observations

- Marker Assisted selection
    - Examples showed that you can speed up selection of traits that are difficult manage and make progress on in the field
    - The approach has the potential to quickly evaluate the effect of farmer selection

Increase of materials after PPB and use of Tissue culture

- Seed increase approaches are critical immediately after PPB (if one is to have significant impact)
- Tissue cultures could be an approach.
- There are examples where farmer are trained to apply approach for quick increase of planting materials---- which is critical for the success of PPB varieties

Concerns:

- Time and cost of development of markers
- Caution expressed on how we move on GMOs
- Utility and application of biotechnology still controversial in conventional breeding (CB). What is the potential in PPB?

Conclusion

- Yes there is a role and value of applying certain tools (MAS, tissue culture) in PPB.
- There is potential for complementarity where biotech helps better meet farmers' traits or capacity building needs or can make the PPB process effective and efficient.

Annex 4

Summary Action Charts

The charts which follow emerge from facilitated discussion, extending over four separate sessions. Participants were asked to reflect on the advantages (if any) of working on the PPB/PGR themes as a collectiveor in sub-groups. Why work togther and for whom?

They then explored the priority areas for action (what) and who might best be involved.

While not binding, the summary charts below reflect experts analysis of most pressing areas for PPB/PGR action research in the next 3-5 years. Three broad areas of intervention were highlighted:

- **Mainstreaming/strengthening scientific credibility----building a critical mass**
- **Influencing policies/policy change (in relation to participatory plant breeding)**
- **Capturing new finances and building new partnerships (in relation to participatory plant breeding)**

CHART 1: **MAINTAINING/STRENGTHENING SCIENTIFIC CREDIBILITY----BUILDING A CRITICAL MASS**

……..→ INCREASED DEMAND FOR PPB PRODUCTS/PROCESSES (popular and scientific)

Item	For whom?	Who?	Resources
PUBLICATIONS • Articles in existing journals • PPB newsletter (email/ printed) • PPB website • Other (videos, briefings, articles)	 Plant breeders, students, policy makers NGO's farmer organizations Public in general The Media…	 Jr. & Sr scientists/teams Rotating editorial team & advisory board PRGA?? …	 ? $ $
TRAINING & TRAINING MATERIALS • Courses (university), curriculae (high school) workshops • PB Book on integrating PPB & social expertise • Farmer-oriented materials (PPB, Diagnostics, seed management, organizing, marketing * consider translations and local language * consider NGO-development-oriented material	 NARS, Scientists, University Students, Technical Staff, Extensionists Breeders, Students, NGOs, Extensionists Farmers and Farmer Associations	 Group of interested experts " " 	$$ Scholarship fund /Young scientists awards $ $
EXHANGE AND PRACTITIONER MEETINGS (face-to-face)—and of various sorts	Practitioners	Practitioners + Coordination unit	$
IMPACT MONITORING STUDIES	…	…	…
COMPARATIVE STUDIES (projects with combined/multiple PPB goals)	…	…	…

CHART 2: **INFLUENCING POLICIES/POLICY CHANGE (in relation to Participatory Plant Breeding)**

Item	For whom?	Who?	Resources
INVENTORY OF SUCCESSFUL PROJECTS/METHODS THAT HAVE CONTRIBUTED TO POLICY CHANGE	Plant breeders…	Team of social scientists and breeders	…
RESEARCH AND EDUCATION POLICIES/ORGANIZATIONS • Comparative cost-benefit analyses • Study on PPB in private companies • Study about incentives and objectives of breeding programs • One 'Big" Victory—where conventional breeding has failed • Guidelines for including policy analysis/action components in research proposals • Trained students (Msc, PhD) and professionals, managers • Gov't policy forum at different levels (could involve farmers, PPB practitioners)	Research Managers Breeders Policy Makers, Donors	***The Group Specific cases depend on specific targets	…
1.1.1 IPR's/FARMER RIGHTS • IPR/PPB Studies/Actions • Rigorous legal/PPB Research • Awareness raising efforts	Legislators Public Colleagues	…	…
SEED & VARIETY RELEASE LAWS • Studies about positive and negative effects of seed laws in meeting small farmer needs • Developing alternative models of seed production	…….	Participate in Working Group Committees	---
GLOBAL PLAN OF ACTION in PGR • PPB Guidelines for including policy analysis in plans and proposals		…	…

CHART 3: **CAPTURING (NEW) FINANCES AND BUILDING NEW PARTNERSHIPS (in relation to Participatory Plant Breeding)**

Item	For whom?	Who?	Resources
ALLIANCES WITH EDUCATION INSTITUTIONS **INTEGRATING PPB INTO ONGOING NATIONAL PROGRAMS**	'New Age" Plant breeders…	PPB Practitioners as Lecturers CG Centers Social Scientists	Trainers/Teachers And Curricula materials…
INTEGRATING PPB APPROACHES IN DEVELOPMENT-ORIENTED WORK (projects, programs, INRM, agro-ecosystem approaches)	Bi-lateral and Multi-lateral Projects	Bilateral projects	PPB consultants, could include farmers
STRENGTHENING PARTNERSHIPS WITH SEED SYSTEM, MARKETING AND PROCESSING INSTITUTIONS	Farmers	Development organizations NGOs Local governments	…
EXPANSION BEYOND CG MANDATED CROPS	Responding to farmer demands (nice) market opportunities.	partnerships	Partnership funds
PARTNERSHIPS WITH IPM/ORGANIC FARMERS, RETAILERS AND FOOD PROCESSORS	Food industry Farmers Consumers	IPM/organic/PPB farmers Global IPM Facility Development Organizations Food processors, supermarkets	Commercial sources (not biotech, not pesticide)
REGIONAL ALLIANCES, **Eg MesoAmerican, European Biological farmers**	Regional Organizations, e.g. Secretariat of Pacific Community, University of South Pacific, PAPGREN	Information already available from PRGA inventory +++The Group	Impact studies that focus on vegetatively-propagated crops (roots and tubers)
GRM---PPB---INRM	Plant Breeders *Ex situ* managers Farming System Specialists	IPGRI, Crop Networks, PPB Breeders, CG (GRM—PPB+ INRM Groups)	Information Systems Diversity monitoring GEF
INTERNATIONAL CONVENTIONS, **CBD, CCD, FCCC**			

Annex 5

CGIAR System-wide Program on Participatory Research and Gender Analysis in Technology Development and Institutional Innovation (PRGA)
and
CGIAR System-wide Genetic Resources Programme (SGRP)
30 September – 4 October 2002

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Annex 6

The Quality of Science in Participatory Plant Breeding
Maccarese, Rome, Italy, IPGRI Headquarters
September 30 - October 4, 2002

Workshop co-hosted by:
CGIAR System-wide Program on Participatory Research and Gender Analysis in Technology Development and Institutional Innovation (PRGA)
and
CGIAR System-wide Genetic Resources Programme (SGRP)

Monday, September 30

8:15 Boarding and buses leave to transport participants to IPGRI Headquarters

Opening Plenary

9:00 – 9:30 Welcome Addresses. Director General of CIAT, Chair, PRGA: Joachim Voss
SGRP Coordinator, IPGRI: Jane Toll

9:30- 10:30 Introduction of participants and clarification of expectations

10:30-10:45 Objectives and Organization of Seminar. Louise Sperling, CIAT

10:45-11:15 Coffee and Tea break

Theme 1 (a): Priority Setting: Methods, Roles and Decision-making in PPB

Facilitator: Jacques Lancon, CIRAD

11:15- 11:40 *Farmer participation in priority setting for breeding programs: methodologies and experiences* Eva Weltzien Rattunde, ICRISAT/Mali

11:45: 12:10 *Role of Farmers' Research Committee (FRC) in Participatory Maize Breeding in Gulmi District* of Nepal, Sanjaya Gyawali et al., LIBIRD/Nepal

12:15- 12: 40: *Methods for understanding farmers' knowledge about genotypes and environments: exploring the basis for enhanced collaboration with plant breeders in Mexico, Syria, Nepal and Cuba.*Daniela Soleri et al. University of California

12:40- 13:00 Initial Discussion (to prepare for working group session. Day 2)

13:00- 14:00 Lunch

Process (background): ***Overviews of PRGA*** *Facilitator: Joachim Voss*

14:00- 14:25 *PRGA/Plant Breeding Group Functions and accomplishments to date*: Louise Sperling/CIAT

14:30-14:55 *PRGA: Next steps*: Jacqueline Ashby, CIAT/PRGA

15:00- 15:30 Discussion

15:30- 16:00 Coffee and Tea break

Process session I: Inter-Agency PPB Group—Why and for Whom
Facilitators: Ronnie Vernooy and Janice Jiggins

16:00—17:30 Sub-group discussion and Plenary Presentations

17:30 onwards Cocktail (IPGRI staff also warmly invited)

Tuesday, October 1

8:00 Boarding and buses leave to transport participants to IPGRI Headquarters

8:30-8:45 Welcome, plan of the day, announcements

Theme1b: On-Farm Testing and Evaluation: Methods, Roles and Decision-making in PPB:

Facilitator: Danny Hunter,TAROGEN

8:45-9:10 *Exploring the potential for crop development and biodiversity enhancement: fostering synergy between the formal and farmers' seed systems in China*. Yiching Song/Chinese Academy of Science

9:15-9: 40 *Evaluation of data from participatory selection in segregating material of sorghum in two villages in Burkina Faso Kirsten Vom Brocke* et al./CIRAD

9:45- 10:10 *Comparing and integrating farmers' and breeders' evaluations of maize varieties in East Africa*. Hugo DeGroote/CIMMYT

10:10- 10:30 Initial Discussion (to prepare for working group session.)

10:30-11:00 Coffee and Tea break

Theme 1 (a&b) Working Group Sessions (priority setting, on-farm testing and evaluation)

11:00- 12:30 Sub-group discussion and Plenary Presentations

12:30-13:30 Lunch

Theme 2: Scaling Up PPB: Organizational and Technical Challenges

Facilitator: Yiching Song, Center for Chinese Agricultural Policy

13:30- 14:05 *Scaling up of participatory cassava breeding in Brazil: a case study from the northeast*. Wania Fukuda et al/Embrapa:

14:10: 15:00 Initial Discussion (to prepare way for working group session)

15:00- 15:20 Coffee and Tea break

Theme 2 (a&b) Working Group Session: Scaling Up

15:20- 16:40 Sub-group discussion and Plenary Presentations

16:40-16:50 Break

Process session II: Inter-Agency PPB Group: What? And Who?

16:50- 18:00 Sub-group discussion and Plenary Presentations

Wednesday, October 2

8:00 Boarding and buses leave to transport participants to IPGRI Headquarters

8:30-8:45 Welcome, plan of the day, announcements

Theme 3: The Impact of Participatory Plant Breeding: process, products, costs and comparisons with classic breeding: *Facilitator: Bhuwon Sthapit, IPGRI*

8:45-9:10 *Benefits and costs of decentralized participatory barley breeding in Syria*. N. Lilja , Aden Aw-Hassan/ ICARDA/PRGA et al (to be delivered by Jacqueline Ashby)

9:15-9: 40 *The impact of PPB in maize and rice in India in comparison to classical breeding programs.* John Witcombe et al/CAZS, University of Wales, Bangor (to be delivered by D.S. Virk)

9:45- 10:10 Impact of participatory plant breeding: an overview Nina Lilja et al: PRGA/CIAT (to be delivered by Jacqueline Ashby)

10:10- 10:30 Initial Discussion (to prepare for working group session.)

10:30-11:00 Coffee and Tea break

Theme 3 Working Group Session: The Impact Of PPB

11:00- 12:30 Sub-group discussion and Plenary Presentations

12:30-13:30 Lunch

Theme 4: Intellectual Property Rights and Code of Conduct for PPB

Facilitator : Eva Weltzien Rattunde, ICRISAT

13:30- 13:55 *Participatory Plant Breeding and Property Rights*. Louse Sperling/CIAT and Dan Leskien

14:00- 15:30 Plenary Discussion

15:30: 16:00 Coffee and Tea break

Process session III: Inter-Agency PPB Group: How? When? And Resources Needed

16:00- 17:30 Sub-group discussion and Plenary Presentations

Thursday, October 3

8:00 Boarding and buses leave to transport participants to IPGRI Headquarters

8:30-8:45 Welcome, plan of the day, announcements

Theme 5 Putting PPB in a More Holistic and Integrative Context

Facilitator: Tom Blake, ICARDA

8:45-9:10 *Role of participatory plant breeding in understanding and supporting farmer management of local crop diversity for livelihoods enhancement*. Bhuwon Sthapit et al./IPGRI

9:15-9: 40 *Understanding farmers' seed management: starting point for future breeding activities and sustainable seed supply*. Anya Christinck et al./Hohenheim (to be delivered by Eva Weltzien-Rattunde)

9:45- 10:10 *How to improve the efficiency of conventional and participatory breeding in open genetic systems: a model based on 'creolization' of maize among small-scale farmers in Mexico.* Mauricio Bellon/CIMMYT and Julien Berthaud

10:10- 10:40 Initial Discussion (to prepare for working group session.)

10:45-11:05 Coffee and Tea break

Theme 5 Working Group Session: PPB in More Holistic and Integrative Context

11:05- 12:30 Sub-group discussion and Plenary Presentations

12:30-13:30 Lunch

Theme 6: Future Horizons: PPB and Biotechnology

Facilitator: Robin Buruchara, CIAT

13:30-13:55 *Combining PPB and marker-assisted selection: strategies and experiences with rice* K. Steele et al/CAZS/University of Wales, Bangor

14:00-14:25 *Use of molecular markers in participatory plant breeding with small-scale cassava farmers.* Jonathan Mkumbira et al./Swedish University of Agricultural Sciences

14:25-14:45 Initial Discussion (to prepare for working group session)

14:45-15:05 Coffee and Tea break

Theme 6 Working Group Session: PPB and Biotechnology

15:05- 16:45 Sub-group discussion and Plenary Presentations

Evening: Preparation of synthesis of work done on 'inter-agency PPB group: if necessary, additional discussions.

Friday, October 4

8:00	Boarding and buses leave to transport participants to IPGRI Headquarters
8:30-8:45	Welcome, plan of the day, announcements
8:45-10:30	Synthesis of working group discussions (content)
10:30-11:00	Coffee and Tea break
11:00-12:00	Synthesis of group discussions (working group)
12:00- 13:00	Lunch
13:00- 14:00	Next steps
14:00-14:30	Workshop Evaluation
14:30 pm	Closing remarks