Challenges of Participatory Plant Breeding

Monika Messmer, monika.messmer@fibl.org
Forschungsinstitut für Biologischen Landbau, Frick, www.fibl.org

Outline

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- Why participatory plant breeding?
  - Level of participation
  - Principles of participatory research
- Challenges of participatory plant breeding
  - Who to get started
  - Communication / Common language
  - Definition of common goals
  - Long term engagement & Gender aspect
  - Implementation of PPB & Struggle with on farm trials
  - Data assessment & sample handling
  - Legal aspects and financing
- Impact of participative plant breeding

FiBL Plant Breeding Strategy

- **Focus on traits that have not been addressed in plant breeding so far**
  - Improved nutrient use efficiency and plant health by breeding for improved Plant – Microbe Symbioses
  - Breeding for mixed cropping (Plant – Plant Interaction)
  - Utilizing Genotype x Management Interaction (low input, organic)
  - Seed born diseases

- **Focus on crops where availability or choice of cultivars is limited**
  - Cash crops where hybrid seeds are too expensive
  - Neglected local crops and legumes (biological N fixation)
  - According to demand of smallholders

FiBL Plant Breeding Strategy

- Networking & Transdisciplinary Research to start and enforce local seed and breeding activities
  - Involvement of all stakeholders and political lobbying
  - Capacity building of smallholders to improve their seed supply
  - Training in seed multiplication, seed processing, seed testing and storage
  - Development of local seed chain and cultivar testing
  - Establishment of decentralized participatory breeding activities with smallholders (including farmers, breeders, researchers, processors and retailers)

  → seed sovereignty, local seed production, diversity

FiBL Plant Breeding Strategy

- **Science based breeding research**
  - Advice in new breeding techniques
  - Combine participatory breeding with marker assisted selection
  - Develop efficient screening methods for plant breeding for improved symbiosis

- **Fast implementation of new cultivars**
  - Independent cultivar testing under organic and low input growing conditions under farmers’ condition (on farm testing)
  - Development of marketing strategies for improved cultivars
  - Cultivar recommendations combined with management guideline

Why we need Participatory Plant Breeding?
Reduced number of crops & varieties per crop
Concentration on global seed market

Increase of GM varieties

Why we need Participatory Plant Breeding?

Food Security & Plant Breeding

Sustainable Use of Plant Genetic Resources

Formal Plant Breeding
Participatory Plant Breeding

Level of participatory research
- Conventional: Research managed on station or on farm trials
- Consultative: Information sharing, farmers are consulted, scientists take decision
- Collaborative: Task sharing between farmers and scientists
- Farmer managed: No scientists involved

Participative breeding of locally adapted Durum wheat coordinated by Dominique Desclaux INRA Montpellier

Goal: Locally adapted varieties for local products, supporting diversity, strengthening of rural regions
- Comprehension of farmers, breeders, merchant, consumer, sociologists (supports exchange of industry & farmers, consciousness of consumers) → leading to new breeding criteria
- Respecting local conditions (soil, climate, management) → decentralized test on farm
- Farmers are involved in decision processes (not only end user of varieties but included in development stage)
- Marketing aspects are included from the start
  → collegial process

Participatory breeding in self-pollinated crops
Ceccarelli, ICARDA

Exploiting different forms of PPB, e.g. in potato in NL (2008-2013):

Different Timing of Participation in the Breeding Process

Quelle: Ceccarelli et al. 2007: Participatory plant breeding in water limited environments
Evolutionary plant breeding
Genetically heterogenic varieties

Composite cross (Wolfe, Elm Farm, UK)
- Instead of breeding homogeneous varieties, as many elite varieties as possible are crossed and planted at different sites and multiplied under natural selection pressure
- ideal adaptation of varieties to local site demands
- varieties can handle stress more easily because of high heterogeneity
- reduced risk of breakdown of monogenic inherited resistances
Example: Composite crosses of winter wheat

Participatory approaches in broccoli – USA for open-pollinated varieties

- Started from an initial broad base population;
- 500 - 1000 seeds sent to each grower to plant, select, allow random mating and harvest seed;
- Portion of harvested seed returned to breeder;
- Seed mixed and redistributed for 3 cycles;
- Cultivar development.

Methodologies and Tools for Participatory Research

- Participatory rapid appraisal
- Mother Baby Trial
- Farmer field schools
- Farmer research committees
- Participatory technology development
- Action research

Participatory Action Research

- Method used to involve community residents, clients, and other constituents in social change oriented research
- Participants work with a facilitator to identify a community problem, develop research methodology, collect data, and analyze findings
- The data is then used to make recommendations about how the problem should be resolved
- Participants advocate for funding, legislation, or government action to adopt the findings
- The end result is to alleviate oppression or improve community or service quality

How to get started with PPB

- Choice of crop
- Identify relevant stakeholders
- Identify most urgent needs, market opportunities
  - Public driven breeding initiative
  - Market driven breeding initiative
  - Farmer driven breeding initiative
- Define common breeding goals
- Find context related solutions
- Organize collaborative process
- Identify persons with high engagement
- Organize necessary infrastructure
- On farm trials, Seed supply, logistics
- Communication platform
Definition of common goals

- Find common solution for conflicting interest of different stakeholders
- Trades more interested in quality
- Farmers more interested in agronomic performance
- Breeders are interested to be competitive to seed company (unique characteristics)
- Multipliers more interested easyness of seed multiplication
- Researchers more interested in publications
- Customers interested in diversified products
- Politicians most interested in food and income security
- Environmentalists most interested in climate change mitigation and sustainable environmentally friendly production...

Example of workshop of small scale producers and processors of Cassava from Brazil

- Most important recommendations
  - Identify most urgent problems (drought, planting material, credit, markets)
  - Prioritize technologies and knowledge for short term and midterm goals
  - Collaboration between biotechnologist, applied research, and farmers (from the gene to the market)
- Work on local level
  - Sensitize farmers, technicians, cassava stakeholders
  - Identify specific local problems (e.g. root rot in the Northeast)
  - Use locally available material
- Training in relevant technologies

Demand driven breeding of food legumes

Pool relevant knowledge

- Traditional & local knowledge of farmers
  - On cultivation & utilization practice, seed multiplication & farmer’s selection often very difficult to get access
- Breeder’s knowledge
  - Crossing techniques, heritability of traits, relatedness of different traits, selection methods, artificial inoculation
- Processors/Trader’s Knowledge
  - Technological quality, customers preferences, quality requirements
- Researchers’ Knowledge
  - Genetic basis of traits, genetic diversity of accessions, access to genetic material, physiological important traits
- Socio-economic Knowledge
  - on market potential

Find common language

- Different native languages
- Scientific language of different disciplines
- Intuition & traditional knowledge of farmers
- Emotional attachment of farmers
  - Careful wording („genetic resources“ offending living organisms)
- Find settings to get in close and trustful dialog
- Respecting different way of thinking and needs
- Involve sociologist to facilitate better understanding
- Define common vision to enforce strong commitment
Change of interaction
- Close multidisciplinary & transdisciplinary collaboration
- Evolution from research driven to farmer driven activities
- Sharing of knowledge and collective learning by integrating new knowledge from different disciplines
- Specific tools for group learning and spread of innovation
- Facilitated group discussions using cards, charts, voting, …
- Field visit and demonstration trials
- Assessment of results PPB using scoring forms based on agreed criteria
- Interpretation of results & further improvements

Sourcing of Seeds
- Farm saved seeds (e.g., landraces)
- Commercially available seeds if not
  - protected by IP rights (Patent)
  - Restricted by breeder’s exemptions (needs registration as breeder)
- International and national gene banks, research institutions
  - Small quantity of seeds
  - Genetic resources are of national ownership, MTA and ABS → complex negotiations
- Exchange with commercial and public breeders
  - Often restricted due to conflict of interest (competition)
- Local and international seed net works, NGO → open seed source

Implementation of PPB
- Incorporate research needs of local communities into design
- Start with few on farm trials
- Chose appropriate on-farm design and do NOT duplicate a research trial on-farm
- Spread on farm trials in stepwise procedure after training and engagement of interested farmers
- Initiate working groups within village
- Exchange knowledge between villages
- Regular meetings of all stakeholders
- Cooperation learning between researcher, breeder and farmer
- Communication of results among stakeholders

Implementation of PPB
- Adjust design to local condition, field size, number of involved farmers
- Choose homogeneous farmers’ fields
- Keep it simple
  - Limited number of entries, reps
- Focus on most relevant traits & contextual data
  (Documentation of crop management & most relevant soil and weather conditions)
- Use different techniques to collect the same data by different participants to verify assessment
- Assess G x E interaction based on unreplicated farmers’ fields

Start of on farm trial and training
- Capacity building in
  - Varietal Testing
  - Seed multiplication
  - Seed processing & cleaning
  - Germination Testing
  - Seed Health
  - Storage
  - Crossing techniques
  - Selection techniques
- Regular Workshops with all Stakeholders
- Farmers Field days and Demo Trials

Quarantine regulations !!!
Spreading of on farm trials

Challenges of on farm trials
- Demanding to organize decentralized field trials
- Communication with many actors with different background
- Unexperienced in field trial set up, recording field data
- Less controlled conditions
- Less homogeneous
- Limited availability (not all have e-mail, mobile phones)
- Risk of neglecting field trial during peak times

→ develop clear field plan and field book together with farmer after definition of best field site
→ develop permanent and easy labelling system
→ agree on recording and sampling procedure
→ continuous learning and adjustments

PPB as evolving process

Shift from research managed trials to farmers innovations

Accompanying process of PPB
- Review knowledge obtained
- Agree and update on a shared agenda
- Adopt research questions and options to test (some may participate at different levels)
- Invest in partnership building, education and capacity building
- Facilitated discussions and brainstorm sessions
- Build in time for reflection
- Keep all participants motivated and engaged
- Communication and exchange is essential!!!
- Acknowledgement of achievements

Gender aspect in PPB
- Women have often less access to land, new technologies but are heavily involved in field work, food processing, responsible for traditional knowledge and house keeping
- Special emphasis are needed to include women in the participative process for their empowerment
- Women have different focus on crops than men → different more comprehensive criteria are considered
- are often better distributors of information, better team players
- are often more persistent to long term activities while men are more enthusiastic about short term progress
Data assessment, recording & Sample handling

- Evaluation criteria (visualized criteria book)
- Farmers’ criteria
- Researchers’ criteria
- Code for labelling of plots
- year_site_experiment_genotype
- Evaluation sheets for
  - Farmer hosting on farm trial
  - Researcher visiting on farm trials
  - Farmer visiting on station or on farm trials
  - Facilitated group evaluation using scores, ranking, charts
- Sampling procedure for quality analysis
- Seed saving for further selection
- Over all assessment of results

Management of Data & Material

- Creation of common database (Rosenfeld MS 2011)
- Statistical analysis of recorded on station and on farm data
- ANOVA
- GxE biplots
- Statistical analysis of farmers’ expectations and preferences
  - Multicriteria mapping
  - Grid analysis
- Results provided to participants for selection
- Central storage of seeds
- Sharing of seeds based on farmers’ choice

PPB-ase: user-friendly open source database for participatory breeding programs

- Biplot of farmers preference in different villages
  - Ceccarelli 2009
- Biplot of grain yield versus farmers selection
  - Ceccarelli 2009
Risk of participatory plant breeding

- Distrust and conflict among participants
- Length of time needed to develop consensus around goals, mission, and methods
- The need for training around research methods, data collection, and analysis
- The need for skilled facilitation, coordination, and follow-up on task completion
- Money and an organizational structure are needed to do all these things
- The group must be able to implement breeding activities in order to achieve an outcome

Requirements for participatory plant breeding

- Trusting relationships among members must be developed in order for a consensus about project goals, data collection methods, an analysis of findings, and recommendations can be reached.
- Training about research methods, data collection, and analysis must be provided for the participants.
- Establishing a good organizational structure to support the work team
- The provision of strong administrative support and adequate resources for the project
- A skilled facilitator to coordinate the process.

Opportunity for Change

- Accommodation
  - Making adjustment to existing system
  - Improve efficiency
  - Reorganize components, procedures, responsibilities (improve effectiveness)
- Reformation
  - Critically reflective adaptation
  - Questioning existing practice, procedures, regulations
  - Collective learning beyond present system
- Transformation
  - Creative redesign of whole system
  - Shift in consciousness

Legal situation

- International Treaty of Plant Genetic Resources
  - [www.planttreaty.org](http://www.planttreaty.org)
- Standard Material Transfer Agreement
- UPOV Convention
- Agreement of Application of Sanitary and Phytosanitary Measures
- Biosafety Protocol
- National variety testing
  - New, distinct, uniform, stable (DUS test)
  - Value for cultivation and Use (VCU) tested under high input farming conditions
- National seed law

Legal Situation

- New regulations needed that allow formal and informal seed sector to coexist
- Establishment of new criteria for variety evaluation
- Easier access to plant genetic resources
  - Farmers acknowledged as breeders
  - Memorandum of Understanding between partners, national and international institutions needed
- Ownership of varieties derived from PPB
- Political awareness for importance of access to seed and planting material
- Institutionalisation and upscaling of PPB
Financing of participatory breeding programs

- Private breeders finance themselves by selling seeds:
  - In case of increased farm saved seeds income with license is not sufficient
  - Shift in breeding towards few profitable cultures and hybrids
  - Association of companies → closed club varieties
  - Patenting instead of variety protection → loss of breeders’ privilege
  - Concentration on seed market → dependence on global companies → limited access to genetic resources

- Foundations:
  - Often only short term sponsorship (1-3 y), only partly financed (G2PK: up to 7 private foundations) → uncertain, time consuming

- Price increase on final product:
  - Consciousness of consumer, communication of additional value (Demeter)

- Public support (is decreasing steadily):
  - Preservation of agricultural diversity and freedom of choice (e.g. GMO free)

→ Sustainable food security and food

Experience after 3 years of participatory barley breeding in Syria

- Farmers were able to handle large number of entries, develop own scoring method
- Farmers select for specific adaptive traits
- Diversity was higher among farmers’ selection in own fields than on station evaluation and also higher than breeders’ selection on station or on farm
- Farmers and breeders used almost the same selection criteria
- Farmers were slightly more efficient to identify highest yielding cultivar in own fields than breeders
- Breeders were more efficient selection on station irrigated, while farmers were more efficient in on station selection under low rainfall conditions

Shortening of breeding process

Greatest impact of PPB

- Demand of farmers, traders, consumers poorly understood or not recognized by formal seed sector
- High degree of risk and uncertainty
  - Volatile or emerging markets
  - Climate change
  - Very diverse cultivation management or stress environment
- Wish of producers and stakeholders or even larger part of society to have control over food system
  - Proprietary of seed
  - Introduction of plants into food chain (GMO)
- Changes the organisation and costs of breeding process and technology management
  - Improves trust in research, research efficiency; enhances productivity and welfare of farmers, traders & consumers

Thanks a lot for your attention