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PARTICIPATORY APPROACHES TO PLANT BREEDER AND FARMER

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Introduction

Plant breeding, as a practice, is as old as agriculture itself, with crops such as barley and emmer wheat domesticated by farmers approximately 10,000 years ago (Harlan, 1992).Plant breeding, as a scientific discipline, can be traced more recently to Mendel's experiments in the early 1900s on the inheritance of genetic traits. Plant breeding is a "science-based technology" that aims to deliver improved cultivars to farmers through selection in genetically variable plant populations (Tracy, 2004).

By the early 1990s, a diverse group of national agricultural research stations, non-governmental organizations and farmers' organizations in developing countries were utilizing participatory research models with success. Trialing an array of advanced breeding lines on farmers' fields, with input from farmers on their preferences, was a straightforward application of this participatory process. Using the term "participatory varietal selection," Sperling *et al.* (1993) demonstrate that Rwandan bean farmers successfully identified superior bean varieties for their particular farms by evaluating on-station research trials. In addition, the farmer-selected varieties outperformed local mixtures 64–89% of the time, while the breeder-selected varieties did so only 34–53% of the time (Sperling *et al.*, 1993). According to Walker (2006), the acronym PVS was first used for participatory varietal selection at a 1995 workshop hosted by Canada's International Development Research Center (IDRC), as was the acronym PPB. Witcombe *et al.* (1996) describe both of these methods for the first time in the peer-reviewed literature, specifically referring to PPB as "a logical extension of participatory varietal selection," in which farmers are involved in the earliest stages of selection from segregating populations.

Participatory Plant Breeding (PPB)

Participatory Plant Breeding (PPB) is based on the idea that farmers as well as professional plant breeders have important knowledge and skills that could complement one another. PPB is broadly defined here as a range of approaches that involve a mix of actors (including scientists, breeders, farmers and other stakeholders) in plant breeding stages. Other terminology has been used to describe such approaches, depending on the stage of the breeding process at which collaboration between farmers and formal breeders starts. For example, in Participatory Varietal Selection (PVS) the materials are stabilized, whereas in the narrower sense of Participatory Plant Breeding the material is still segregating. These different approaches are generally subsumed under the term Participatory Plant Breeding (or Participatory Crop Improvement). Depending on who controls the breeding process (researchers or farmers) and the scale on which the work is undertaken (community-centered

or research to extrapolate results) two broad categories are usually differentiated: 'farmer-led' and 'formal-led' PPB.PPB is collaboration between breeding institutions and farmers that aims to develop cultivars relevant to farmers needs. The main difference between a participatory and conventional breeding program is that in PPB most of the early selections takes place on farm. The theory behind these methods is that farmers are more likely to adopt new agricultural technologies (including new varieties) when they have actively participated in their development. This process is particularly relevant for resource poor farmers, especially in developing countries, whose diverse and complex needs are often underserved by agricultural innovations designed for larger commercial farms (Merrill-Sands *et al.,* 1989).

Where PPB is initiated by or under the primary leadership of formal sector institutions such as national plant breeding programmes or international research centres (formal-led PPB), it is expected to complement the formal research system and to improve its effectiveness. Formalled PPB mainly seeks to give more attention to farmer preferred quality traits and local environmental conditions, as well as to reorient general breeding directions and to reach a broader range of potential users and stakeholder groups – including women and the poor. Development agencies often support formal-led PPB or disseminate breeding products. However, the major interest of development agencies tends to be directed towards supporting farmers' own systems of crop development, i.e. 'farmer-led PPB'. Participatory plant breeding has emerged in recent decades with the recognition that farmers and researchers working collaboratively can address this question. Plant breeders in the developing world pioneered this process by moving away from the breeding stations and into the farmers' yields to develop varieties adapted to marginal growing conditions (Pixley *et al*., 2007). This shift back to farmers' yields has allowed farmers to re-engage with the breeding process. Rather than treating farmers as the end-users of their product, participatory plant breeders work collaboratively with farmers in various stages of the breeding process. This includes setting goals, forming breeding populations, implementing effective selection methods, and releasing new varieties. Participatory plant breeding around the globe has markedly enhanced adoption of new varieties by prioritizing locally important characteristics, performance in marginal production environments, and unique quality traits (Weltzien and Christinck, 2008).

Two types of PPB programmes can be distinguished: consultative and collaborative. In consultative programmes, farmers are consulted at every stage to set goals and choose parents that are entirely appropriate. In collaborative programmes, farmers grow the early, variable generations and select the best plants amongst them on their own fields. The choice of consultative or collaborative methods will depend on the crop and the availability of resources.

Participatory Variety Selection (PVS)

Participatory variety selection (PVS) refers to processes whereby farmers are involved in selecting lines that they judge to be most appropriate for their own uses from amonga range of fixed (stable) lines that are being field tested. PPB generally involves higher and more complex degree of involvement of farmers, as they are engaged in decision-making in earlier and more fundamental stages of the variety development chain; PPB therefore has a higher empowerment effect than PVS (Witcombe 2005).Participatory varietal selection (PVS) is the

selection by farmers on their own fields of finished ornear-finished products from plant breeding programmes. These include released cultivars, varieties in advanced stages of testing, and well characterized material such as advanced non-segregating lines in inbreeding crops, or advanced populations in out breeding crops. In contrast, participatory plant breeding (PPB) employs the active participation of farmers in breeding programmes, and will usually involve farmers selecting genotypes from genetically variable, segregating material. The difference between PVS and PPB may not appear to be great at first sight. However, PPB requires more resources and more time than PVS, and PVS identifies material that can be supplied morerapidly by the formal seed sector. The contrasting impacts of PVS and PPB on biodiversity havebeen discussed by Witcobe *et al*. (1996).

Communication is crucial to ensure that participants understand and embrace their respective roles. Levels of involvement can include:

- **Researcher managed:** the farmer contracts land and/or services to the researcher
- **Consultative:** the researcher consults with the farmer for input throughout the project
- **Collaborative:** the farmer and the researcher make decisions in a collaborative process
- **Farmer managed:** the farmer leads the project and works with the researcher as a colleague

Three different objectives:

- (1) To obtain suitable planting material by improving local adaptation,
- (2) To promote genetic diversity, and
- (3) To valorize farmers' knowledge and know-how.

Development projects can support farmer-led PPB through four broad types of interventions:

1) Germplasm support to increase farmers' access to diversity (using fixed or segregating, local or external materials), combined with testing new material, and supporting seed systems (community seed banks)

2) Skills support in breeding, testing or seed production (either new skills or extending local best practices)

3) Support in forming links and networks to exchange material or information

4) Indirect support to confront barriers to farmer-breeding (e.g. restrictive seed laws), or help promote PPB in other ways, such as market development.

Key assumptions for PPB

- Farmers are interested in participating in plant breeding
- Farmers and scientists can successfully collaborate.
- It will not fail because:

– The parents of crosses include locally adapted material;
– Selection is in the local environment;

– Varieties are selected by farmers for the traits farmers consider important.

Advantages of participatory over conventional breeding methods

1. At least one parent in any cross is well adapted to the local environment.
2. Genotypes x environment interactions are used positively because breeding is done in the target environment.
3. The impact of genotype x year interaction is probably reduced because local parental materials have adapted to local year-to-year variations.
4. Only a few crosses are made, so large F_2 and F_3 populations can be grown to increase the likelihood of selecting desirable segregants.

Possible Outcomes/Benefits of PPB

I. Production gains: yield increases; increases in stability of yield; faster uptake; wider diffusion; and higher market value of products.
II. Biodiversity enhancement: communities have wider access to germplasm; wider access to related knowledge; and increased inter- and intra-varietal diversity.
III. Cost-efficiencies and effectiveness: fewer research dead-ends; more opportunities for cost sharing in research; and less expensive means of diffusing varieties.
IV. Effective meeting of user needs: higher degree of farmer satisfaction; broader range of users reached, including marginal farmers; and promotion of group learning through farm walks.

Conclusion

It is neither a farmer-led nor a formal-led programme, but a programme led by both professionals and researchers, in which farmers' critical participation is encouraged right from the first steps of the breeding scheme. The main decisions have been taken collectively to cope with the sustainability challenges addressed by organic agriculture. This represents a major breakthrough from conventional breeding schemes, insofar as farmers play the role of real partners and not only of consumers or end-users of newly created varieties. This programme's experience also highlights the benefits obtained from open interactions between different professional partners and researchers from relevant disciplines. Involving pasta manufacturers in the programme allowed farmers to leave behind their original notion of manufacturers as multinational profit-makers with no societal preoccupations, and to identify concrete options for collaboration. This next step involves more in-depth collaboration with agronomists, economist's and legal experts to better formalize and implement different but complementary action systems around specific varieties, combining technical innovation with specific rules. However, there is not only one way to organize breeding, farming and valorization systems with a view to sustainability. Agricultural projects that promote multi-actor participation right from the beginning, that is right from the plant breeding stage, along with an ethical perspective that takes in account actors or material objects that are usually discredited, may be a more fitting response to sustainability challenges. Co-breeding is no longer only an end in itself but also a means of facilitating the production of knowledge and rules relevant for the development of circumscribed and meaningful agro-food systems, rather than merely the adaptation of models produced in other settings.

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