



Empowering Farmers: The Vital Role of Agricultural Extension and Plant Breeding in Participatory Plant Breeding

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Imagine a world in which farmers may influence how crops are developed in the future. Imagine a situation in which they actively engage in plant breeding, collaborating closely with experts to develop crops that are more appropriate for their particular requirements and regional circumstances.

Participatory Plant Breeding (PPB), a ground-breaking method of farming that enables farmers to co-create improved crop varieties, is making this goal a reality. From variety selection to field trials, farmers are fully involved in the breeding process through the collaborative methodology known as Participatory Plant Breeding (PPB) (Ceccarelli & Grando, 2007). Two essential components are at the center of this change: plant breeding and agricultural extension.

In this participatory paradigm, agricultural extension services are essential because they serve as a bridge between farmers and academic institutions. Extension agents conduct training programs, encourage communication, and make sure that better varieties and technology are distributed. Plant breeders and extension agents work together to provide a two-way knowledge exchange that encourages local creativity, empowerment, and adaptation.

Agricultural Extension: Bridging the Gap

For decades, agricultural extension has been an essential component of farming communities. To put it simply, it entails farmers receiving knowledge and useful information from agricultural experts, such as scientists, extension agents, and specialists. Through this interchange, farmers are able to embrace contemporary methods, enhance existing practices, and remain current with agricultural advancements.

For many years, the information flow was primarily one-way, with farmers receiving knowledge from experts. Although this strategy has produced many agricultural breakthroughs, it has also neglected the abundance of traditional wisdom that farmers hold. This is where PPB and other participatory approaches are useful.

Participatory Plant Breeding: A Revolution in Crop Development

The conventional approach to plant breeding is completely transformed by Participatory Plant Breeding. PPB gives farmers the ability to actively engage in the selection and development of crop types, as opposed to being a top-down approach that is exclusively under the direction of scientists.

In order to determine farmers' unique needs and priorities, researchers and agricultural extension agents first interact closely with farmers. Scientists can learn a great deal about local conditions, agricultural methods, and the characteristics that are most important for better crop production by working with farmers and comprehending their difficulties.

Steps in Participatory Plant Breeding (PPB)

Farmers and researchers work together to generate superior crop varieties using a collaborative strategy called Participatory Plant Breeding (PPB). It guarantees that the final varieties satisfy farmers' preferences and are more suited to regional conditions. The following are the main steps in the PPB process:

1. Define objectives and Partners: The first step involves describing the breeding objectives (product profile) and specifies who should be involved: farmers (male and female), breeders, extension agents, seed companies, non-governmental organizations (NGOs), and market players. Early, clear consensus on responsibilities and decision-making fosters relevance and confidence. Farmers play a key role in determining the desired ends, such as yield, resistance to pest and diseases or tolerance to drought and salinity.

2. Participatory needs assessment and priority setting: Documents farmers' limitations, trait preferences (yield, flavor, cooking quality, stress tolerance, etc.), and target environments through household interviews, focus groups discussion and field visits. This outlines the program's target customer and product profiles.

3. Collection of Germplasm and parental selection: Select exotic germplasm, improved varieties, and local landraces that correspond to the selected habitats and priorities. Farmers frequently assist in locating promising local material that is missed by official collections.

4. Generate variability (crossing / population development): Breeders develop segregating material (F_2 – F_5 or population mixes) that contain the desired features by creating crosses or assembling various populations, sometimes with assistance from farmers. Keep track of the population's composition and parentage.

5. Early-generation selection with farmer input: Early generation selection is primarily carried out by plant breeders under controlled conditions. Begin on-station or on-farm selection in segregating generations, where farmers' score or choose specific plants or plots according to predetermined criteria (sometimes including features not recorded by agronomic data). The focus is mainly on eliminating undesirable genotypes and retaining those with promising traits such as yield potential, disease resistance and adaptability. Alignment with local preferences is accelerated by early farmer involvement.

6. Decentralized on-farm trials (baby/pilot trials): Analyze potential lines in a variety of target conditions in farmers' fields (decentralized testing). In order to capture real-world performance and interactions between genotype and environment, trials are conducted under local agronomic conditions.

7. Participatory Varietal Selection (PVS): Provide farmer groups a manageable selection of advanced lines to assess and rate in the field (usually using basic scoring sheets, pairwise comparisons, or matrix ranking). Finding immediate farmer-preferred types and determining the best parents for PPB can be done at a reasonable cost with PVS.

8. Recurrent selection cycles (refinement): Utilize PVS farmers' feedback and on-farm trials to inform future cycles of crosses and selection. Keep breeding cyclical to ensure that materials are always improving for the clientele.

9. Seed multiplication and quality assurance: Following the selection of superior lines, farmers should plan seed multiplication (using community seed systems or farmer seed producers), guarantee basic seed quality, and reach agreements on seed-sharing or commercialization that align with local norms.

10. Monitoring, evaluation and impact assessment: Monitor adoption, yield, trait performance, farmer satisfaction, and socioeconomic impacts. Employ both quantitative and qualitative techniques, and use the data to modify objectives and strategies.

11. Institutionalization & scaling: To ensure that farmer-developed varieties can be maintained and scaled where necessary, record procedures and results, establish local capacity (training for farmer-breeders, extension, and seed producers), and collaborate with policy and release systems.

The Power of Farmers' Knowledge

Farmers have a wealth of knowledge that has been accumulated over many generations of farming expertise. It is impossible to duplicate their comprehensive knowledge of the environment, pests, illnesses, and cultural preferences in a lab. PPB creates new opportunities for innovation by fusing this traditional knowledge with scientific understanding. Farmers actively assess various crop varieties for characteristics that suit their needs and preferences during participatory variety selection. Through this technique, scientists can adjust breeding goals depending on direct input from farmers, who are the end users. PPB essentially makes sure that the new crop types are customized to meet local demands, which eventually results in increased productivity and better lifestyles.

Sustainable Agriculture through Local Adaptation

PPB's focus on local adaptation is one of its key benefits. Participatory techniques acknowledge the diversity of agroecological zones, microclimates, and agricultural systems, whereas standard plant breeding frequently concentrates on creating "one-size-fits-all" types. PPB produces resilient crop types that can endure regional difficulties like pests, illnesses, and climate change by breeding for certain regions. Additionally, farmers who actively engage in the breeding process have a great sense of ownership over the crop varieties that are produced. Because farmers are more willing to embrace and promote crops they had a direct involvement in developing, this sense of ownership translates into higher adoption rates.

The Role of Agricultural Extension

Services for agricultural extension serve as a link between rural populations and research. Their participation in PPB is essential to ensure community involvement and scaling up ideas. In PPB, extension plays crucial roles such as:

- 1. Capacity Building and Farmer Training:** Farmers can learn about basic plant breeding concepts, experimental design, and data gathering techniques through capacity-building workshops organized by extension staff. This information boosts farmers' self-assurance and encourages them to take responsibility for the research process (Rivera & Alex, 2004).
- 2. Facilitating Farmer–Researcher Linkages:** In order to ensure that farmers' opinions are included in research agendas, extension agents serve as a link between farmers and breeders. These connections guarantee that breeding programs tackle actual problems like soil salinity, pests, and drought.
- 3. Promoting Knowledge Exchange:** Extension systems spread improved varieties and encourage the sharing of scientific and traditional knowledge through farmer field schools and field demonstrations. Farming communities' social capital and collective learning are strengthened by this process.
- 4. Monitoring and Evaluation:** Extension specialists help track on-farm experiments, gather input, and assess varietal performance under various circumstances. Continuous improvement and local adaption are guaranteed by this iterative procedure.

The Way Forward: Empowering Farmers for a Sustainable Future

A paradigm shift in crop development, participatory plant breeding places an emphasis on sustainability, local adaptation, and farmer involvement. PPB has the potential to transform agriculture and increase global food security by fusing the advantages of modern knowledge with traditional knowledge. Agricultural extension services need to be improved and expanded if PPB is to be successful on a larger scale. Governments, academic institutions, and non-governmental organizations must make investments to invest training extension agents and increase their ability to interact with farmers in an efficient manner. Giving extension agents the skills and resources they need will empower them to promote participatory procedures and encourage the adoption of improved crop varieties.

Conclusion

A potent technique that puts farmers at the forefront of agricultural development is participatory plant breeding. We can build a more resilient, inclusive, and sustainable agricultural future by appreciating and embracing the wealth of knowledge that farmers possess. This change is sparked by agricultural extension, which works with farmers and scientists to jointly develop crop varieties that satisfy the various demands of farming communities. Together, we can pave the way for a future in which farmers are active agents of agricultural transformation rather than merely recipients of benefits through PPB and improved extension services.

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