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Participatory Plant Breeding: A Farmer Centred Approach for Crop Improvement

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INTRODUCTION

Plant breeding is one of the most important scientific methods used to improve crop productivity, quality, and resistance to pests, diseases, and environmental stresses. Traditionally, plant breeding programs have been conducted by scientists in research institutes and agricultural universities. In such conventional approaches, breeders develop improved crop varieties in experimental stations and later release them to farmers. However, varieties developed under research station conditions may not always perform well in farmers' fields because environmental conditions such as soil type, rainfall, management practices and pest pressure vary widely. Farmers also have specific preferences for traits such as grain quality, taste, maturity period, fodder value and storage ability. Conventional breeding often fails to fully consider these local preferences and conditions.

Participatory Plant Breeding (PPB) emerged as an alternative approach to address these limitations. It involves collaboration between farmers and plant breeders throughout the breeding process. Farmers participate in evaluating, selecting and testing breeding materials in their own fields. Participatory Plant Breeding involves farmers in the breeding process to develop crop varieties suited to specific environmental condition. The farmer's traditional knowledge and practical experience contribute significantly to the identification of desirable traits and the development of improved varieties suited to local conditions.

Concept of Participatory Plant Breeding

Participatory Plant Breeding is defined as a breeding approach in which farmers, plant breeders, and other stakeholders collaborate in the development and selection of improved crop varieties. In this system, farmers are not only the end users of improved varieties but also active partners in the breeding process.

The main principle of PPB is that crop improvement should occur under the real environmental and management conditions in which crops are grown. By conducting selection in farmers' fields rather than only in research stations, breeders can develop varieties that perform better under local conditions. Participatory breeding combines scientific breeding methods with farmers' indigenous knowledge, resulting in more effective and locally adapted crop improvement programs. Compared with conventional breeding approaches, Participatory Plant Breeding (PPB) provides greater opportunities for developing crop varieties that closely match farmers' needs and preferences, especially in marginal and stress-prone production environments. Farmer involvement in research and selection can also influence the conservation and utilization of crop genetic diversity. Participatory Varietal Selection (PVS) may contribute to maintaining or increasing varietal diversity by encouraging farmers to cultivate suitable alternatives; however, in regions already rich in indigenous genetic resources, the promotion of a limited number of preferred varieties could sometimes reduce existing diversity. In comparison, PPB has considerable potential to broaden and maintain genetic diversity, although its effects may be concentrated within specific farming communities or geographical areas. Consequently, PPB can be regarded as a dynamic approach to in situ conservation, allowing genetic resources to be maintained and further adapted under farmers' actual production conditions (Witcombe *et al* 1996).

Objectives of Participatory Plant Breeding

The major objectives of participatory plant breeding are:

- To develop crop varieties that are well adapted to local agro-climatic conditions.
- To incorporate farmers' preferences and knowledge into crop improvement programs.
- To improve the adoption rate of newly developed varieties among farmers.
- To enhance crop productivity and stability under diverse farming environments.
- To conserve and utilize local genetic diversity and traditional crop varieties.
- To strengthen collaboration between researchers, farmers, and agricultural institutions.

Types and Methods of Participatory Plant Breeding

1. Participatory Varietal Selection (PVS)

Participatory Varietal Selection is the simplest and most widely used form of participatory breeding. In this method, farmers evaluate a set of improved crop varieties or breeding lines developed by researchers. The evaluation is carried out in farmers' fields, and farmers select the varieties that perform best according to their preferences and local conditions (Almekinders and Elings, 2001).

2. Collaborative Plant Breeding

In collaborative plant breeding, farmers and breeders work together at different stages of the breeding process. Farmers may participate in activities such as selecting parent materials, evaluating segregating populations and selecting superior plants. This approach allows farmers to contribute their practical knowledge directly to the breeding program.

3. Decentralized Plant Breeding

Decentralized breeding involves conducting selection in multiple locations, especially in farmers' fields across different environments. This method increases the chances of identifying varieties that perform well under diverse conditions. Decentralized breeding focuses on developing varieties specific to the unique conditions of various environment, considering the interactions between genotype and environment. This approach involves directly breeding crops within the particular environment to enhance adaptation and

performance in those specific environmental conditions (Noru *et al*. 2024 and Ceccarelli and Grando 2007).

Steps in Participatory Plant Breeding

The participatory plant breeding process generally involves the following steps:

- Identification of farmers' needs and preferences for crop traits.
- Selection of parent materials and development of breeding populations by plant breeders.
- Evaluation of breeding materials in farmers' fields.
- Selection of superior plants or lines by both farmers and researchers.
- Testing and validation of selected varieties across multiple locations.
- Release and dissemination of improved varieties to farmers.

Advantages of Participatory Plant Breeding

Participatory plant breeding offers several advantages compared to conventional breeding systems:

- Development of crop varieties adapted to local environments.
- Higher acceptance and adoption of improved varieties by farmers.
- Utilization of farmers' indigenous knowledge and experience.
- Conservation of traditional crop varieties and genetic diversity.
- Increased efficiency of breeding programs in marginal environments.
- Strengthened cooperation between farmers, researchers and institutions.

Limitations of Participatory Plant Breeding

Despite its benefits, participatory plant breeding has certain limitations:

- It requires strong coordination between farmers and researchers.
- The breeding process may be slower due to decentralized selection.
- Farmers may require training to participate effectively in the breeding program.
- Limited financial and technical resources can restrict large-scale implementation.

Future Prospects of Participatory Plant Breeding

Participatory plant breeding has great potential for improving crop productivity and sustainability, particularly in developing countries. With the increasing challenges of climate change, resource limitations and environmental stress, there is a growing need for crop varieties that are resilient and locally adapted. Modern technologies such as molecular markers, genomic selection, and digital data collection tools can be integrated with participatory breeding to improve efficiency. PPB can also play a crucial role in developing climate-resilient and stress-tolerant crop varieties that meet farmers' needs and contribute to sustainable agriculture.

CONCLUSION

Participatory Plant Breeding (PPB) is an inclusive crop improvement approach in which farmers actively contribute to the development and selection of improved plant materials. It combines formal breeding techniques with farmers' indigenous knowledge, field experience, and preferences to identify genotypes that perform well under local growing conditions. Since farmers participate in evaluating and selecting promising materials, the resulting varieties are more likely to satisfy local production requirements and consumer preferences. PPB also facilitates the wider acceptance of improved varieties, supports crop productivity, and contributes to the maintenance of valuable genetic diversity. Therefore, participatory plant breeding offers a practical and sustainable approach to developing locally suitable crops and strengthening food and nutritional security, particularly in regions with diverse agro-ecological conditions.

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