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METHODOLOGY OF PARTICIPATORY PLANT BREEDING (PPB) IN CUBA

Metodología del fitomejoramiento participativo (FP) en cuba

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ABSTRACT. This paper presents a study of the implementation of Participatory Plant Breeding in Cuba, a methodology based on the experience gained by a group of researchers, farmers and technicians. The proposal presents in materials and methods the four fundamental phases of this process: 1) Diagnosis, 2) Collection of plant genetic resources, 3) Establishments of demonstration plots and development of diversity fairs and 4) Peasant experimentation; The structure provides the necessary flexibility that will allow a proper application of the method and follows a logical order of the activities to be executed in a way that facilitates its execution in the different contexts in which it is of interest to apply it. It was obtained as a result that in addition to the four basic stages of Participative Plant breeding, other tools were used that allowed a successful process, they were: action learning according to interests, Farmers' schools, Innovation festivals, Exchange visits and coexistence, Training of students' capacities in the local innovation scenarios and creation of local seed banks.

Key words: improvement, field experimentation, agricultural fairs

RESUMEN. En el presente trabajo se presenta un estudio de la implementación del Fitomejoramiento Participativo en Cuba, una metodología sustentada sobre la base de la experiencia adquirida por un grupo de investigadores, agricultores y técnicos. La propuesta presenta en materiales y métodos las cuatro fases fundamentales de este proceso: 1) Diagnóstico, 2) Colección de recursos fitogenéticos, 3) Establecimientos de parcelas demostrativas y desarrollo de ferias de diversidad y 4) Experimentación campesina.La estructura brinda la flexibilidad necesaria que permitirá una adecuada aplicación del método y sigue un orden lógico de las actividades a realizar de forma tal que facilita su ejecución en los diferentes contextos en los que sea de interés aplicarla. Se obtuvo como resultado que además de las cuatro etapas básicas del Fitomejoramiento Participativo se utilizaron otras herramientas que permitieron un proceso exitoso, las mismas fueron: aprendizaje en la acción según intereses, escuelas de agricultores, festivales de innovación, visitas de intercambio y convivencias, formación de capacidades de los estudiantes en los escenarios de la innovación local y creación de bancos locales de semillas.

Palabras clave: experimentación en campo, ferias agrícolas, mejoramiento

INTRODUCTION

Conventional improvement generally results in a system of improvement based on programs conceived and developed by researchers in research centers without taking into account the needs and knowledge of farmers (1).

The conventional systems of plant breeding (SCF) present limitations for the satisfaction of the farmer demands in terms of diversity and quantity of improved seeds because these systems have focused on obtaining improved varieties with general adaptation and use of high inputs agrochemicals (2). This situation is further exacerbated by farmers' limited adoption of improved seeds in the face of increasing cost increases and rejection of some ethnic groups due to their deficient conservation and diversity, the decrease in the value of harvests and the intensification of unequal relationships of the farmers with the rest of the actors of the productive chain (3).

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Participatory Plant Breeding constitutes a novel methodology that involves farmers as direct actors in the processes of technological innovation and crop improvement. In the PPB the farmers maintain a direct relationship with the technicians and professionals who become their partners in the production and improvement processes (4).

Participatory Plant Breeding has among its main goals to facilitate access to genetic diversity for farmers with the objective that they select those materials with greater adaptation to the specific biophysical and socioeconomic conditions of their farms (5). The PPB, in principle seeks to strengthen local seed systems through the injection of new genetic diversity or rearrangement and redistribution of existing in the communities, in order to meet the various demands of farmers, in terms of genetic variations and environmental.The genetic diversity that is provided to farmers includes the landraces that they have traditionally managed, which, while maintaining their basic identity can show variations in their yield under different environmental and crop conditions (6).

MATERIALS AND METHODS

Participatory Plant Breeding began as a process in Cuba in 1999 in the cultivation of corn and beans, later it was incorporated into rice, at the beginning it was implemented in the provinces of Pinar del Río and the old province of Havana, current Mayabeque province. Subsequently, it was disseminated to the Villa Clara and Holguin provinces, executing in these four provinces until 2005.

The Cuban experience of Participatory Plant Breeding has focused on four stages: diagnosis, collection of plant genetic resources, establishment of demonstration plots and development of diversity fairs and peasant experimentation (7).

Methodology of Participatory Plant Breeding in Cuba

The PPB: concepts and Description

Plant breeding

It is the knowledge application of genetics for the selection of plants with desirable characteristics, such as higher yield, tolerance to pests, among others (8). There are different concepts of Participatory Plant Breeding, the main ones are:

- It is a strategy of genetic improvement of plants where the different actors of the productive chain (researchers, farmers, organizations and others) work together in the process of developing varieties for the strengthening of local seed systems (9).
- It is a process where the farmer acts as a subject who researches, measures and studies in collaboration with the researchers (10); it brings together the knowledge and research capabilities of local farming communities with that of institutions and organizations, in an interactive way. The approach has also been called 'farmer to farmer' or farmers´ research comes back to farmer ' (11).

Terms associated with Participatory Plant Breeding

Biodiversity: biological diversity is defined as the variability between living organisms, including, among others, terrestrial, marine and other ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and diversity of ecosystems, while in general terms it is defined as the diversity of life on earth (12).

Agrobiodiversity: The term agrobiodiversity can be defined as that part of the biodiversity on which man depends to obtain food, fuel and fiber, including plants, animals, trees and other organisms that have direct importance for agricultural production (13).

Participatory variety selection (SPV): It is the selection of fixed lines (released to the market, advanced lines or local varieties) by farmers in defined environments (14).

For the SPV to be successful, the following four steps must be carried out:

- Identification of farmers' needs
- Search for suitable materials
- Experiencing their acceptance in farmers' fields
- Greater diffusion of favorite cultivars by farmers

Some authors (15,16), establish the classification of the selections according to the actors and the place in which it is carried out as:

Non-participatory selection. It is the one made by the breeders.

Participatory selection. It is the one made by the farmers.

Centralized selection. It is carried out in research stations.

Decentralized selection. It is done on farmers' land.

Centralized non-participatory selection. It is carried out by the breeders in the research stations.

Participatory centralized selection. It is carried out by farmers in research stations.

Decentralized non-participative selection. It is done by breeders on farmers' land.

Participatory decentralized selection. It is the one made by the farmers on their land.

For the PPB to succeed, it must have the following characteristics (17):

- Understanding the reasons why different varieties are grown
- Identifying expert farmers, with skills to manage diversity and for the selection of seeds
- Together establish improvement goals (and functions that participants must meet) that meet the needs of farmers
- Use local varieties as parent material
- Decentralized selection of segregation lines by farmers
- Participation of farmers in all stages of selection and evaluation
- Transferring of skills and knowledge among farmers and plant breeders
- Evaluation and monitoring of the dissemination of varieties by scientists; use of informal seed supply systems for wider dissemination

The present methodology is based on the experience acquired by a group of researchers, farmers and technicians from Cuba in the implementation of Participatory Plant Breeding. The proposal presents a series of methodological considerations with the necessary flexibility that will allow an adequate application of the method and follows a logical order of the activities to be executed in a way that facilitates its execution in the different contexts in which it is of interest to apply it.

The instrumentation of the methodology as such constitutes a process of learning in action for all the actors involved in the implementation of it. The process allows the participants to understand the dimension of the real needs of the farmers and to direct the improvement programs and the dissemination of varieties according to their real interests and needs.

This initiative is aimed at promoting the sustainable development of Local Seed Systems (SLS), based on the participation of farmers as direct actors in the process of selection, use and conservation of genetic resources at the local level.

The adaptability of germplasm to farmers' specific conditions, adaptation to different environments, farmers' acceptance, economic stability or other similar characteristics that are important from the farmer's point of view are generally not considered in the programming of the investigations, this methodology is specially directed to foment a method that has like premise that the needs and interests of the farmers constitute a priority.

Stages of the methodology

The PPB methodology in Cuba has four phases or stages (7):

- Diagnosis
- Collection of plant genetic resources
- Establishment of demonstration plots and development of diversity fairs
- Peasant experimentation

RESULTS AND DISCUSSION

1. Diagnostic stage

The diagnosis constituted the initial stage of the methodology and in essence allowed typifying the farmers according to the socio-economic and biophysical characterization of the productive systems and determining the leadership relationships that are presented in each locality. This provided key arguments to know the points of entry of Participatory Plant Breeding in the communities and from this phase the farmers began to feel an active part of the community knowledge systematization.

The steps to follow to carry out this stage were the following:

Conformation of a multidisciplinary team composed of researchers from different institutions, policy makers and farmers.

Definition of the objectives and information to obtain during the diagnosis:

The main objective of the diagnosis is to obtain real and accurate information about the productive systems of the farmers, the flows and management of the seeds in each locality, the socioeconomic and biophysical environment and the main needs in terms of diversity and technologies of the regions. . In addition, solutions that farmers have found to different local problems must also be raised.

Preparation of the necessary documents to carry out the diagnosis: these documents are surveys and questionnaires that should allow the capture of as much information as possible according to the objectives of the diagnosis.

The application of the questionnaire to farmers. At this point, as many farmers as possible are visited in order to obtain reliable information, the visits focus on an informal and sociable conversation in such a way that the farmer understands the true objective of the interview and provides as much information as possible. At this time, visual observation and taking pictures is important.

Processing and systematization of information: in this step, a detailed report is made on the results of the diagnosis, which will allow defining the work strategies to be followed during the rest of the process.

Return of the results of the diagnosis to the farmers. It is important to return the results of the diagnosis to farmers in such a way that farmers feel they are an important part of the process and not just passive donors of seeds and experiences. The return is usually done through participatory workshops in each town visited and with each group of participating farmers, where these results are presented and the problems found in their area are discussed with the farmers. In addition, the possible alternatives to be followed are established as a whole to solve the problems encountered.

The diagnostic stage allowed determining what specific objectives should be worked on during the process, it also allowed to know what the demands are regarding diversity and technologies and provided the necessary information to select the localities and farmers with whom to work throughout the process. It is necessary that from this initial stage the farmers feel part of the team and take with the other actors the decisions to follow during the rest of the process.

2. Collection of plant genetic resources

Collecting plant genetic resources was one of the most important stages of the process, providing the possibility of knowing and collecting the diversity managed by local systems in order to facilitate access to the participating communities, to the formal system of plant breeding, to other communities and groups of farmers.

The collection stage of plant genetic resources was often carried out in parallel and jointly with the diagnostic stage in order to optimize time and resources. The main objective of this stage is to collect the greatest possible number of varieties or accessions that guarantee having diversity wide enough to satisfy the greatest possible range of needs of the farmers. In this stage, commercial varieties, pre-commercial varieties, landraces and experimental lines must be collected, both from formal and informal seed systems, because in both systems there are materials of interest to farmers.

The collection of materials was accompanied by a format (passport data) that allowed taking the essential data depending on the crop or crops to be collected which allowed identifying the source of the material. During the collection, the data of interest that the donor provided with respect to some specific feature that describes said material was taken. The collection should not be based on large volumes of seeds because this may limit the number of varieties to be collected.

In this stage it was possible to collect a large number of varieties and accessions according to the crop of interest in each of the localities where it was made.

3. Establishment of demonstrative plots and development of diversity fairs

The diversity collected in the previous phase was concentrated in demonstration plots, which may be located on land belonging to public institutions, on land owned by private institutions or on the farmers' own land. The parcels are recommended to be attended by groups of farmers giving them the same cultural attention that they use in their farms, always with the objective of reducing the use of agrochemical inputs as much as possible, this will guarantee a greater adoption of the method and varieties on the part of the farmers. Each variety sown is identified only by a number of order and the information of the seed origin is not informed until after making the selection so that the name of the variety or its origin does not influence the farmers when the selection.

It is important that farmers participate from planting to harvest so that they can have a clear idea of the behavior of the crop throughout the cycle, having the possibility of evaluating from germination, through phenological development, behavior against pests and diseases until you reach performance. In addition, work experience has shown that as the farmers´ participation of increases throughout the process, the cost of maintaining the plots decreases considerably.

Area for the assembly of the demonstrative plot

Defined the crop (or crops) to be exhibited, the next step was to select the specific area for the assembly of the demonstration plot. The selection of this has to be done with enough time, in order to be able to carry out all the necessary conditioning work, including the preparation of the soil for the sowing or crop planting and other no less important directed to give the greatest possible lucidity to the area of exposition.

The area to assemble the plot must meet, among others, the following characteristics:

Uniformity: As for the type of soil, it is an essential requirement that the area selected for the assembly of the plot must comply with to avoid the expression of differences between the varieties due to factors other than the characteristics of each of them. Thus, the selected area must be fundamentally delimited on the same type of soil with a uniform relief.

For those cases in which the area of the plot does not comply with the previous requirement, it is recommendable to repeat the varieties in at least two plots or rows, in order to allow a more precise assessment of their behavior.

Representativity: It should be as representative as possible of most of the farms in the region, so as to ensure a high degree of adaptation of the selected varieties to the specific conditions for which farmers make their selection. Preferably, a framed area should be chosen within the boundaries of a farmer's farm, distinguished by the diversity of species and varieties it grows and by the level of satisfaction of its food and marketing needs, which would be an example not only to imitate but to overcome by the rest of the farmers.

Accesibility: The selected area should be easily accessible for each of the participants, in order to ensure the greatest possible assistance.

Soil preparation and assembly of the exposure area

The preparation of the soil and the assembly of the exhibition area must ensure the observation of the following two basic premises:

- The development of the crop in conditions is very similar to those existing in most of the farms in the region.
- The differences between the varieties must obey only the characteristics of each one.

Therefore, during the preparation of the soil and the assembly of the exhibition area, the following aspects must be taken into consideration:

Soil preparation and other tasks such as irrigation applications, fertilizers and other products must be carried out uniformly throughout the exhibition area and in accordance with the tasks that farmers perform on their farms.

The set of new varieties to be exhibited should be composed of varieties of very diverse provenance, which should include: local varieties, varieties collected in other regions of the country, commercial varieties, advanced lines of classical breeding programs and varieties introduced, among others.

The seed to be used must be as uniform as possible in terms of age, quality and origin.

All the varieties to be exhibited must be planted on the same date.

The design to be used for the location of the plots or rows of each variety must be such as to allow free access and circulation of the participants during the process of variety selection.

All varieties must be represented on the same planting or planting surface, with at least two repetitions preferably.

Between the plots or furrows, each variety must be left a minimum space that avoids the possible effect of competition between the varieties.

The varieties must be identified through previously established codes, which will avoid the predisposition of the farmers in the process of participatory selection of them.

The presentation of samples of seeds, fruits or others, according to the characteristics of the crop that is exposed, it is recommended to assure the participants the maximum information that allows the most accurate selection of the varieties they want for their farms.

For the identification of the exhibition area it is advisable to place a poster or banner at the entrance of the field, in which the main characteristics of the area should appear, such as: general outline of the area, soil type, and date of planting and age of cultivation, more important cultural services such as crops, irrigation and fertilization.

Finally, it is recommended as an element of good pleasure, the adequacy of the area with elements of the farm, characteristic of the area or any other element that gives lucidity to the exhibition area.

The assembly of the demonstration plots allowed the farmers to evaluate the behavior of the varieties collected in the soil and climatic conditions of the farm where the assembly was carried out.

Diversity fairs

A fair of diversity is nothing more than those meetings of farmers, plant breeders, political decision-makers, germplasm bank preservers and leaders of peasant organizations, among others, who in fields, previously prepared for such purposes, pursue the fundamental purpose of contributing to through the participatory selection of accessions to maintenance and increase of the biodiversity of species and accessions of crops of economic interest for the farmers, so that the needs of family consumption and commercialization are satisfied as sources of income of new resources.

Diversity fairs are in essence an alternative in which breeders or farmers themselves give access to genetic diversity from formal and informal seed systems.

The Agrobiodiversity Fairs are executed according to the Methodological Guide for their organization and development (18).

The Agrobiodiversity fairs were an efficient tool to increase genetic diversity with wide acceptance in the communities; they were also an important strategy for the conservation of materials in danger of loss and an extension of the demand spectrum of the farmers in terms of diversity. .

4. Peasant experimentation

The main goals of peasant experimentation are:

- Select at the farm level the varieties that best adapt to their edaphoclimatic conditions.
- Find alternatives, which based on the increase in diversity, allow for better yields, lower production costs and decrease the incidence of pests and diseases.
- Search joint alternatives between technicians and farmers that allow obtaining new varieties or acquiring technologies that allow increasing their productions and their profits.
- Recognize the knowledge and capacity of farmers in terms of experimentation and diversity management.
- Establish new farmers' associations united around diversity and experimentation.

Once the farmers selected the materials of their interest in the diversity fair, one of the steps that ensured the positive impact and the credibility of the whole process was the delivery of the seeds selected by the farmers during the fair, for this they held seed delivery workshops, where all farmers who participated and selected at the fair were invited and the seeds were delivered formally. Later the farmers took the selected materials to their farms and together with the technicians and researchers they developed experiments with the purpose of analyzing the response of the selected materials in their specific conditions.

Researchers and farmers jointly designed the experiments to be carried out these should be aimed at improving aspects of interest to farmers. As each culture has its specificities when designing the experiments it is necessary that there is a constant monitoring of a technical team specialized in the crop in such a way that the problems that arise can be evaluated as a whole and find a solution.

This local experimentation allowed the complementation of the practical and empirical knowledge of the farmers and the theoretical-technical of the researchers, resulting in the obtaining of an important number of varieties with adaptation to the specific conditions that allowed them to obtain acceptable yields. This mutual work also allowed an exchange in both directions, where farmers learned from researchers and vice versa, where all acquired knowledge and experience from practice.

The results of each experiment mounted on farmers' farms were discussed between them and the researchers or technicians in a workshop prepared for that purpose; in this workshop the results of the experimentation of the farmers are presented and the fulfillment of the objectives defined as a whole at the beginning of this stage is analyzed.

In addition to the four basic stages of Participatory Plant Breeding in Cuba, other tools were used that allowed the PPB to constitute a successful process, these tools were:

- Learning in action according to interests
- Farmers schools
- Innovation Festivals
- Exchange visits
- Coexistence
- Capacity building of students in local innovation scenarios
- Creation of local seed banks

CONCLUSIONS

Participatory Plant Breeding contributed to the conception of an alternative and decentralized seed system, adapted to the new rural conditions of the country and able to produce seeds adapted to local agro-systems, involving small rural farmers in scientific research for the first time in the recent history of Cuba's agricultural science and technology system.

The implementation of the methodology increased Agrobiodiversity in the areas where it was implemented, as well as increasing the productivity of small rural farmers thanks to the dissemination of varieties adapted to local agrosystems.

The program stimulated agricultural research in Cuba, making part of the research community appreciate the advantages of participatory research and enhanced the capacity of farmers to create technologies and experiment with varieties in the search for their own solutions adapted to their living conditions.

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