CHARACTERIZATION OF LOCAL BEAN AND MAIZE SEED SYSTEMS OF LA PALMA, PINAR DEL RÍO

Sandra Miranda✉, Daniela Soleri, Rosa Acosta and H. Ríos

ABSTRACT. Local maize and bean seed systems were characterized in "El Tejar-La Jocuma" community, as part of a diagnostic stage from the participatory plant breeding program through farmers'surveys. Farmers produce, exchange, select and conserve seeds by apparently maintaining and preserving diversity. They have little access to seeds derived from formal system, their primary seed source being exchanged with other farmers within the community. Most farmers have only one maize landrace, «criollo» cv, that has been selected and maintained by local farmers for many years. This variety produces moderate yields under low input conditions and shows resistance to the primary diseases and pests of maize in the area. In contrast, beans present high varietal diversity on farm, although there is a lack of resistant genes to diseases like rust, whose occurrence has exponentially increased in the last five years. Facilitating farmers continuous access to new varieties may be an important means to support the incorporation of disease resistant genes into the local seed system via gene flow.

Key words: maize, kidney beans, seed, plant breeding

RESUMEN. Como parte de la etapa de diagnóstico del programa de fitomejoramiento participativo (FP), se realizó una caracterización de los sistemas locales de semillas de maíz y frijol de la comunidad El Tejar-La Jocuma. La información se obtuvo por medio de encuestas a los agricultores. El estudio mostró que el acceso de la comunidad a semillas provenientes del sistema formal es escaso, por lo que la producción, selección y conservación de semillas son realizadas por los propios campesinos en sus fincas y el intercambio ocurre fundamentalmente entre campesinos y con variedades de la misma comunidad. En el caso del maíz, los campesinos siembran fundamentalmente un tipo criollo local, que ha mostrado ser resistente a plagas y enfermedades, a través del tiempo, en condiciones de bajos insumos. En el caso del frijol, se observó que en la actualidad las fincas poseen una diversidad varietal relativamente alta. Esta diversidad, al parecer, no garantiza la presencia de genes de resistencia a enfermedades como la roya, que han tenido en los últimos años un aumento exponencial, según la percepción de los campesinos. Este estudio mostró la necesidad de facilitar a los campesinos de esta comunidad un acceso regular de nuevas variedades, que garanticen un flujo constante de genes que permitan el acceso a genes relacionados con la resistencia a enfermedades.

Palabras clave: maíz, frijol, semillas, fitomejoramiento

INTRODUCTION

Local seed systems are those in which farmers, as main actors when managing phytogenetic resources, preserve, produce, select and exchange seeds, either in improved or local varieties of different agricultural crops. Varietal diversity in such systems tends to be high and production activities, as well as seed selection and exchange are linked to agricultural production and socioeconomic processes in farmers' communities (1). On the other hand, formal seed system is the one where scientists, in addition to public and private institutions, mainly manage phytogenetic resources. The conventional plant breeding system, as a component of the formal seed system, has focused on obtaining and releasing varieties of general adaptation, stimulating yield increase by using high agrochemical inputs, and reducing agrobiodiversity (2). Conventional plant breeding has access to diversity in different parts of the world and can generate, as well as recombine characters through different methodologies, such as: breeding by means of mutation, somaclonal variation, hybridization, among others. At first, these methodologies were structured for supplying the demands of homogeneous agroecosystems under high input conditions (3). However, conventional plant breeding presents several limitations in small-scale agricultural systems that are developed in unstable and marginal environments, which have brought about low agroeconomical and socioeconomic impact in such systems (4). In this model, varieties are obtained in experimental stations under controlled conditions and high levels of energetic inputs, which are not usually found in farms. Therefore, materials obtained from the conventional plant breeding system are not necessarily adapted to marginal or low agrochemical input environments (2).

Sandra Miranda and Rosa Acosta,Researchers; Dr. H. Ríos, Senior Research Assistant from the Participatory Plant Breeding Group, pertaining to Crop Genetics and Breeding Department, National Institute of Agricultural Sciences, PO Box 1, San José de las Lajas, Havana, Cuba, CP 32 700; Dr. Daniela Soleri, Researcher from the Environmental Studies Program, University of California, Santa Barbara

✉ sandra@inca.edu.cu, cucusandra@yahoo.com

Moreover, farmers and breeders usually differ in their selection criteria; that is why, varieties sometimes present features of no interest for growers. Thus, varieties obtained through conventional plant breeding are genetically homogeneous, which is not a necessity for small-scale farmers, and such system does not provide alternatives for intravarietal selection. On the contrary, materials presenting genetic diversity could be more appropriate for unstable and heterogeneous environments, since they present buffer capacity, as well as an increase in the adaptation potential, providing several choices of selection to farmers (4).

Due to those limitations, farmers structured a system of Participatory Plant Breeding (PPB) in the 80's, as an alternative for improving plants and increasing variety adoption. By means of such system, breeders and growers work together in genetic breeding (5, 6).

One of the main challenges of PPB is precisely making a single system by joining the formal and local seed systems. This facilitates the continuous access to varieties of both agroecosystems, favoring specific adaptation of varieties as a way of increasing yield and comfort to participants, based on a higher diversification in the agroecosystems (3). In this sense, PPB programs have been developed in recent years, which main objectives are: obtaining higher and more stable yields, achieving faster variety release and dissemination, improving biological diversity and preserving germplasm. Other purposes include identifying efficiently what the users need, increasing crop profitability, strengthening capacities as well as generating knowledge for agricultural communities and formal systems of research and development (7). In many of such applications, PPB have presented great impact in recent years, not only in heterogeneous environments (2, 9), but also in homogeneous ones (9).

As a general rule, investigations related to PPB present an initial stage of diagnosis or characterization of local seed systems, regarding management of phytogenetic resources in the participanting communities. This allows to determine both, local problems before applying PPB and the points where plant breeding should be applied, as well as making an inventory of phytogenetic resources, managed by local seed systems (9). The next stage after diagnosis consists of giving the community access to new varieties of the crops as such. In Cuba, this access is provided by means of diversity fairs, where growers have the chance of selecting varieties, within a great quantity of materials, according to their particular interest (10). Then, during the third stage, farmers compare behaviour of new and old varieties in their on farms, by means of field experimentation, which allows them to determine in practice the varieties that will be preserved, spread or put aside.

The present article focuses on characterizing local seed systems, as part of the diagnosis, in terms of management and conditions of bean and maize phytogenetic resources, before applying PPB in «El Tejar-La Jocuma» La Palma, Pinar del Río.

MATERIALS AND METHODS

The present research was carried out in El Tejar-La Jocuma community, located to the north of La Palma municipality, Pinar del Río.

Such community, chosen as subject of study due to its typical heterogeneous environment, embraces 10 km^2 and is characterized by a very irregular topography, presenting relieves with wavy flats, naked- accumulative dissections, as well as with slates and sandstones. The relief is relatively young and the representative soils are brown and fersialitic (11). Forty-nine peasant families, grouped in several credit and service cooperatives (CSC) make up the selected community. Rice, bean, maize, cassava, dasheen and tobacco are the main crops and the modernization level of production systems is low, regarding irrigation and mechanization systems. Historically, farmers from such community have produced food in their farms, under low energetic input conditions (12), presenting little dependence on formal seed systems.

The studied crops were bean and maize, due to their importance for economy and nutrition, as well as to be possible models for studying autogamous and allogamous crops in those communities.

Bean and maize are cultivated by every family in the community, seeding each crop twice a year. January is the most favorable season for seeding bean in the region, as well as the moment in which the largest areas are sown. This crop is also seeded in September, but in small quantities, for multiplying seeds. On the other hand, maize is sown in May-July as optimal season, as well as in January, via intercropping with bean.

Information used in this work was mainly collected through a survey of 42 questions, formulated by a multidisciplinary team (breeders, sociologists, biologists and biochemists). The elaboration of the survey was based on recognition visits, individual interviews, as well as on reports about agrobiodiversity management, which were previously prepared (12, 13, 14). The questions mainly focused on bean and maize seed flow and management, taking into account: a) seed origin, b) frequency of introduction of seeds which do not belong to the farm, c) times for selecting seeds, d) methods for seed preservation, e) average of cultivated varieties by farmers during the last five years, f) farmers' opinion on disease attack in recent years.

This survey was applied on March 19-26, 2001 to eight women and 23 men, belonging to 23 families, which represent 47 % of the community. The survey embraced all the information concerning bean crop and part of the information about maize. The remaining information regarding this last crop was obtained through previous interviews, applied to 20 farmers from the community in the period between the days 2 and 11 of November, 2000.

RESULTS AND DISCUSSION

Most of the seeds used for sowing in both cultures belong to harvest from the previous year (Figure 1). There is no local seed market in this region and the access to formal seed system is limited. However, in addition to keeping seeds for the next sowing, a great number of farmers introduce new seeds from other farms, by exchanging with neighbors and relatives from the surrounding areas.

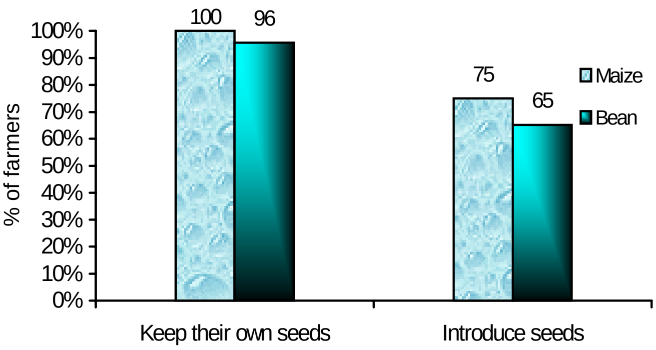

Figure 1. Origin of bean and maize seeds in farms

Such seed exchange is a usual practice in the zone and its purpose varies according to the crop. In the case of bean, seed introduction has been reported due to loss of the seed or its quality, as a result of yield reduction in the variety and/or variation of other morphoagronomic features, which is known as «variety degeneration». Another objective for exchanging seeds is the interest for experimenting with new varieties in their farms.

On the other hand, regarding maize, the introduction is made for «refreshing» seeds, which means that farmers get seeds from near farms and present the same «Criollo» local type together with their own ones. Likewise, some farmers have occasionally shown interest in other maize varieties, different from the local «Criollo» type («mexicano», «argentino», «gibara», «colorao chiquito», «amarillo» and «rosita»), introducing them in the zone. However, growers have shown poor interest in such varieties, rejecting them quickly. It is curious to note that, different from bean crop, maize presented no varietal degeneration (variety change in phenotype by the pass of time), according to confirmations made by farmers.

In most of the cases, frequency for introducing seeds in farms oscillates between one and five years for both crops (Figure 2), generating a strong internal gene flow in the community. However, in many cases, this fact does not imply access to new genes since farmers work with the same varieties of the region. As an exception in such phenomenon, there is a short-season variety of black beans that has been recently introduced in the zone by farmers, who were directly linked to a conventional program of seed spreading through formal seed system, less than a decade ago. These farmers made such variety available for the remaining farmers in the zone through the usual flow among growers. This variety has been broadly adopted, since it presents a shorter cropping cycle, which is convenient for avoiding losses brought about by rain, when bean remains in the field for a longer time before harvest, as it happens in long-season varieties, traditionally cultivated in the studied zone. As to maize, sometimes, introduced varieties from other regions were not accepted and spread by growers, who preferred the «Criollo» local type.

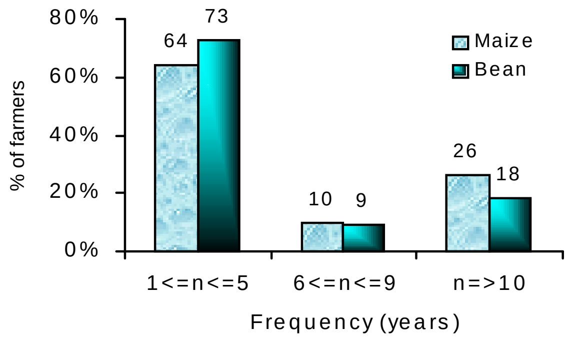

Figure 2. Frequency for introducing bean and maize seeds from other farms

In both crops, most of the farmers evaluate their varieties continuously, regardless of whether they are new or old and, according to their behavior, farmers decide which of them are to be preserved or not. This is the first level of selection. The second level consists of selecting, within each variety, seeds to be used in the next sowing (15). In «El Tejar-La Jocuma» community, most of the farmers usually applied such level of selection to both crops, using different selection strategies.

Regarding bean, the selection is mainly performed before harvest, when the most vigorous and/or healthy groups of plants are selected directly in field and, afterwards, submitted to harvesting and threshing individually. A smaller group of farmers selects the best «cufflinks»[1] after harvest for threshing them separately. There is also a small amount of growers that select in these two times, whereas others who do not select (Figure 3), but harvest and thresh the entire bean at the time of sowing. Then, they take the needed amount of seeds without making a selection.

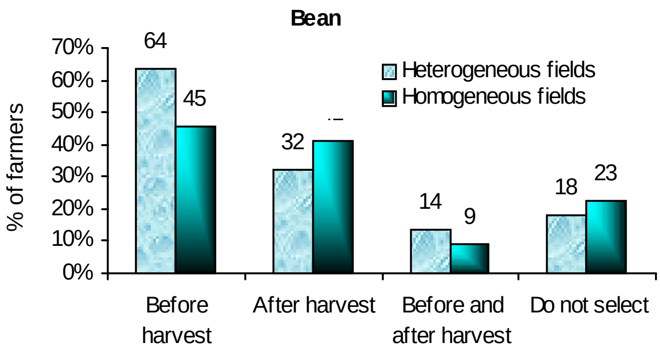

Figure 3. Times for selecting bean

[1] In agricultural terms, a cufflink is a group of plants, which are tied up at the time of harvest for performing a more comfortable storage and transfer of dry plants, which will be threshed afterwards

It is interesting how the selection patterns vary, according to filed appearance. In years when field appearance is homogeneous, a less strict selection is made and the amount of growers who select before harvest is smaller. On the other hand, when field appearance is less regular the selection is stricter, since there is a higher percentage of growers selecting the best groups of plants in the field.

In autogamous plants, like bean, low levels of interbreeding among varieties allow them to keep their distinctive features. However, seed selection by farmers is a practice that could influence such features (16).

In this kind of plants, where hybridization of varieties occurs at low levels, selection could be also important for identifying and separating any new population or variety, originated by spontaneous hybridization or mutation, in an attempt of creating a new type. This process could be important for increasing diversity in autogamous crop (17).

In the case of maize, all growers select seeds and, differently from bean, field appearance has no influence on the time for selecting. This is owing to the fact that selection is never performed in the field but after harvest. Most of the growers practice seed selection just after harvest, choosing the best cobs (already harvested) and storing them apart. The remaining growers select before sowing, choosing the best cobs from the ones that were left after consuming (Figure 4). In this sense, their selection patterns are mainly based on maize cob features.

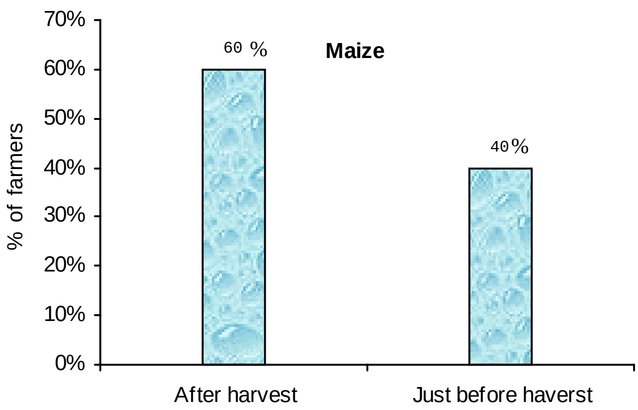

Figure 4. Times for selecting maize

In the case of «criollo» maize, which was cultivated by every farmer to answer the survey, as well as exclusively in most of the cases, the cob should be full of grains and present good closure. There are two main phenotypes within the «criollo» local type, which can be distinguished by the cob straw color that could be purple or white, as well as by other phenotypic differences in the plant. Regarding such diversity, farmers are able to preserve the features of their interest in the «criollo» variety by means of selection, which is an important activity for keeping the phenotypic solidity of any variety of allogamous crops, like maize (17). In the latest years, farmers from the region tend to select cobs with purple straw, associating them with resistance to drought and pests.

Seed storage of any of the two crops was not reported as an important problem in the community, because growers do not need to store high amounts of seeds, according to the sowing areas at their disposal. Most of the farmers use small amounts of agrotoxic products, mainly parathion, for warranting grain preservation, in addition to other alternatives like drying to sun and the use of smoke, which are feasible choices for such grain quantities. Alternatives used by the farmers are presented in Table I, where insecticides are the poorest method used, which could be linked to the possible grain tolerance to pest attack. Also maize is commonly preserved with straw that, due to features of the «criollo» type, makes grains less available to insects.

Table I. Methods for seed preservation

	Bean (n=22)	Maize (n=20)
Treatment for seed storage	Insecticide=95 % (21) With threshing remains= 5 % (1) Sun= 18 % (4) Insecticide + sun= 18 % (4) Nothing= 5 % (1)	Insecticide= 85 % (17) Smoke= 60 % (12) Insecticide+smoke= 45 % (9)
Seed storage way	Grains= 100 % (22)	Cobs= 82 % (14) Grains= 18 % (3)

The ability of these farmers for selecting, exchanging and preserving seeds has allowed them to manage a relatively high varietal diversity of bean in their farms, compared to more technical systems (18). At the community level, bean diversity is more difficult to determine with accuracy, without making an inventory of the varieties in the region through an agromorphologic or molecular evaluation of materials, since the name farmers give to varieties could hide the real diversity. This may be because, several names are sometimes given to the same variety and, some other times, different varieties are named the same (19).

It is interesting that the concept of variety managed by farmers is different according to bean color. Black and white bean varieties must keep uniformity as to grain color and size, for them to be accepted by farmers.However, in the case of bay beans, as well as in red ones, the farmers sometimes tolerate certain heterogeneity concerning grain color and size, within a same variety.

During the last five years, the average analysis of bean varieties per grower did not show significant differences among years for any bean type, from the statistical point of view (Figure 5). However, the average of red and white bean varieties tends to decrease, showing a reduction in the number of farmers who sow varieties presenting such colors (from 57 to 48 % and from 52 to 35 %, respectively). In the case of black beans, due to their economical and culinary importance in Cuba, every farmer has at least one variety and the same tendency is not seen in red and white beans. On the other hand, varieties of bay beans are less cultivated in the zone. However, through the survey, many farmers expressed their interest in including this type of bean within their varieties. Bay beans are mottled and, after being cooked, they present the appearance of red beans.

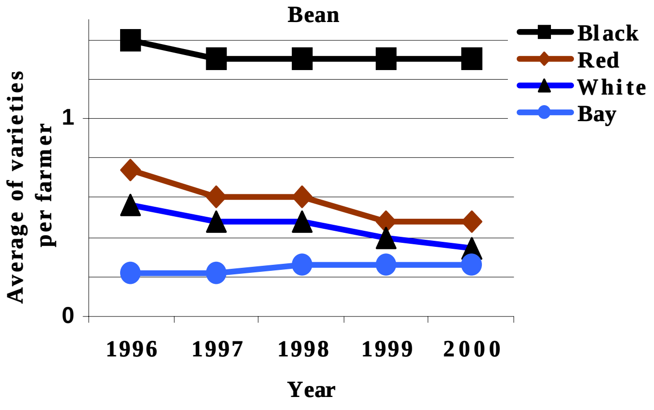

Figure 5. Average of bean varieties in El Tejar-La Jocuma during the last five years

Regarding maize, during the last five years, most of the farmers have only sown their local «criollo» type variety; therefore, the average of maize varieties per farmer during all these years is close to 1 (Figure 6). In previous years, some farmers used to cultivate other foreign maize varieties («mexicano», «argentino», «gibara», «colorao chiquito», «amarillo» and «rosita»), but they put such varieties away during the last two years and, currently, the «criollo» type is almost the only sown variety.

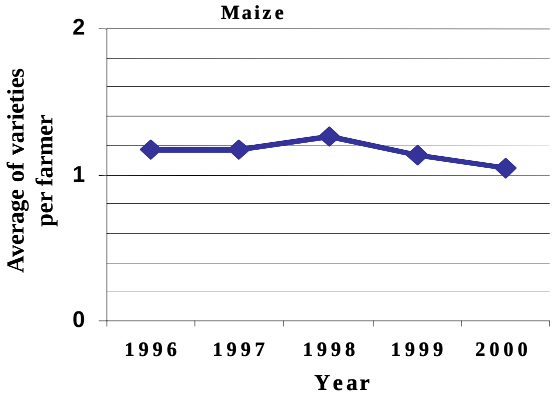

Figure 6. Average of maize varieties in El Tejar-La Jocuma during the last five years

Considering the fact that only the «criollo» local type is cultivated in the zone, it could be thought that diversity is low for this crop. However, significant differences have been reported as to quantitative and qualitative characters, within and among the populations managed by each grower (20), implying that such variety presents a high intravarietal diversity. On the other hand, this suggests that the maize sown by each grower presents features that make it different from the rest, regardless of the allogamy conditions under which the crop is developed, and of the usual maize seed exchange produced among growers.

Regarding pests and diseases during the last decade, 90 % of the growers consider that pest and disease attack has been always low for maize crop. However, concerning bean, they have noticed a substantital increase in pest occurrence, mainly rust, from the last five years (Figure 7), which constitutes an important phytosanitary problem for growers in the region.

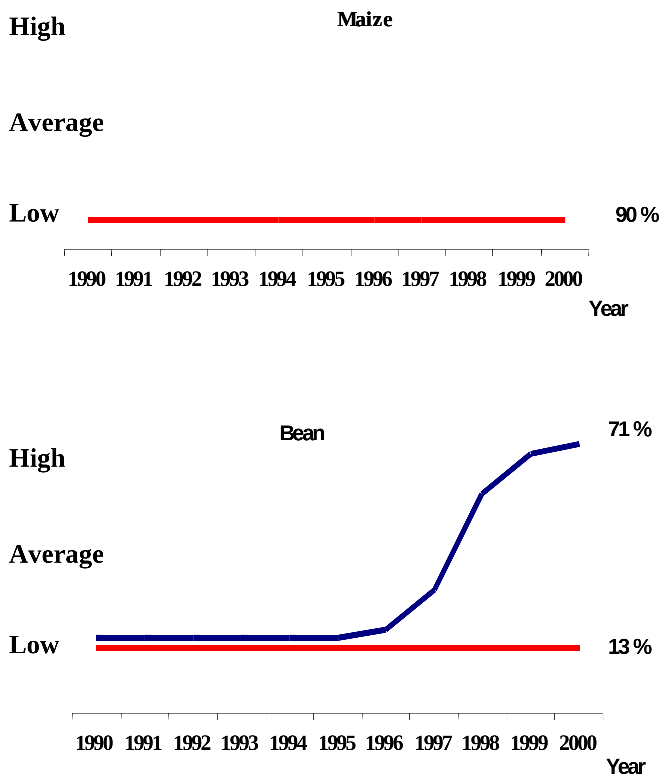

Figure 7. Farmers' estimation regarding disease occurrence during the last decade (n = 31)

Growers in the region carry out an integral management of genetic diversity in maize and bean crops. They produce, exchange, select and preserve seeds, keeping the relatively broad genetic diversity in their farms for these crops. In the specific case of maize, growers have been able to keep, through selection and exchange, the features of «criollo» type varieties that produce stable yield under low fertilizer and irrigation available conditions. This «criollo» type has also shown resistance to pests, such as moth, which is a very convenient feature in view of the low insecticide availability in the region.

Concerning bean, a great diversity currently exists on farms, no matter the decreasing average of red and white beans in the latest years. In this crop, selection and exchange within the community have not warranted the incorporation of resistant genes to diseases, mainly rust, which constitutes the main current problem for growers.

The formal seed system is provided with useful material for facing such problem. However, there is poor contact with the system in the region. Under these conditions, PPB is an alternative that could constitute a bridge between both systems, making the new material for managing bean and maize available to farmers in the community, by means of the so-called diversity fairs. Therefore, farmers can select varieties of their interest out of a great amount of material, seeded together and through agricultural experimentation, where farmers can establish a comparison between new and old varieties under their real conditions. Moreover, PPB allows putting «criollo» local type varieties, appropriate for the prevailing low input conditions in Cuba nowadays, at the disposal of farmers from other regions.

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Received: July 19, 2002
Accepted: December 10, 2002