IMPACTS ON FARMER EXPERIMENTATION IN AGRICULTURAL AND LIVESTOCK COOPERATIVES OF HAVANA

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ABSTRACT. The present challenge of plant breeding approaches to strengthen varietal flow in our national agriculture by means of more diverse, decentralized and low agrochemical input productive systems. Farmers' active participation in seed selection, experimentation, multiplication and preservation is a viable choice to increase yields on the basis of a wider varietal diversification. Producers' varietal selection also strengthens its adaptation to the environmental and socioeconomic conditions of Cuban productive systems. The lack of an improved seed has given rise to a peasantry seed supply system based on their own seed production of different crops, either for consumption or the market. Thus, there is a need to implement some plant breeding ways to encourage the capacity of preserving, selecting and supplying seeds to farmers, so that helping to establish diversity by putting into practice some choices providing a fair participation balance between farmers and plant breeders, which would enable to complement the current Cuban plant breeding system. Both, spontaneity and creativity developed by farmers from different agricultural production cooperatives of Havana, after attending several biodiversity fairs on maize and bean crops celebrated at the National Institute of Agricultural Sciences, proved farmers' good choice of the right genotypes for sustainable conditions. Results of some study cases are also presented, which showed how positive biodiversity is through fairs and farmers' experiments to increase maize and bean production and diversity in the agricultural productive cooperatives of Havana.

Key words: plant breeding, rapid rural appraisal, producers' cooperative, alternative agriculture

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RESUMEN. El actual reto del fitomejoramiento se enfoca a fortalecer el flujo de variedades en una agricultura nacional con sistemas productivos más diversos, descentralizados y de bajos insumos agroquímicos. La activa participación de los campesinos en la selección, experimentación, multiplicación y conservación de semillas es una alternativa viable para el aumento de los rendimientos sobre la base de una mayor diversificación varietal. La selección por los productores fortalece a la vez la adaptación de variedades a las condiciones ambientales y socieconómicas de los sistemas productivos cubanos. El déficit de semilla mejorada ha dado lugar a un sistema de provisión de semilla del campesinado basado en su propia producción en los diferentes cultivos para el autoconsumo o mercado. Lo anterior permite asumir la necesidad de implementar formas de fitomejoramiento que estimulen la capacidad de conservar, seleccionar y distribuir las semillas de los campesinos, contribuyendo a un fomento de la diversidad, sobre la base de la puesta en práctica de alternativas que contemplen un justo balance entre la participación campesina y la de los fitomejoradores, lo que permitiría una complementación del sistema actual de fitomejoramiento cubano. La espontaneidad y creatividad desarrollada por campesinos de varias cooperativas de producción agropecuaria de La Habana, posterior a su participación en las ferias de biodiversidad desarrolladas en el Instituto Nacional de Ciencias Agrícolas en los cultivos de maíz y frijol, demostró lo acertado de la selección de los mejores genotipos para las condiciones de sostenibilidad. Se presentan resultados de algunos casos de estudio, que demuestran lo positivo de la diversidad por medio de las ferias y la experimentación campesina, con resultados concretos de aumento de la diversidad y la producción de las especies de maíz y frijol en cooperativas de producción agropecuaria de La Habana.

Palabras clave: fitomejoramiento, diagnóstico rural rápido, cooperativa de productores, agricultura alternativa

INTRODUCTION

The current agricultural development demands new approaches in order to provide more possibilities of solving population's necessities, which increase steadily. At the same time, it is necessary to use sustainable systems, from a productive, ecological and economical point of view, which should also be socially fair and acceptable in cultural terms (1).

Amidts of the current economical restrictions and intending to reduce such impressive damages, the Cuban government has adopted some measures, such as giving land to thousands of smallholders, creating new cooperatives starting from big enterprises and strengthening the existing cooperatives, mainly those of credit and services (CSC). At the same time, it promoted concepts of sustainable and urban agriculture to the limit and activated production of biopreparation for controlling pests, as well as biofertilizers for plant biological nutrition. However, in nutritious crops, there is still lack of seeds with high quality that should present good adaptation to different existing sustainability conditions along the country nowadays. Obtaining such seeds would not be possible without farmers' active participation not only in seed production, but also in creating genotypes responding to specific adaptation to thousands of field conditions existing in Cuba (2, 3, 4). This active participation of farmers is known as participatory plant breeding (PPB) and its variants are being studied for their further promotion (5).

Diversity fairs constitute the perfect way of providing farmers with exploitable diversity. Farmers not only participate in these events, but also have the possibility of selecting material which, according to their criteria, presents good adaptation in their farms, having also the possibility of taking such material to their farms and choosing the most adapted one. Material in the fair should be commercial and pre-commercial, collected in different zones of diversity as well as taken from *ex sito* germplasm banks.

Results from some study cases are also presented, in order to evaluate the positive side of introducing diversity through fairs and peasant experimentation, so that concrete results are obtained on diversity increase and production of maize and bean species in agricultural cooperatives, located in Havana. The effect of genotype-environment interaction will be also evaluated, which strengthens the principle of peasant experimentation.

MATERIALS AND METHODS

Maize fair. The collected biodiversity was sown during winter seasons at the National Institute of Agricultural Sciences*. No irrigation, phytosanitary control or fertilization was applied. Two blocks were formed, each line represented by a furrow, achieving 70 different types, which included four commercial varieties and three Cuban hybrids. Thus, a portion of land was planted with a seed mixture, in order to introduce newer and very diverse blood to each type. When the fair was developed, the portions of land were fully physiologically ripened.

Farmers from agricultural production cooperatives (APC) of Havana participated in the fair, four of them belonging to «Gilberto León» APC, located in San Antonio de los Baños.

The fair was carried out in April, 1999; each farmer selected the best five lines according to his criteria, also preselecting five individual plants from the mixed field. Afterwards, the selected material was sent to each farmer.
Bean fair. The collected biodiversity was sown during late seasons applying three survival irrigations, without phytosanitary control or fertilization. Two blocks were formed: each line represented by four 4-m-long furrows, obtaining 80 different types that included Cuban commercial and pre-commercial varieties. While the fair was developed, lands were fully physiologically ripened.

The fair was carried out in agricultural areas at the National Institute of Agricultural Sciences on April 6, 2001. Farmers from APCs of Havana, as well as others from CSCs Credit and Service Cooperatives of La Palma were chosen. Each farmer selected the seven lines of his preference.

Study case: "Gilberto León" APC located in San Antonio de los Baños

Maize case

The 15 maize lines selected during the first maize fair, as well as an amount of kernels from selected cobs in the mixed field during such fair, were given to the APC in June, 1999.

As a result of attending the fair and delivering farmers' selected material, the following ones were introduced to the APC simultaneously (Table I): three commercial hybrids, six accessions collected in La Palma, Pinar del Río, six accessions collected in Catalina de Güines, Havana, as well as a group of 15 grains from the mixed area. The simultaneous introduction of a wide diversity presenting high agricultural quality was achieved in maize crop, this material being under the supervision of Feliz Chávez González (Felo), who works in the APC. By means of diversity fairs, a wide diversity was introduced to maize and bean species in farmers' lands. Fairs are real and efficient interfaces for introducing good quality diversity from the formal and local systems; therefore, they constitute a link between both systems that allow strengthening the local one. This is a perfect way of spreading the useful genetic diversity (3).
First selection stage in the APC. 15 lines, selected by participants during the fair, were sown on July 10, 1999, each one in a 200-m-furrow, intercropping kernels obtained from the 15 cobs collected in the mixed area, forming 34 furrows as a result. The field was under sustainable conditions and free from grass weeds.

Eighty days after sowing, maize was beat down to a great extent by the influence of strong wing and rain and, after the following 20 days, the crop was even more affected by the influence of «Lily» cyclone.

*A year before developing the fair, both collections were performed by Pierre Richard Lafond and Michel Martínez, advised by Gladys Verde, Humberto Ríos and Rodobaldo Ortiz, belonging to the Agrarian University of Havana and the National Institute of Agricultural Sciences, respectively.

Table I. Selected material by the four farm participants

Accesion key	Selected lines Origin	Number of the selected cob in the mixed field
R~2	"Liliana Dimitrova" Research Institute	2
R~3	"Liliana Dimitrova" Research Institute	10
R~4	"Liliana Dimitrova" Research Institute	19
13	La Palma	22
14	La Palma	29
20	La Palma	45
21	La Palma	47
26	La Palma	50
27	La Palma	53
48	Catalina de Güines	72
50	Catalina de Güines	80
51	Catalina de Güines	83
52	Catalina de Güines	126
55	Catalina de Güines	145
70	Catalina de Güines	146

The field was harvested in November 1999, selecting the best cobs with no influence of rain and presenting good closure, without taking into account their lines of origin; 250 kg of seeds were obtained.

Second selection stage in the APC. From March 10 through 14, 2000, sowing was performed in the field 33 of the APC, with an 8.05-ha area. Thirty 200-m-long furrows were selected to go on with the selection process and almost 300 000 edible corn cobs were harvested in the rest of the field and sold afterwards. The 30 selected furrows provided more than 20 000 dry cobs.

Selection criteria applied: 1 000 individual plants were marked and harvested, as well as separately processed, for obtaining an elite foundation seed population. The following characters were considered: mid-high plant with good development, free from moth (*Spodoptera frugiperda*), cob development, height and closure and, when taking straw away in the dump, cobs with small kernels were removed; plant and cob colors were not taken into account. 1 319 kg seeds were obtained (1 227 kg commercial seeds and 91 kg foundation seeds).

During this stage, a parallel comparison was established between the improved line in the APC and a Cuban hybrid; both of them were seeded in continuous fields and harvested as green corn.

Third selection stage in the APC. During spring seasons (March-May, 2002), 65 maize hectares were seeded using APC's variety. The field for obtaining seed was sown with foundation seed obtained during the preceding cycle, where 1 000 plants for selecting foundation seeds were marked, achieving 1 863 kg seeds (1 818 kg commercial seeds and 45 kg foundation seeds).

Fourth selection stage in the APC. About 72 ha were seeded using APC's variety during spring season in 2002.

⌖ **Bean case**

The 13 bean varieties, selected by farmers from "Gilberto León" APC during the bean fair, were delivered to them in August, 2001.

First bean selection stage in the APC. 13 varieties were seeded on September 26, 2001 during early seasons, each one in a different sized furrow according to the amount of seeds delivered; three bean furrows were intercropped, separated by 90 cm, in a new one of plantain. Harvest of the latest varieties finished on December 27; all varieties were superior to the ones used in the APC.

A workshop was developed on January 8, 2002, where results of the early bean sowing in "Gilberto León" and "Jorge Dimitrov" APCs were discussed and the material was exchanged.

Second bean selection stage in the APC. On January 18, 2002, 20 varieties (13 from early sowings in the APC and seven from exchanging with another cooperative) were seeded for their evaluation during late sowings. Every three bean furrows, one of maize was intercropped, leaving 80 cm between furrows.

With the purpose of evaluating the effect of season on varieties, the behavior of different varieties, belonging to early and late sowings, was represented. Thus, a test for determining differences among means with inequal number of individuals was applied for comparing the mean value of each season in each cooperative.

An analysis of Additive Main Effects and Multiplying Interactions (AMMI) was applied to estimate genotype-environment interaction (6, 7).

Likewise, for comparing the effect of the technology used by each grower, the response of varieties simultaneously evaluated in both cooperatives, during early and late sowings, was represented.

Also, the existing diversity in each APC before and after applying participatory plant breeding was evaluated, as well as seed sufficiency as a result of introducing varieties in the cooperatives and the effort made for spreading them.

Study case: "Jorge Dimitrov" APC located in San Antonio de los Baños

⌖ **Bean case**

The 15 varieties selected by farmers from "Jorge Dimitrov" APC during bean fair, were delivered to them in August, 2001. Miguel Cruz Chávez, member of the cooperative, was in charge of leading material selection.

First bean selection stage in the APC. On October 2, 2001 in early sowing, 17 varieties (15 from the fair, as well as red and white beans used in the cooperative) were seeded, each one in two different sized furrows according to the amount of seeds delivered, leaving 60 cm between furrows.

Harvest of the latest varieties finished on December 27; all varieties surpassed the ones used in the cooperative.

A workshop was developed on January 8, 2002, where results of early bean sowings in "Gilberto León" and "Jorge Dimitrov" APCs were discussed and materials exchanged between them.

Second bean selection stage in the APC. On January 14, 2002, 22 varieties (17 from early sowings of APC and five

from exchanging with another cooperative) were seeded for their evaluation in late sowings.

RESULTS AND DISCUSSION

The main results from farmers' selection in two APC's of San Antonio de los Baños are presented below:

Study case: "Gilberto León" APC

⌖ **Impact of the created maize line**

1. Comparative result with a hybrid seeded in March 2000

Seeding was performed in adjacent fields, during the second half of March, 2000. Table II shows the comparative aspects considered by evaluative farmers of the APC.

Table II. Elements for comparing a hybrid and the developing "Criollo" line

Cuban hybrid	Felo selection
Excellent field preparation	Bad field preparation
Area 11 ha	Area 8 ha
High fertilization	Low fertilization (30 % hybrid)
Frequent and systematic irrigation	50 % irrigation with respect to the hybrid
Two pesticide applications	One incomplete pesticide application
High moth attack	Medium moth damage
High damage in dry leaves up to cob top	No damage
Long and thin cobs without closure	Medium to big cobs with good closure
Lowest yield – 30 %	Highest yield + 30 % compared to hybrid
Bitter flavor of the green grain	Sweet and tasty flavor

Although field preparation for the "Criollo" line was based on less energetic expenses and severity, fertilization represented only 30 % of the one used for the hybrid, irrigation reaching only 50 % of the one applied to the hybrid. The use of pesticides was much lower in the line. However, the hybrid was more intensively attacked by moth and the yield as well as quality were lower than the one presented by the line. Therefore, the comparison favored the line in all parameters. In this sense, the APC decided not to use hybrid seeds any more, but to promote the creation of its "Criollo" line "Felo".

2. Yield from "Felo" selection at different selection stages

Under sustainable production (neither fertilizers nor pesticides), yield of APC's created line has increased through different generations, with a tendency to stability at the fifth generation (Figure 1).

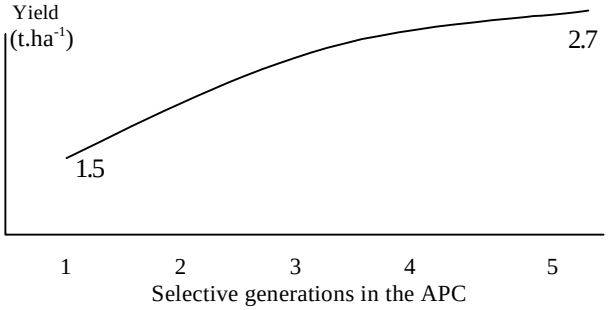


Figure 1. Relative yield of the line created by the cooperative from 1999 to 2003

3. Seeded areas of the APC over the latest years

Years	1999	2000	2001	2002	2003
Estimated seeded area	36	52	65	72	120
Seeded area by APC's own seed	0	10	65	72	120

This crop has gained importance by the APC production, where maize-sowing areas have trebled, since the APC produces its seeds from a selected line in the cooperative and such crop yield has increased. Less importance was given to maize crop before 2000 but, nowadays, it is the third crop in terms of importance among all crops seeded in the cooperative.

4. Farmers preference for "Felo" selection

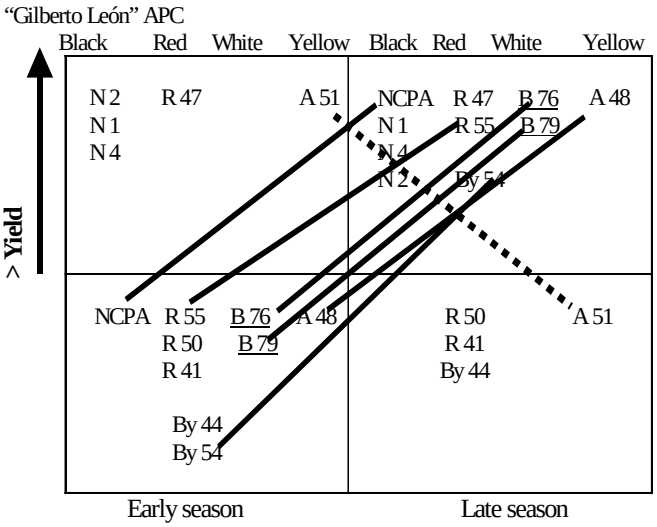
In a maize fair developed at the cooperative in March 2001, "Felo" line was selected by 47 participants, who were supposed to choose five lines of their preference among the existing 102. Likewise, in maize fairs developed in Batabanó and La Palma, Pinar del Río, in August 2002, such line was always among the favorite ones for participants, indicating its satisfactory behavior.

⌖ **Impact for introducing new bean varieties to the APC**

1. Effect of season on varietal response

A differential response of varieties is observed according to the season. There is a group of varieties presenting a stable behavior, but there are others presenting a highly differentiated response according to sowing season (Figure 2).

High interaction was observed between white and red varieties according to sowing season. In "Gilberto León" APC, there was a tendency to favor late sowing; most of the varieties showed good behavior. There was only one variety presenting good behavior in early sowing but became bad in late sowing; behavior of six varieties went from unsatisfactory to satisfactory in late sowing.



N~ Black, R~Red, B~White, By~Bay, A~Yellow
Underlined varieties come from the informal system

Figure 2. Effect of genotype-season interaction on sowing

It is seen in this figure that white 76 and 79, bay 54, red 55 and black varieties, which were used by the cooperative, went from an unsatisfactory behavior in early sowing to a satisfactory one in late sowing. It was also observed that yellow 51 variety showed a totally different response: it went from 130 % regarding mean of varieties in early sowing to 69 % in late sowing.

As it is seen in Table III, the late sowing was highly superior to the early one in this cooperative. There was a genotype (A51) that showed a different response from the rest, presenting a better behavior in early sowings than in late sowings.

Table III. Yield from evaluated varieties in early and late sowings in "Gilberto León" APC

Varieties	Kernel color	Yield (t.ha^{-1}) Sept/01	Jan/02	Difference Jan/Sept
N 1 CC 25 9	Black	0.94	1.46	0.52
N 2 Bolita 42	Black	0.99	1.13	0.14
N 4 ICA Pijao	Black	0.83	1.23	0.40
Negro CPA	Black	0.71	1.61	0.90
N 9 Tomeguin 93	Black	.....	0.26	~
R 47 Delicias 364	Red	0.82	0.91	0.09
R 55 Rosas	Red	0.32	0.62	0.30
R 50 Lagrimas Roja	Red	0.34	0.33	(0.01)
R 41Velazco largo	Red	0.33	0.48	0.15
R 42 CC 25 9 R	Red	.....	0.80	.....
By 44 M 112	Bay	0.31	0.43	0.12
By 54 P 2258	Bay	0.31	0.65	0.34
Nelson CPA G.L.	Bay	.....	0.31	.....
B 79 Sel. Sosita INCA	White	0.61	1.13	0.52
B 76 Sel. Tony P. La Palma	White	0.70	1.17	0.47
B 72 Chevere	White	.....	0.90	.....
B 77 Sel. Porro La Palma	White	.....	0.86	.....
B 73 Lewa	White	.....	0.87	.....
B 75 Sel.Sergio T.La Palma	White	.....	0.95	.....
A 48 Engañador	Yellow	0.45	1.20	0.75
A 51 P 186	Yellow	0.78	0.72	(0.06)
General mean		0.60 b	1.05 a	0.45 *

Commun letters do not differ significantly to p<0.05 %

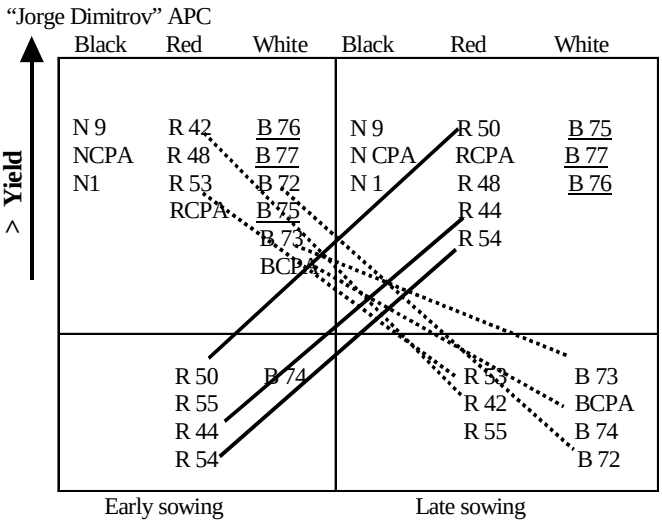
Study case: "Jorge Dimitrov" APC

⌖ Impact for introducing new bean varieties to the APC

1. Effect of the season on varietal response

In "Jorge Dimitrov" APC, there was a balance in the behavior of both seasons (Figure 3); behavior of five varieties became unsatisfactory in late sowing. There were three varieties showing unsatisfactory behavior in early sowing, which became satisfactory in late sowing, proving the importance of varietal management according to sowing season.

Generally, varieties from the informal system, represented only by white color, showed a satisfactory behavior during both seasons in this APC.



N~ Black, R~Red, B~White, By~Bay, A~Yellow
Underlined varieties come from the informal system

Figure 3. Effect of genotype-season interaction on sowing

These results show how diversity fairs can intensify the flow of seeds from different varieties belonging to formal and informal sectors, since it is the need for managing specific genotypes for early and late sowings.

Early sowing in this cooperative presented a tendency to a higher yield potential than the one recorded in the previous APC during the same season (Tables III and IV), even though at the beginning of the cycle, the first sowing was affected by "Michelle" cyclone. The adjacent effect of older plantations in late season influenced the result to a higher extent, due to the appearance of diseases and the great level of harmful insects that reduced yield of different genotypes.

Tabla IV. Yield from evaluated varieties in early and late sowings in «Jorge Dimitrov» APC

Varieties	Kernel color	Yield (t.ha^{-1}) Sept/01	Jan/02	Difference Jan/Sept.
N 1 CC~ 25~ 9	Black	0.73	0.80	0.07
N 9 Tomeguin 93	Black	1.31	1.19	(0.12)
N 2 Bolita 42	Black		0.73	
N CPA	Black		0.99	
R 42 CC~25~9~R	Red	1.30	0.50	(0.80)
R 44 M~112	Red	0.28	0.62	0.34
R 47 Delicias 364	Red		1.09	
R 48 Enganador	Red	1.28	0.82	(0.46)
R 50 Lagrimas Rojas	Red	0.84	1.09	0.25
R 53 P~219	Red	1.10	0.58	(0.52)
R 54 P~2258	Red	0.28	0.62	0.34
R 55 Rosas	Red	0.28	0.36	0.08
R 41 Velasco Largo	Red		0.36	
RCPA	Red	1.04	0.94	(0.10)
B 72 Chevere	White	1.39	0.59	(0.80)
B 73 Lewa	White	1.15	1.23	0.08
B 74 Pilon	White	0.56	0.65	0.10
B 75 Sel. Sergio T. La Palma	White	1.15	1.49	0.34
B 76 Sel. Tony P. La Palma	White	1.68	0.96	(0.72)
B 77 Sel. Porro La Palma	White	1.48	0.98	(0.50)
B 79 Sel. Sosita INCA	White		1.45	
BCPA	White	1.11	0.68	(0.43)
General mean	~	1.00	0.85	(0.15) ns

Comparison of results between both cooperatives

1. Specific response according to the technology used in each cooperative

Varieties that coincided in the early and late sowings were influenced by technology/variety interaction (Figure 4).

Cooperatives are adjacent and fields for evaluating varieties were separated as far as 600 m. Moreover, the same soil type was used in both fields, which presented a difference of only six days regarding time for performing early sowing. In "Gilberto León" APC, bean was intercropped in a new plantain field, leaving 80 cm between furrows, whereas in "Jorge Dimitrov" APC, bean was seeded as monoculture and furrows were 60 cm apart. This brought about a differential response in an important group of varieties, seeded in both APCs using different technologies, as it is seen in Figure 4.

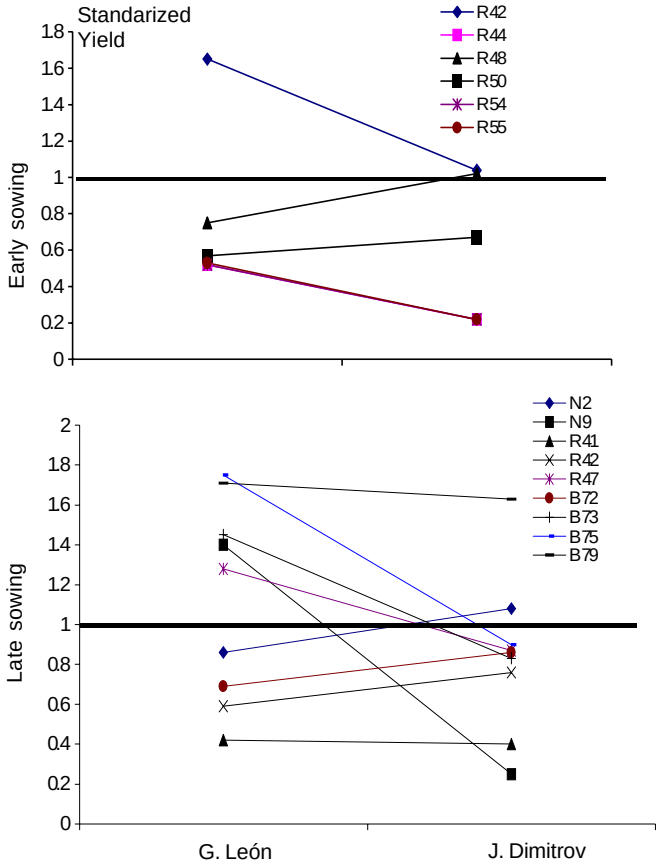


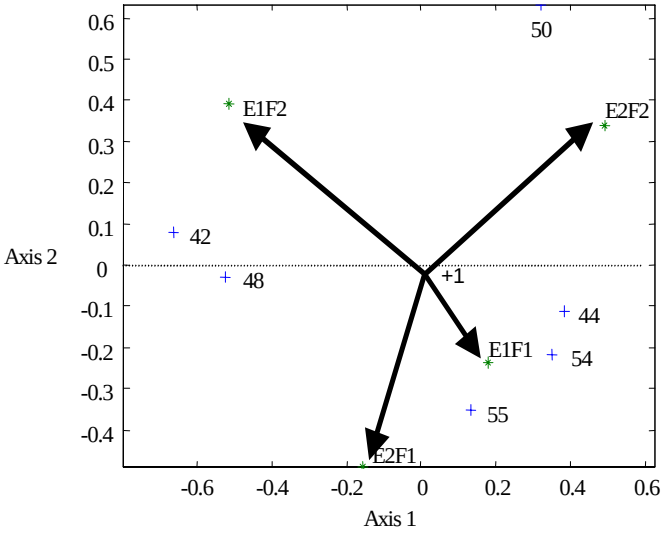
Figure 4. Variety response during both seasons in both APCs

After analyzing the nine varieties obtained through exchange between both cooperatives and, seeded in late sowing, a higher interaction of technology and variety is seen. In late sowings, fields were separated as far as 400 m, presenting the same soil and a difference of only four days from the early sowing. However, in "Gilberto León" APC, bean was intercropped with maize and furrows were 80 cm apart; in "Jorge Dimitrov" APC, it was seeded as monoculture, at 60 cm between furrows. All this brought about a different response in an important group of varieties, as it is seen in the figure.

These results emphasize the importance of selecting varieties under the specific conditions and technologies of farms. This is only achieved by farmer experimentation on the farm, proving the importance of applying surveys to growers in their plots, in order to know details of each ecosystem (8).

By means of introducing diversity and evaluating a group of varieties on farms, genotype-environment interaction can be exploited to the maximum in specific ecosystems that are mainly determined by soil type, farm environment, crop technology and specific sowing season, bringing about a different response of diverse genotypes.

After applying the analysis of Additive Main Effects and Multiplying Interactions (AMMI), carried out using yield data recorded on six coincident varieties in both cooperatives during early and late seasons (1, 44, 48, 50, 54 and 55), a high effect of variety x season interaction was observed (Figure 5). In this case, the first and second axes represented 58.80 and 31.2 % of variation, respectively.



F_1 "Gilberto León" APC F_2 "Jorge Dimitrov" APC
E_1 Early sowing E_2 Late sowing

Figure 5. Values of Biplot 1 and 2 axes in varieties and combinations of season x farm (cooperative)

It can be seen in this figure that varieties 1, 44, 54 and 55 interact positively in E_1F_1 and negatively in E_1F_2. Thus, interaction of variety 50 is positive in E_2F_2, and negative in E_2F_1 whereas varieties 42 and 48 interact positively in E_1F_2 and negatively in E_1F_1 and E_2F_2. In general terms, a high effect is found as to variety x season interaction.

With the purpose of getting more information on the technology/variety interaction, another analysis of Additive Main Effects and Multiplying Interactions (AMMI) was applied. This time, yield data corresponded to the nine varieties evaluated in the cooperatives during late sowings (2, 9, 41, 42, 47, 72, 73, 75 and 79). In this case, only one

axis was enough for explaining interaction variability (Table V and Figure 6).

Table V. Late sowing trial AMMI scores for bean varieties and the APCs located in San Antonio de los Baños

Variety	Yield (t.ha^{-1})	AMMI scores
2	0.93	0.5789
9	0.73	-0.8647
41	0.42	0.2750
42	0.65	0.4700
47	1.00	-0.050
72	0.75	0.4810
73	1.05	-0.2460
75	1.22	-0.4414
79	1.29	-0.2030
"Gilberto León" APC	0.830	0.461
"Jorge Dimitrov" APC	0.960	-0.461

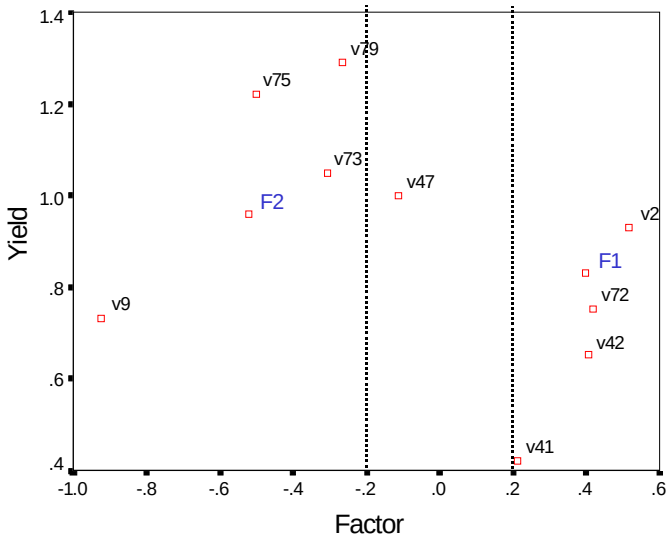


Figure 6. Yield and values corresponding to the first axis of the main component of nine bean varieties and two APCs located in San Antonio de los Baños

Table V and Figure 6 present yields and AMMI scores observed when evaluating both cooperatives. Varieties 79, 75, 73, 47 and 2 showed the highest yields, they being superior to the controls used in the APCs. Each variety and cooperative present different interaction patterns, depending on yield. In both APCs, variety 47 presented the highest stability, providing the nearest AMMI values to zero (-0.05).

2. Spreading varietal diversity and seed sufficiency

Starting from 80 g of bean seeds, delivered in August 2001, "Jorge Dimitrov" APC reached 230 kg seeds from all varieties in 2002. Moreover, growers in such cooperative have sown 27 ha, which are expected to produce more than 30 t grain and 4.5 seeds by 2003.

In 2000, this APC worked only on three bean varieties. Nowadays, large areas are sown with five black, six red and four white varieties. Growers keep on seeding the same old varieties in each group, producing seeds from these 15 varieties, selecting elite material from varieties they used to grow for recovering them and comparing Bolita 42 variety to BAT 304, in order to determine which one would keep on spreading.

The cooperative will preserve small quantities of the 22 varieties, just in case of an emergency. In other words, an increase in diversity of this species, as well as yields per area and total of the cooperative was achieved to more than 180 %.

Concerning "Gilberto León" APC, starting from 80 g of bean seeds, delivered in August, 2001, it has been obtained 1 t seeds of all varieties during 2002. At the same time, through the offers provided by seed enterprises, two additional tons of seeds from the best four varieties were bought and produced which became self-sufficient for supplying bean seed demands. The cooperative will preserve small quantities of the 22 varieties, just in case of an emergency. In other words, an increase in diversity of this species, as well as in yields per area and total of the cooperative was achieved to more than 140 %, seeding 45 ha bean during 2003, out which 38 ha with the new varieties introduced (84 % of the total).

It is stated that agroecosystems based on seeding diversity of crops and varieties have made traditional growers maximize harvest security by means of using low technological levels with limited environmental impact (7). Recovering agrobiodiversity is a crucial element; growers can reduce external inputs, since their crops become less vulnerable to pests and diseases, therefore, their domestic needs can be more easily satisfied (9).

On the other hand, there is little impact of technological innovations and agricultural development in marginal areas, where management systems keep unalterable in some cases and, in others, not each crop of the system has been influenced by the «advantages» of green revolution (10). Maize is a basic nutritious crop in Mexico, Central America, Africa, as well as in some parts of South America and Asia, where data from the mid 90's indicate that only 47 % of the maize area from developing countries is planted with improved varieties of the formal seed system (11).

This APC could produce its own maize seed for the first time, surpassing the production obtained in 2001. Nowadays, the APC has increased the seeding area to 111 %, as well as yield to more than 200 %.

The potentiality of farmer experimentation has been proved and kept as a common practice for testing new varieties. Likewise, innovations are seen among farmers when selecting maize material in the field and the recovery of landrace has started, based on elite material selected. Thus, farmers' self-esteem rise through the recognition of their analysis and experimentation capacity.

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