IMPLEMENTATION OF PARTICIPATORY COCOA SELECTION METHODOLOGY IN TECPATÁN, CHIAPAS, MEXICO

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ABSTRAC

Cocoa farming is of great importance for Mexico as this is where it was domesticated as a crop and since pre-Hispanic times has been linked to its culture. It is also the primary source of income for families in the states of Chiapas and Tabasco. There is a great diversity of samples in the country, which is due to the native species as well as the foreign examples that have entered through diverse routes. This has led to samples with different morphological, productive, and quality characteristics. It is for this reason that through the participatory selection methodology in the municipality of Tecpatán, Chiapas, it was intended to identify and select samples of cocoa that have the salient features of quality and productivity. Fifteen producers in five towns participated in the effort, which resulted in the identification and study of 47 trees. On these samples, a description was elaborated using 14 characteristics of the flower, 13 characteristics of the fruit, 7 of the seeds and 5 of the leaves, seed index indicators, pod index, and estimated annual production. It was found that trees # 265, 269, 262, 244, 256 and 233 meet the criteria established for high performance and quality, accounting for 12.7% of the trees that were studied. This indicates strong a potential presented by this region with respect to cocoa samples with high productive potential.

Keywords: *interculturalism, dialogue about knowledge, education, human resources, institutions of higher education.*

It is believed that cocoa (Theobroma cacao L.) originated in the headwaters of the Amazon Basin and in ancient times a natural population of Theobroma cacao spread throughout the central part of the Amazon-Guiana area to the west and north, reaching southern Mexico. These two populations were developed in geographically separated regions by the Isthmus of Panama. The first of these was the group called Forastero - Amazonica (Foreign-Amazonian) and the second group called Criollo(Native), which is well accepted in the market due to its high organoleptic quality (Foniap., 1993, Moreno, L. et al, 1983; Ruiz , 2003; Castillo, 2003).

Today this tree is grown commercially in Asia and Oceania, Central and South America and Africa, with global participation with respect to production at 12.5%, 12.7 and 74.8% respectively. Most of the cocoa destined for international trade is grown in Africa, with the Ivory Coast as the largest producer and Ghana having the highest quality (International Cocoa Organization - ICCO, 2011).

For Mexico cocoa is more than a food product-it represents a tradition, a great cultural legacy to preserve, a great source of natural wealth and a source of employment. Presently they are 61385.98 ha planted and in production located in four states, generating more than eight million work hours a year, with a contribution of 27,619.11 tons. The average reported for 2012 was 450 kg / ha (SIAP, 2014).

Cocoa cultivation in Mexico has been mainly driven by small producers who rely almost exclusively on family labor to work the plantations. They have low levels of education and low economic capacity to reinvest in their plantations.

Low yields of the current cocoa production in Mexico are largely due to the presence of plantations over 40 years old, low yielding genetic, susceptibility to pests and diseases, low or nil management culture, and the presence of a large diversity of phyto-sanitary problems.

This gradual decline in production has led to a crisis directly affecting more than 50,000 families, which has increased poverty in these communities which are already depressed. This has accelerated migration, further environmental degradation by the demolition of the plantations, and expanded the shortage for the Mexican chocolate industry which has to import cocoa beans from other countries.

In the case of the two major cocoa producing states, the plantations belong to the basins of two of the most important rivers in Mexico: the Grijalva and Usumacinta. Given the high impact of disease, farmers in the midst of despair for not having production and therefore income, are opting for the demolition of the plantations to change crops, mainly for grassland and maize. This in turn is threatening the capture and buffer systems and the reserves that cocoa farms represent which include the diversity of shade trees, thus creating an environmental problem with serious consequences.

The lack of technology implemented in plantations, diseases and pests that attack the crop, the advanced age of older cocoa plantations and the cultivation of low quality and high heterogeneity genetic materials, are the main factors affecting production.

However, cocoa is of high social and ecological importance. In the state of Tabasco this crop supports 40,000 families in 368 communities, while in Chiapas 11,000 families in 118 communities depend on this crop as their source of income. From the agro-ecological point of view, cocoa has a high value as a provider of ecosystem services because its cultivation fosters biodiversity and contributes to the conservation of natural basins. The cocoa agro-ecosystem resembles tropical forest in structure and function and nourishes the life of rivers and streams, providing water for human and animal consumption, irrigation, hydropower generation and the maintenance of biodiversity of flora and fauna. Therefore, it contributes to the sustainability of the tropical regions of Mexico and the world, which is threatened by the gradual demolition of cocoa plantations. In addition, cocoa plantations play an important role in mitigating the effects of global warming and climate change. A plantation (cocoa + shadow) can store 60-100 tons of carbon / ha. in the aerial biomass.

THE GENETIC IMPROVEMENT OF COCOA

The genetic improvement of this species is one of the most promising strategies to improve the performance of cocoa plantations, and as a result the producer's income. In Latin America, there has been development in the improvement of this species for nearly 80 years, basically by the application of two methods: 1) vegetative or cloning selection and 2) generative selection based on artificial hybridization between clones.

The basis of vegetative selection arose in Trinidad in the 30's (Pound, 1931; Pound, 1934), and consists of the individual selection of trees in commercial plantations or in the wild, on the criteria of its fruit and seed characteristics, as well as identifying its resistance to disease. Two items are defined from the selection: the cob index which expresses the number of cobs needed to make a kilogram of dried cocoa, and the seed index which indicates the dry weight of the seed. Each country adapted these parameters to the local population, and thus was gradually selecting a considerable amount of clones.

In Mexico, the genetic improvement of cacao based on clonal selection began in 1945 at the Research Station on Tropical Crops, today called Experimental Field Station Rosario Izapa of the National Institute of Agriculture, Forestry, and Livestock Investigations (INIFAP) located in Tuxtla Chico , Chiapas (López, Fraire and Cueto, 1994; López, 1995; Cueto and Lopez, 2005). As in other countries, the potential of clonal material has not taken advantage of- the impacts and benefits of these clones among producers have been limited despite the efforts for dissemination.

Very few plantations have been established with this material due to the limited acceptance by farmers.

A well-known fact is that breeding developed in research centers is disconnected from producers, the technological demands of the productive sector, and industrial and market demands.

Participative improvement consists of taking advantage of the natural variability in the cocoa plantations and through a combination of selection criteria together with the involvement of producers, identify and select highly productive trees and high quality seeds(Engels and Eskes, 2009) . This strategy allows for the selection of genotypes that are a product of domestication in environments and local communities, differentiated by their origin, quality and flavor, and adapted to particular environments (López and Ramírez, 2006). Unlike other strategies in which the producer is not involved and it is a mere spectator, in participatory selection they play an important role for the identification, the definition of variables and criteria, and the rating in the selection of elite trees.

The process of tree selection is made according to the following work methodology:

- Exchange with producers, defining of selection criteria.
- Site visits to plantations with producers, marking of trees.
- On-site assessment for at least one harvest cycle: every 15 to 30 days depending on production periods. Variables of selected trees are recorded and healthy cobs are harvested and studied.
- Evaluation and final selection involving producers.
- Vegetative propagation of elite trees, establishment of plant material in local clone banks and dissemination of clones to producers.

The participatory improvement methodology has produced good results in the cultivation of cocoa. In Mexico this strategy was first implemented by Cocoa Program at the Autonomous University of Chiapas (UNACH) in 2000. The work began in the Soconusco region in the communities of Raymundo Enriquez and Miguel Hidalgo in Tapachula, Chiapas. This formed the basis of the methodology and generated indicators. Later this type of work was in other communities in the municipality of Tapachula and in the municipalities of Tuzantán, Ostuacán and Pichucalco (Lopez et al., 2006). The significance of applying this methodology lies in the selection of materials based on agronomic criteria of quality and disease resistance within a given area, so that locally adapted and accepted materials are obtained, which are the basis for the redesign of the local cocoa plantations having a high yield cacao in a short period of time and generating better earnings for producers, thus encouraging the cultivation and protection of the environment.

Based on this background, the purpose of this investigation was to exploit the variability present in cocoa communities in the township of Tecpatán. In order to obtain cocoa samples with high performance and quality, the methodology of implementing participatory selection was an important basis for the establishment of sustainable cocoa, which helps improve profitability and environmental preservation.

METHODOLOGY

The selection process only included trees in the period from October 2012 to April 2014 and was performed according to the following guidelines:

a. Exchange with producers, definition of selection criteria.
b. Tours of plantations with producers. Marking of trees. During trips, sampling of fruits and seeds of the indicated trees.
c. Site evaluation of each tree and the characterization of agronomic variables.

d. Evaluation and final selection.

The characterization and data collection were performed according to the methodology established by CATIE (Phillis-Mora, et al, 2012), which features 14 flower, 13 fruit 13, 7 seed and 5 leaf characteristics as quality indicators.

Agronomic characteristics. These variables were performed by taking data on the number of fruits of each tree and cutting the fruits, leaves and flowers, from each tree. The material was transferred to the ADUES Cocoa-Chocolate Agrotechnology Laboratory , located at the University City of the Autonomous University of Chiapas (Tuxtla Gutiérrez, Chiapas), in order to record the respective data according to the following list:

Fruit characteristics: healthy samples were harvested, weighed, length, diameter, number and types of rows, number of seeds per fruit, the weight of fresh and dry seeds, immature and mature color, the presence of pigmentation in the loins, shape & texture of the surface. Information for calculating the cob index (number of cobs per kg) and the selection limit was equal to or less than 25.

Seed: color of cotyledons, shape, length, width, thickness, dry weight, husk or seed coat content (%). These values generated the seed index (number of dry seed per kg), and the selection criterion for this character was set equal to or greater than a gram, and that their number per kg is less than 1000.

Flowers: Stamen length (cm), number of ovules per ovary, ovarian length in mm , ovary width (mm), length of sepal (mm), sepal width (mm), length of petal ligule (mm), width of ligule (mm), length of style (mm), color of flower stem; presence of anthocyanin in the flower bud, in the petal ligule, and in the upper ovary and in the stamen.

Plant: Plant height, number of flower cushions in a linear meter of trunk.

Leaves: Color of the tender shoot, leaf width (cm), leaf length (cm), petiole length (cm), length from base to widest point.

Selection limits: considering the relevance of productive variables, selection limits were set with the following values:

- Performance: at least 1 kg of dry cocoa per year.
- Cob index: equal to or less than 25 cobs per kg of dry cocoa.
- Seed index: equal to or greater than 1 g.

RESULTS AND DISCUSSION

Exchange with producers and definition of selection criteria. As part of the development of the investigation, a meeting took place with the directors and associates of the Tecpateco Society of Rural Cacao Production. The project was presented to the group and the objectives were laid out. There was also a call for producers who were interested in participating in the project.

Site visits to plantations with producers; marking of trees. A plan of the route of plantations visits was established as part of a common agreement with the producers, and trees were marked which were considered important as part of the study. In this manner 15 farmers participated from five different localities of the municipality of Tecpatán, who studied and marked 47 trees.

In situ evaluation of each tree with agronomic variables . There were periodic tours of the marked trees in order to collect data and samples such as leaves, fruits and flowers which were transferred to the Agro technology Laboratory to be used in the study.

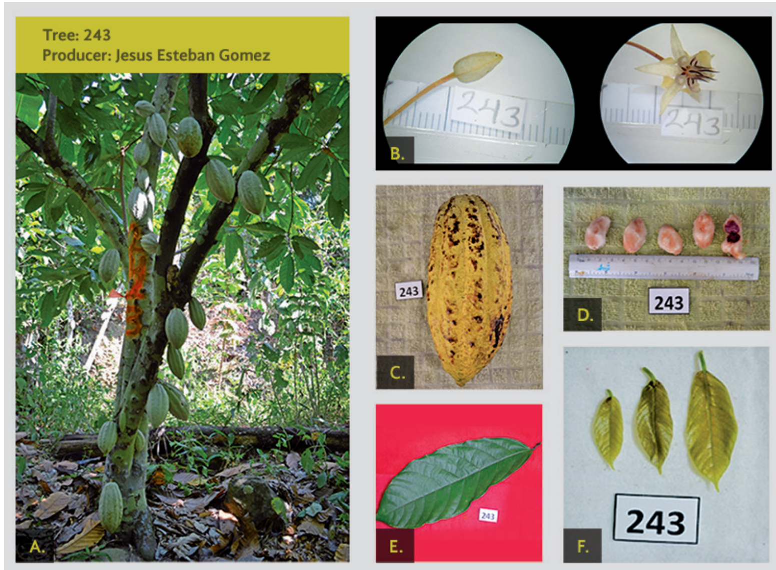

Figure 1. Morphological characteristics of tree 243, selected by the methodology of participatory selection in Tecpatán, Chiapas, Mexico. a. Tree, b. Flower c. Fruit, d. Seed, e. mature leaf, f. young leaves.

In Figure 1. The morphological characteristics of one of the trees that formed part of the study can be appreciated, from which data variables were taken from young and mature leaves, fruit, seeds and flowers, in order to identify and differentiate the particularities of each of the selected materials among themselves and with others.

EVALUATION AND FINAL SELECTION

In Table 1., the data of morphological characteristics and evaluated indicators from 14 outstanding cacao trees studied using the methodology of Participatory Selection is concentrated. Differences were observed in the variables of the flowers: stamen size, number of eggs per ovary, length of ovary, ovary width, sepal length, length of ligule and length of style.

With respect to the characteristics of the fruit, trees were found to have variables with respect to fruit shape, apex shape, roughness of the skin as well as fruit weight. The variable of the number of seeds per fruit shows that it has a range of values of 16-48 seeds; individual seed weight showed values between 0.9 to 1.7 g, and a dry cocoa weight on a cob ranging between 28.4 and 71.2 g.

In considering the selection limit established for the pod index, whose value was equal to or less than 25, the trees that meet these criteria were numbers 133, 144, 153, 156, 160, 162, 165, 166 and 169. However, for the seed index the trees that met these criteria were numbers 133, 243, 144, 153, 156, 295, 160, 216, 162, 165, 166, 169 and 170.

While considering the variable of production, the trees that achieved higher values above 1000 g / year were numbers 165, 243, 169, 162, 244, 295, 166, 141 and 133.

Trees 165, 169, 162, 144, 295 and 133 met the selection criteria that were set, that is to say 12.7% of the trees which were studied. This indicated a good potential presented by this area with respect to cocoa materials with high productive potential.

Selection is one of the oldest methods and is the basis of all plant breeding program. According to Gallais (1989), it is a process that can be applied to a given population to identify the best plants. Its efficiency is higher in populations with wide genetic variability.

One of the major limitations for the recovery of Mexican cocoa production is the lack of improved genetic material adapted to the environmental conditions of the producing regions. This has limited the impact of support programs implemented for the cocoa industry by the federal and state governments.

The results obtained in this investigation, while they are important inputs for producers, presented prospects for applying selection strategies in existing plantations aimed at obtaining germplasm in a relatively short time with outstanding features and adapted to production regions. Thus, this genetic improvement strategy helps to support the recovery of the cocoa sector of Mexico.

The lack of improved cocoa germplasm is a world-class problem that has previously been noted by several authors (Larson, 1986; Enriquez and Soria, 1996, Lopez et al, 1996;. Zadoks, 1996; Van Der Vossen, 1996) who point out that a limitation in most cocoa producing regions is the lack of improved high yield and disease resistant varieties that adapted to the conditions of the various production regions. One strategy to overcome this limitation in a short time is participatory improvement which is proposed by López and Ramírez (2006). They have proposed the selection of germplasm from the plantations of the producers as one of the most promising avenues for obtaining genetically superior material that allows increased yields in cocoa regions.

The selection of outstanding trees in polymorphic plantations complemented with vegetative propagation would allow clones high agronomic value to develop in a short time, allowing their immediate use by producers.

The results obtained in this investigation confirm the efficiency of this breeding strategy, since the selection has allowed the identification and selection of notable trees that show a high productive potential.

From the perspective of the sustainability of the cocoa agro ecosystems, the direct selection of materials involving both producers and breeders is a potential strategy for increasing productivity of agro ecosystems and promoting the maintenance of genetic diversity for the production regions of Chiapas and Tabasco.

The selected genetic material that was a product of this investigation can be used in two ways. In a first phase, they can be multiplied by grafting and utilized directly by a producer for the renovation of existing plantations. At a later time they may be used as parents for the creation of inter clonal hybrids. Under this approach, the genetic material selected in this investigation constitutes basic material to start a hybridization project that would generate segregated populations directed to where the combination of different characters of agronomic interest is favored.

Table 1. Characteristics of trees selected by the methodology of participatory selection in the town of Tecpatán, Chiapas, Mexico.

Selection Number	133	141	243	144	153	156	295	160	216	162	165	166	169	170
FLOWER CHARACTERISTICS														
Color of the flowers peduncle	Green with red pigment	Green	Green with red pigment	Green	Green	Green	Green with red pigment	Green with red pigment	Green with red pigment	Green	Green with red pigment	Green with red pigment	Green with red pigment	Red
Presence of anthocyanin in the flower bud	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Lightly pigmented	Absent
Presence of anthocyanin in the petal ligule	Lightly pigmented	Lightly pigmented	Lightly pigmented	Lightly pigmented	Lightly pigmented	Lightly pigmented	Absent	Absent	Absent	Absent	Absent	Lightly pigmented	Absent	Absent
Presence of anthocyanin in the superior part of the ovary	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Stamen size / length in cm	5.71 ± 0.67	3.08 ± 0.41	8.06 ± 0.68	7.57 ± 0.44	7.75 ± 0.4	7.49 ±0.47	6.94 ± 0.41	6.43 ±0.71	7.14 ± 0.44	6.87 ± 0.57	6.14 ± 0.40	7.65 ± 0.48	7.33 ± 0.55	6.63 ± 0.67
Presence of anthocyanin in the stamen	Intense	Intense	Intense	Intense	Intense	Intense	Intense	Intense	Intense	Intense	Intense	Intense	Intense	Intense
Number of eggs per ovary	26.85 ± 2.70	13.4 ± 2.82	34.15 ± 3.29	35.05 ± 3.17	34.6 ± 3.54	38.15 ± 2.43	35.05 ± 4.03	35.55 ± 4.59	34.4 ± 3.81	34.05 ±3.11	32.2 ± 2.62	31.8 ± 2.01	32.75 ±3.14	33.35 ± 2.85
Length of ovary (mm)	1.49 ± 0.34	1.00 ± 1.35	1.74 ± 0.31	1.68 ±0.33	1.38 ± 0.08	1.52 ± 0.21	1.33 ± 0.09	1.37± 0.48	1.37± 0.16	1.37 ± 0.22	1.45 ± 0.23	2.02 ± 0.04	1.09 ± 0.09	1.97 ± 0.34
Width of ovary (mm)	0.85± 0.08	0.61 ± 0.48	1.12 ± 0.10	1.16 ± 0.09	1.14 ± 0.07	1.15 ±0.09	1.02 ± 0.04	1.08 ± 0.22	1 ± 0	1.05 ± 0.06	1.06± 0.07	1.08 ± 0.10	1.07 ± 0.09	1.18± 0.08
Length of sepal (mm)	5.73 ± 0.48	3.4 ± 0.53	8.47 ± 0.49	8.73 ± 0.63	8.4 ± 0.50	8.41 ± 0.49	8.51 ± 0.52	7.36 ± 0.45	8.67 ± 0.56	7.83 ± 0.53	7.19 ± 0.54	7.92 ± 0.54	7.5 ±0.68	7.11 ± 0.55
Width of sepal (mm)	1.77 ± 0.360	0.94 ± 0.26	2.14 ± 0.09	2.26 ±0.34	2.27 ± 0.04	2.22 ± 0.07	2.02 ± 0.06	2.05 ± 0.10	2.09 ±0.10	2.07 ± 0.08	2.04 ± 0.05	2.2 ± 0.41	2.05 ± 0.22	2.75 ± 0.51
Length of sepal ligule (mm)	3.1 ± 0.51	2.2 ± 0.53	4.82 ± 0.37	4.71 ± 0.34	5.10 ± 0.13	4.9 ± 0.30	3.30 ± 0.50	4.01 ± 0.90	3.86 ±0.41	3.83 ± 0.62	3.24 ±0.57	2.97 ±0.11	3.03 ± 0.07	3.35 ± 0.67
Width of ligule (mm)	2.215 ± 0.57	1.025 ± 0.36	2.62 ± 0.39	2.65 ± 0.35	3.14 ± 0.09	3.11 ±0.10	2.5 ± 0.43	2.41 ± 0.45	2.76 ±0.34	2.75 ± 0.34	2.25 ± 0.36	2 ± 0	2.9 ± 0.30	2.24 ± 0.39
Length of style (mm)	0.97 ± 0.07	0.55 ± 0.05	1.45 ± 0.07	1.44 ± 0.06	1.4 ± 0.05	1.48 ± 0.07	1.41 ± 0.09	1.26 ± 0.11	1.425± 0.08	1.36 ± 0.08	1.37 ± 0.08	1.11 ± 0.11	1.195 ± 0.06	1.35 ± 0.17
FRUIT CHARACTERISTICS														
Color of immature fruit (2 months)	Light green with white gooves	Light green with white gooves	Light green with white gooves	Light green with white gooves	Green with purple	Green with purple	Light green with white gooves	Light green with white gooves	Light green with white gooves	Light green with white gooves	Light green with white gooves	Light green with white gooves	Green	Red
Color of mature fruit	Yellow	Yellow	Yellow	Yellow	Yellow	Red with yellow	Yellow	Yellow	Green with yellow	Yellow with green	Yellow with green	Yellow	Yellow	Yellow
Fruit shape	Angoleta	Pentagon	Pentagon	Angoleta	Angoleta	Angoleta	Amelonado	Angoleta	Angoleta	Angoleta	Angoleta	Amelonado	Cundeamor	Cundeamor
Apex shape	Acute	Obtuse	Obtuse	Obtuse	Obtuse	Acute	Obtuse	Attenuated	Attenuated	Attenuated	Acute	Round	Obtuse	acute

Shape of basal constriction	Inter-me-diate	Inter-me-diate	Inter-me-diate	Inter-me-diate	Absent	Strong	Soft	Inter-me-diate	Strong	Strong	Inter-me-diate	Soft	Soft	soft
Skin wrinkle	Inter-me-diate	Soft	Inter-me-diate	Inter-me-diate	Soft	Inter-me-diate	Soft	Inter-me-diate	Rough	Rough	Inter-me-diate	Soft	Inter-me-diate	soft
Weight (g)	950.3	701.3	557.9	505.7	704.0	763.5	361.7	398.0	533.0	658.3	620.8	571.7	737.5	818.8
Length (cm)	21.0	17.8	17.7	17.6	18.5	23.3	17.0	20.0	24.0	22.0	20.7	14.5	20.5	23.0
Diameter (cm)	10.3	9.5	8.9	8.7	9.0	8.8	7.5	7.0	8.0	8.7	8.8	9.5	8.7	9.0
Ratio L/D (cm)	2.0	1.9	2.0	2.0	2.1	2.7	2.3	2.9	3.0	2.5	2.4	1.5	2.4	2.6
Ridge thickness (cm)	2.2	1.8	1.9	1.5	1.5	1.9	1.1	0.8	1.5	1.8	1.5	2.0	1.9	2.0
Groove depth (cm)	1.7	1.4	1.4	1.2	1.3	1.5	0.9	0.7	0.9	1.1	0.9	1.5	1.3	1.6
Fresh weight per fruit (g)	131.3	84.0	95.3	114.9	194.0	177.0	100.7	140.0	60.0	113.7	123.8	117.3	143.0	110.0
SEED CHARACTERISTICS														
Number of seeds per fruit	39.3	32.7	32.3	39.8	48.0	42.0	27.3	42.0	16.0	27.3	41.8	37.0	36.0	16.8
Seed weight with testa (g)	1.2	0.9	1.2	1.0	1.5	1.5	1.1	1.3	1.8	1.7	1.4	1.2	1.3	2.1
Dry cocoa weight per cob (g)	47.0	30.8	38.7	41.4	71.2	62.4	29.5	53.4	28.4	45.2	58.2	42.9	48.5	34.5
Percentage of flesh	10.0	25.1	11.9	8.8	7.6	7.1	16.4	9.7	7.3	7.2	9.8	8.5	9.2	
Length (cm)	2.1	1.9	2.3	2.1	2.1	2.2	2.0	2.1	2.2	2.2	2.4	218.2	2.1	2.2
Diameter (cm)	1.1	1.0	1.1	1.1	1.1	1.2	1.1	1.1	1.2	1.2	1.1	119.7	1.2	1.3
Thickness (cm)	0.7	0.8	0.7	0.6	0.8	0.7	0.5	0.7	0.9	0.8	0.8	52.1	0.8	1.0
TREE AND LEAF CHARACTERISTICS														
Number of flower clusters/m	44.0	19.0	22.7	24.7	31.7	24.3	24.0	32.0	43.7	37.7	31.7	33.7	34.7	22.7
Height (m)	4	4	4	4	7	6	3	3	4	4	6	4	4	5
Color of pigmentation at 6-7 days old	Café	Café	Café	Café	Rosa-da	Rosa-da	Café	Café	Café	Café	Café	Café	Café	Rosa-da
Leaf width (cm)	12.7	10.8	12.7	12.9	10.6	9.8	2.5	11.9	13.6	10.9	14.1	14.9	13.4	14.8
Leaf length (cm)	32.6	30.2	32.8	31.3	31.2	35.7	6.1	35.9	37.1	31.8	41	38	34.9	39.6
Petiole length(cm)	1.2	1.2	1.1	1.0	1.3	1.0	0.2	1.5	1.3	1.3	1.7	1.5	1.5	1.5
Length from the base to the widest point (BPA)	17.7	17.8	18.5	16	16.4	17.7	3.12	18.3	18.6	16.3	20.4	18.3	18.5	20.2
INDICES														
Cob index (number of cobs per 1kg of dry cocoa)	21.3	32.5	25.8	24.2	14.0	16.0	33.9	18.7	35.2	22.1	17.2	23.3	20.6	29.0
Seed index (number of seeds for 1kg of dry cocoa)	836.2	1061.1	833.3	962.2	674.2	672.6	927.6	786.2	563.2	604.8	718.6	862.7	742.4	485.4
Production g/year	1175.9	1200.6	3758.1	2399.0	640.7	1935.9	913.5	747.9	710.2	2440.5	4191.7	1329.6	3443.1	655.6

CONCLUSION

The implementation of the Participatory Selection Methodology developed in the Municipality of Tecpatán allowed for the identification and characterization of six trees which have high production potential and quality indicators, such as number of cobs to complete a kilogram of dry cocoa.

In considering the morphological characterization done on 47 cacao trees, a high diversity of cocoa materials can be seen. There is also good potential for highly productive trees in the town of Tecpatán, with only 6.8% of the 220 producers who belong to the association having implemented the methodology.

The selection of materials led by the producers is an innovative strategy to regain productivity and maintain genetic diversity of cacao plantations in the state of Chiapas, which can be extrapolated to other regions with similar characteristics.

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