

I.N.I.A.P

ESTACION EXPERIMENTAL TROPICAL PICHILINGUE

COCOA RESEARCH AND TECHNOLOGY TRANSFER TEAM

SPECIFIC COOPERATIVE AGREEMENT INIAP-USDA (ARS): 58-6631-2-F077

PROJECT: GERMPLASM EVALUATION, BREEDING AND PHYTOPATHOLOGICAL STUDIES FOR OBTAINING IMPROVED COCOA VARIETIES

**TECHNICAL PROGRESS REPORT
YEAR 2 (April/2003 – April/2004)**

**QUEVEDO – ECUADOR
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INIAP

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Authors:

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Summary

Evaluation continued of the Nacional cocoa germplasm available in the CGN and SNA collections. Most productive clones in CGN yielded between 2.91 and 3.56 kg of dry beans per tree per year. Some showed a clear tendency for harvest concentration during the dry part of the year. Clones CCAT 1858 and CCAT 2143 stand out as superior in both traits and additionally show the lowest pod index and the highest seed index. Some clones of the young SNA collection began to show some interesting behavior which will be monitor closely in the future. Three introductions of Nacional cocoa germplasm have been made and new trees have been identified for additional introductions planned for this year. Characterization of all accessions in Chalmers collection was completed. Results showed that ample variability exists and clones TAP 12, TIP 1 and TAP 6 stand out for their highest resistance to witches broom. Reaction to artificial inoculation with *C. fimbriata* at the lab was measured in this collection and results clearly showed three groups of clones with different levels of resistance. Monilliasis tests were also attempted but unsuccessfully; new attempts are planned for the dry part of the year. Some Chalmers' clones are already being used as parents in ongoing breeding schemes within this project. Measuring of yield and sanitary variables is currently taken place in the Allen collection and promising results are expected. Evaluations of two old hybrid families populations established in the early fifties and late sixties at Pichilingue (plots 2A and 7A) continued and are providing valuable information. The first population allowed the selection of 15 trees and five progenies showing superior performance in productivity and disease resistance. Highest yield and number of healthy pods recorded per tree per year in these selections were 13.15 kg and 283 respectively. Witches broom's more resistant trees in the same group are coded as 2506, 2126, 2786 and 2748. The identification of a hybrid tree showing complete resistance to witches broom (no broom observed in the last 18 months) and good productivity is an outstanding outcome. Clonal propagation of selected trees is ongoing and evaluation trials using these selections will soon be set up in the Amazonia region. The second population under study is made up of five hybrid families. Tabulation of historical data records on these continued and a 80% progress has been reached. Most of these data will be used for QTL analysis to identify markers associated to disease

resistance. In the same context data analysis for the family SCA 6 x Silecia 1 (1971-1985) led to the identification of 19 high yielding trees. Nine of them showed low witches broom incidence and only a few pods rotten by moniliasis. This disease was the main cause of pod loss in all families among the years. The planned breeding scheme for the project is made up of 157 crosses and a 80% progress has been reached so far in the production of such crosses. Around 2000 bagged plants from 39 progenies were already placed within an old cocoa "huerta" to measure their response to witches broom under a high disease pressure environment. A similar number of plants and progenies are ready in the greenhouse to undergo a WB resistance test under the SAI in a few more weeks. Some 5300 cocoa seedlings belonging to 55 hybrid families are currently developing in the nursery and will be taken out gradually to measure their response to WB under lab and field conditions. A study is also in place to compare 10 lab screening test regarding their capacity for an early discrimination for WB resistance in cocoa seedlings. About 23.5 hectares of land originally covered with shrubby degraded pasture were cleared out and prepared to plant selected hybrid plants and progenies which will result after they go through the SAI; a pond to provide water for irrigation was conditioned in the middle of the cleaned area. A sampling was carried out in main cocoa growing areas and 181 samples of diseased materials (broom and pods) were collected. DNA was extracted from these and RAPDs was applied. Genetic diversity analysis showed an important variability for *C. perniciosus* and *M. roleri* strains. Three articles have been written and published regarding germplasm behavior and diseases evaluation. An inventory on all cocoa germplasm available in Ecuador and associated knowledge is currently being prepared as part of the project with a 60% progress so far. Its publication is strategic for the future development of cocoa research in Ecuador.

Germplasm Evaluation

Nacional Type Clones:

Data were produced to measure yield potential and yield pattern distribution through the year of 77 cocoa clones. These clones make up the Collection CGN (Genotipos de cacao Nacional). To carry out this evaluation firstly pod counts were made at two different dates (on February and July 2003) on each clone. Number of witches broom was also measured as a sanitary variable (July 2003). The number of pods registered on February was considered as a rainy season pod count (rainy season usually goes from December to May). Pod count made on July was considered as a dry season pod count (dry season usually goes from June to mid-December). Figure 1 shows the comparative differential behavior of the best performing 18 clones for pod count and number of witches broom. It should be noted that almost all clones set most of their pods during the dry season. This means that the bulk of the pods set by these cultivars have an opportunity to escape diseases. This suggest important breeding and economic values. It is interesting to see that the clone CATT 18-58 shows a high pod set in the dry season, low pod set during the rainy season and very low witches broom incidence. This behavior together with the low pod index and high bean index makes it a quite promising clone. It should be also noted that as an average, the incidence of witches broom is low with half of the clones showing less than ten brooms per tree.

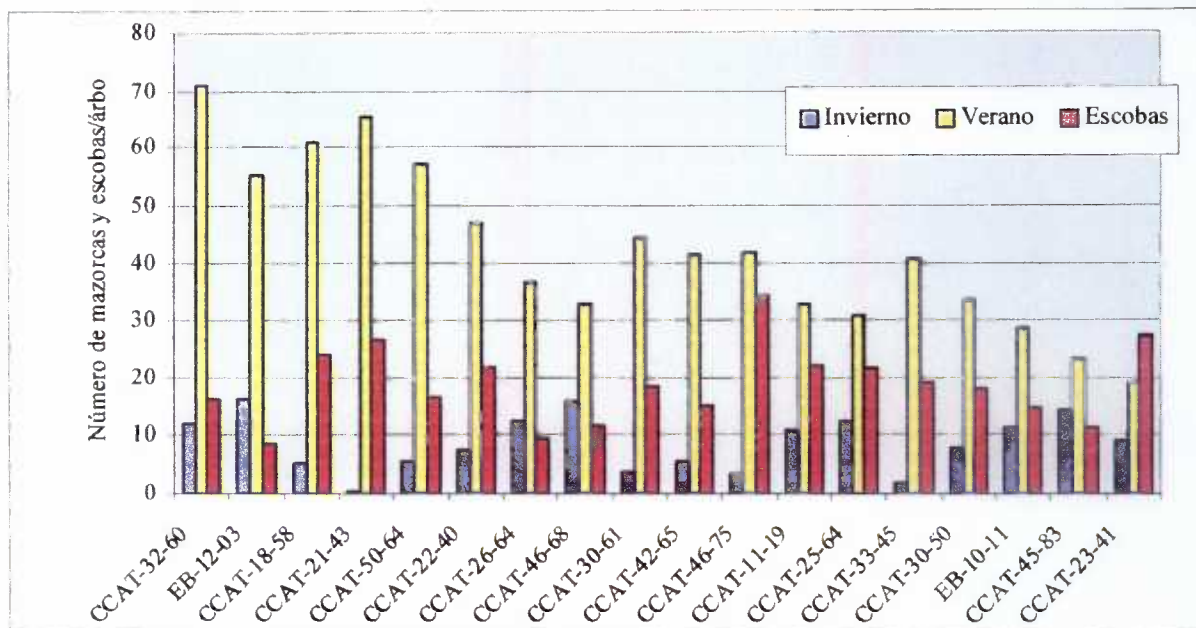


Figure 1. Differential behavior of a group of Nacional cocoa clones by the pod number in rainy (blue bars) and dry seasons (yellow bars), and incidence of Witches' Broom (red bars) per tree (February 2003 – January 2004).

A complementary approach for the evaluation consisted of harvesting the ripe pods every two weeks or whenever necessary to generate fresh bean weight data. Accumulated fresh bean weight data obtained during the period February 2003 - January 2004 was turned into dry bean weight data after multiplying by 0.4 (a constant for this type of transformation). Yield of dry beans together with pod index, seed index, healthy pods and diseased pods are shown in Table 1 for the best 10 clones. Not all of them coincide with the group of clones showed earlier in Figure 1. However two of them emerge clearly as promising ones for commercial development in both groups: CCAT 18-58 and CCAT 21-43. Both set most of their pods during the dry part of the year. A scientific article describing this result was published in the ANECACAO magazine. Annex 1 shows a complete list of the clones making up the collection CGN. Annex 2 shows several graphs illustrating harvest distribution through the year of some of these clones.

Evaluation is currently ongoing to confirm these results but to gain time in benefiting from them, a decision has already been made to start establishing a small clonal garden with these cultivars. The aim is to gradually increase the availability of budsticks for grafting. It is envisioned to use up these clones to reinforce the value of the present Nacional type policlon available for commercial distribution since 1978. Its reinforcement will provide it with more productive capacity as well as a more convenient pod set distribution through the year. The clones with poorer performance (regarding total yield and harvest distribution) could be replaced by these new ones, thus changing the structure of the commercial policlon. This can benefit the farmer through a higher total income as well as a more uniform income distribution through the year. A complementary study of the commercial clones is currently ongoing to produce results which are necessary to feed on the decision process related to the issue discussed.

Table 1. Accumulated dry weight per tree of the 10 highest yielding clones identified in the collection of Nacional Genotypes (CGN) during the period February/2003 to January/2004.

Clones	Kg. of dry bean / tree	Pod Index*	Seed index*	# Healthy Pods	# Diseases Pods
CCAT-42-65	3.56	23.60	0.97	47.6	25.1
CCAT-46-75	3.32	22.60	1.10	42.9	11.3
CCAT-18-58	3.07	18.80	1.32	41.6	18.5
CCAT-33-45	2.93	22.90	1.08	36.1	10.7
CCAT-46-68	2.73	27.40	0.80	45.5	21.8
CCAT-11-19	2.72	22.05	1.02	38.1	16.6
CCAT-32-60	2.71	29.20	0.87	42.3	11.9
CCAT-21-43	2.71	21.30	1.46	29.2	11.3
CCAT-26-64	2.69	31.80	0.84	44.2	12.0
CCAT-45-83	2.67	26.50	0.96	41.5	19.8
X	2.91	24.61	1.04	40.9	15.9

The collection SNA (Selección Nacional Arriba) is also under evaluation within the frame of this project. This collection is made up of 96 accessions and planting started in 1999. Data are being produced of the following variables: healthy pods, diseased pods and fresh bean weight. We can see (Annex 3a and 3b) that only 34 clones set pods which were harvested in 2003. A total of 25 clones were harvested during the first months of 2004. It should be noted that there are ample differences in age between accessions in this collection and most of the clones are still in their juvenile stage. However, it is clearly shown that the clones with more pods harvested in the second half of 2003 are for the most part the same which more pods harvested during the first four months of 2004. The data produced show a good level of variability. Consequently good expectations exist to carry out future selections of promising material for breeding and commercial purposes from this population.

On the other hand new germplasm introductions have been made from Chone (a traditional cocoa growing zone) and plans are underway to introduce new Nacional germplasm during the next two years. A cocoa growing farm with very old cocoa trees have been recently identified and visited in the same zone. Preliminary characterization studies have already began on some of the trees in this farm. News are (contacts have already been started) that another cocoa growing farm with very old Nacional cocoa trees (more than 80 years old) exists in the traditional cocoa growing zone of Vinces. A visit is being planned within the next few weeks. If this is confirmed plans will be prepared to identify germplasm promising for introduction.

Collections Chalmers and Allen

Estacion Napo -Payamino

The Amazonian cocoa germplasm established in the Estación Napo-Payamino of INIAP at San Carlos was collected during 1980 - 1985 by Allen with the participation of the INIAP 's cocoa team at that time. The main objective of the expeditions was to collect

wild cocoa trees with the highest possible diversity. From 1985 on some phenotypic evaluations were made on a few variables (mainly vigor, production and diseases resistance) though this work was discontinued. Existing data were incomplete and dispersed. A decision was taken to recover, organize and analyze the available data records. Progress is currently being made in this direction.

As part of this project all the cocoa material have been identified individually using metal tags. Trees were pruned as part of a rehabilitation plan and an updated map was drawn. Previous to the pruning a count of the number of witches broom present in each tree as well as an assessment of the sizes of those brooms were made. During 2003 new data on selected variables were produced on 142 clones and 169 hybrid trees. Though data measurement for some variables have been completed, morphological evaluation of fruits (pod and seed) is still ongoing as well as pollination work to determine each tree compatibility. A more detailed information will be assembled and presented in the next progress report.

Estación Pichilingue

The characterization of the germplasm available in the Chalmer 's collection is completed. Data were subjected to multivariate analysis by Jhonny Demey (a project consultant). Figure 2 show results which came out from these analysis. The two principal components account for 52.11% and 14.86% of the total variance (see Annex 4). The distribution of the accessions in the two-dimensional space shows that the ranking of selected variables offer sufficient information to differentiate between accessions. These results confirm that the descriptors selected for evaluation show a good discriminating capacity.

On the other hand, buds of cocoa trees (located in a plot called H-1) from Amazonian origin and believed to belong to the original Chalmers' collection at Napo and which were brought to Pichilingue several years ago, were grafted on roostocks of IMC-67 and later field planted at 3x3m next to the Collection Chalmer. Unfortunately, taking up of graftings was only partially successful (see Table 3 for more information). Attempts will continue to complete propagation of these materials.

Measuring of yield and sanitary variables is also currently taken place in the Collection Allen at Pichilingue. Se Annex 5a and 5b for additional information on this Amazonian germplasm.

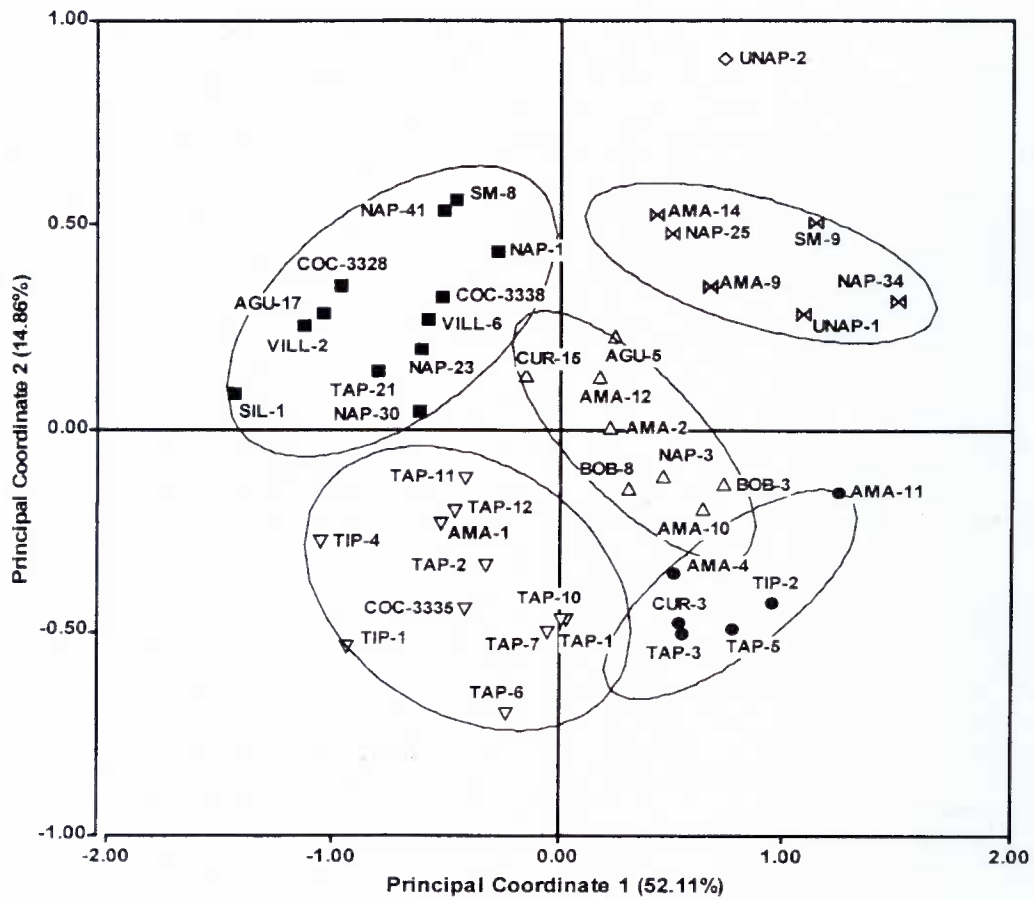


Figure 2. First two coordinates of dissimilarity ranking matrix

Table 3. Group of Amazonian cocoa accessions located near the plot known as H-1. These were grafted on IMC-57 roostocks and field planted on April 2003.

Clones	# of graftings	# of successful graftings	grafting date
COCA-3333	8	0	25/11/03
AMA-5	7	0	25/11/03
AGU-17	9	2	25/11/03
BOB-3	8	2	25/11/03
UCA-1	6	0	25/11/03
UCA-2	6	0	25/11/03
COCA-3023	7	1	26/11/03
TAP-10	8	1	26/11/03
AMA-2	8	0	26/11/03
TAP-3	7	0	26/11/03
TAP-8 (a)	7	1	3/12/03
TAP-2 (b)	5	2	3/12/03
AMA-12 (b)	7	0	3/12/03
NAP-25 (a)	9	2	3/12/03
TAP-14	8	2	8/12/03
NAP-40 (b)	9	3	8/12/03
TAP-11 (b)	7	1	8/12/03
TAP-11 (a)	10	2	8/12/03
NAP-41 (a)	8	0	8/12/03
LZ-12 e	10	3	11/12/03
GS-37 (a)	7	1	11/12/03
NA-950 (b)	10	4	11/12/03
TIP-6 (b)	7	2	14/12/03
UCA-8	9	3	14/12/03
UCA-3 (a)	10	2	14/12/03
UCA-3 (b)	8	0	14/12/03
MA-11 (a)	10	2	18/12/03
COCA-12	7	0	18/12/03
AMA-14	5	0	18/12/03
Total	227	36	

Evaluation of old cocoa progenies.

Selection of elite trees and progenies in Plot 2 A

A total of 26 hybrid progenies making up a population of 517 trees are currently under evaluation in this plot. The hybrids are crosses of different genotypes (Nacional, Trinitario and Forastero amazónicos) which were produced in the early fifties. The main objective of the present study is to explore the existing variability within this population to select elite trees and cocoa progenies. Criteria applied to carry out these selections are: number of healthy pods, number of diseased pods, witches broom incidence, pod index and seed index. As a result of a complete first year evaluation 15 trees have been selected. Hand pollinations were also carried out to determine the compatibility of the

trees. The number of healthy pods ranged from 127 to 283, while the weight of dry beans ranged from 4.15 to 13.15 kg per tree per year. Trees coded as 2506, 2126, 2786 and 2748 showed the most resistance to witches broom with 0, 3, 7 and 8 brooms respectively. The tree coded as 2506 besides being productive has not shown any broom in the last 18 months, suggesting its complete resistance to the disease (See figure 3 and Annex 6 for more information). The selected trees are being currently multiplied as clones to fix their economic traits and within three months some 2000 plants will be transported to the Amazonia region in order to establish the first two trials as a part of a multi-site clone evaluation project for that region. A preliminary work is being conducted by a new estudent to determine the organoleptic profile of these selections. Based on this work a decision will be made within one year to test the trees with the best profiles through the coastal region. Another result of this study is the identification of five progenies coded as 1, 4, 10, 11 and 25 as responsible for 80% of the total production in the population under evaluation. Finally, a monillia resistant assessment is also being conducted since January 2004 by one of our students on pods from the selected trees and interesting results are coming out so far. These will be reported in the next progress report.

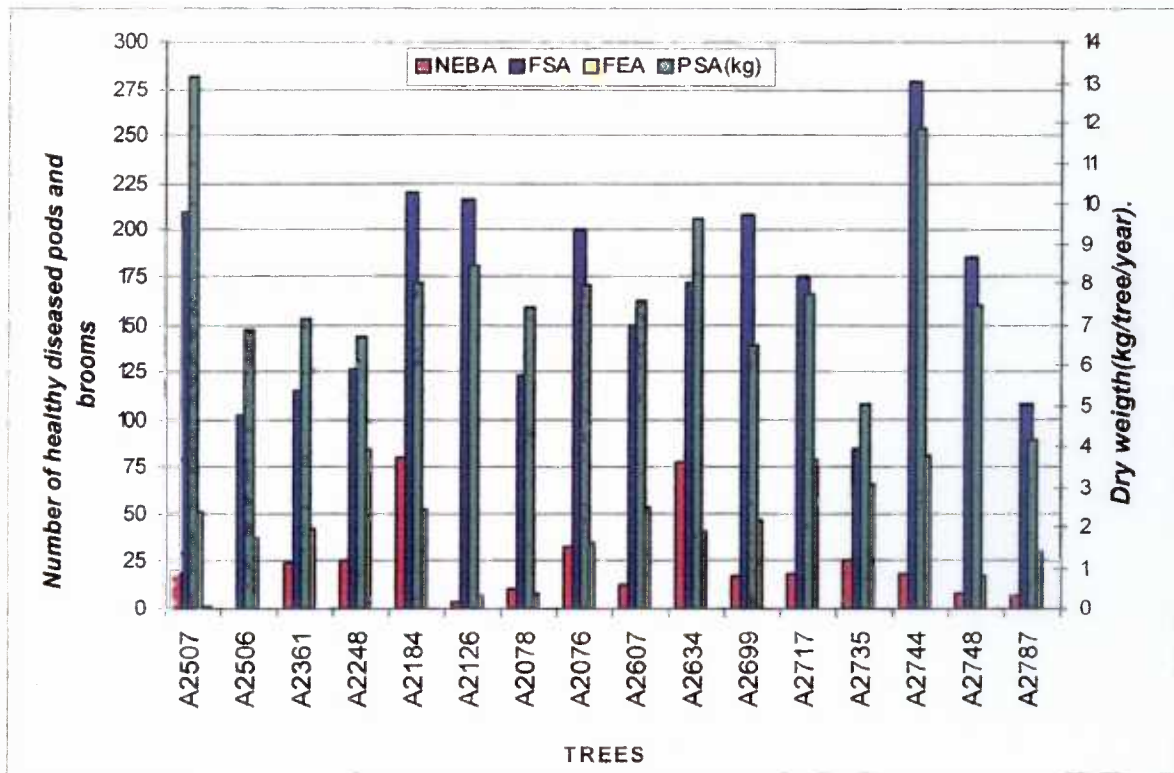


Figure 3. Differential behavior of selected trees in plot 2A regarding the variables: Number of Witches' Broom per year (NEB/A-red bars), Number of healthy pods per year (FSA-blue bars), number of diseased pods per year (FEA-yellow bars) and Dry weight per year (PSA-green bars). EET-Pichilingue 2003.

Compilation/organization and analysis of historical and present disease data in Lote 7A.

Organization and analysis of historical data produced during the period 1969 – 1985 on progenies created and planted in the late sixties continued. This work is important to explore unknown opportunities for selection of elite trees showing breeding and /or commercial value. Tabulation for the families SCA 12 x Unknown, SCA 6 x Silecia 1 and SCA 12 x Silecia 5 has been completed. Data for the family EET 95 x Silecia 1 and for the period 1981 - 1982, still remain to be typed. The same is true for the progenie SCA 6 x Silecia 5 and for the data produced during the period 1973 – 1983. It is expected to complete most of this work during year 3 of the project. In all cases data corresponds to the following variables: healthy pods, frosty pods, other diseased pods, fresh bean weight and number of vegetative and cushion brooms recorded per tree. See Table 4 for more information.

As already mentioned, the analysis of present and historical data will provide a platform for selection of superior trees with breeding and / or commercial values. An additional application has to do with the search of quantitative trait locus (QTL) in order to find molecular markers associated to resistance and productive traits. Work toward this aim will be done in collaboration with scientific staff at the USDA headquarters in Miami.

Table 4. Present progress situation of data tabulation for past and present records of the families under study.

Family	Data tabulated	To be tabulated
EET 95 x Silecia 1	1969-1980, 1983-1985	1981-1982, 2003*
SCA 12 x Unknown	1970-1985, 2001-2002	
SCA 6 x Silecia 1	1971-1985, 2002, 2003	
SCA 12 x Silecia 5	1971-1985, 2002, 2003	
SCA 6 x Silecia 5	1971-1972, 1984-1985	1973-1983, 2002-2003

*Partially typed.

So far nineteen trees from the SCA 6 x Silecia 1 family have been identified as high yielding applying the criteria of fresh bean weight. It was also observed that nine trees showed low quantities of vegetative and cushion brooms, and few pods rotten by *M. royeri*. This last result occurred even though the trees had not received sanitary management at all during several years. See Table 5 and 6 for more information. Another interesting fact is that frosty pod rot was the main cause of yield losses along the years as shown in Figure 4. During the phenomenon “el Niño” which occurred in the early eighties, pod losses were extremely high and altered drastically the relationship diseased pods / healthy pods as compared with years receiving normal rainfall amounts and distribution.

Table 5. Results of fresh bean weight and sanitary variables of superior trees selected from the progeny SCA 6 x Silecia 1 (Data from 1971-1985).

Tree N°	Cherelles	Monilia	Total Diseased Pods	Healthy pods	Fresh Bean Weight (g)
1	107	40	44	57	5622
100	37	16	22	52	5913
102	35	8	14	61	6832
131	30	18	20	52	5248
133	90	56	69	194	17137
160	18	31	34	45	5431
172	66	31	44	87	11928
173	32	30	36	74	6642
177	15	32	37	45	6436
179	12	6	7	41	5027
199	24	16	18	50	7314
201	112	49	54	140	12417
29	26	40	52	95	8139
3	24	43	52	56	6766
57	5	10	17	34	5194
66	33	34	37	54	6146
67	157	24	27	89	9506
70	20	23	25	54	6198
99	14	20	34	43	5243

Table 6. Hybrid plants (SCA 6 x Silecia 1) with low incidence of witches' broom (Vegetative broom less than 40, and cushion brooms (CB) less than 100) and frosty pod rot (less than 80). Data used October 2002 - March 2003.

Tree	Cherelle	Veget. broom	C B	Canker	Total Brooms	Chirimoiias	Monilia	Other pods rots	Total Diseased Pods
35	0	38	22	4	64	19	2	8	10
39	8	31	53	7	91	35	5	3	8
134	5	28	27	7	62	8	13	18	31
136	3	26	55	4	85	16	1	3	4
164	4	24	27	4	55	12	1	6	7
168	4	18	7	5	30	5	0	2	2
170	12	28	47	6	81	15	12	14	26
171	6	36	41	12	89	65	5	11	16
172	24	29	74	4	107	75	3	9	12

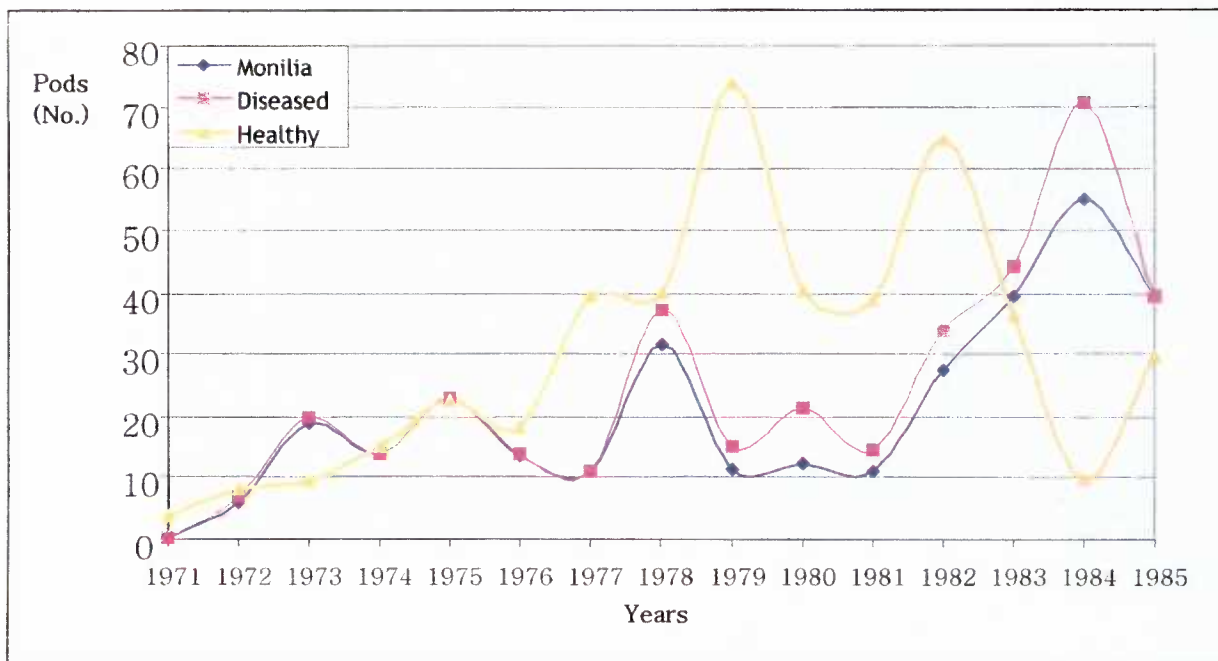


Fig. 4. Mean per tree of healthy,diseased and frosty pods in family SCA 6 x Silecia 1. INIAP-EET Pichilingue, 2003.

Breeding of new progenies

Planned new crosses to take advantage of the breeding value of Amazonian and Nacional cocoa germplasm is underway and progress achieved is described next.

Population A (Wilds). A total of 91 crosses are planned within this population. Eighty percent of the progenies have been already produced. Sixteen crosses were unsuccessful and need to be repeated. Weak flowering and loss of developing fruits due to diseases affected the availability of pods and seeds. Approximately 2000 plants corresponding to 23 families are developing at this moment in the nursery. Some 1300 three month old bagged plants from 26 progenies have been taken out to the field and placed within an old cocoa “huerta” to measure their response to a high disease pressure environment (see photographs at the end of the Annex). A similar number of plants of the same progenies are ready to undergo artificial inoculation with the SAI (system of articial inoculation). See Table 7 for more information and Annex 7 to illustrate the experimental design and distribution of the hybrid plants within the “huerta”. Data produced by both infection methods will be used as inputs in the process of validating the value of the SAI for an early prediction of disease resistance and for final selection of disease resistant plants for field planting. Breeding efficiency for witches broom resistance can be importantly improved as a result of this activity.

Table 7. Crosses performed within the population A (Wilds)

♀	♂	A 645	B 60	D 147	2057	2367	2416
EET 233		+ (-)	+	+ (-)	+	+	-
EET 387		+	+	+	+	+	+
CCN 51		+	+	+	+ (-)	+ (-)	-
Silecia 1		-	+	+	+	-	+
EET 58		*	+	*	*	*	*

*Pods still growing at field.

-Need new pollinations.

+Pods harvested.

Population B (Known clones). A total of 30 crosses are planned within this population. Though all crosses were completed, diseases (mainly *Phytophthora sp.*) affected the development of pods for some of them, mainly in those crosses that had the CCN-51 and EET 233 as one of their parents. Eight crosses need to be performed again in order to produce enough pods to obtain the progenies. See Table 8 for more information.

Table 8. Crosses performed within the population B "Known clones".

♀	♂	LCT-368	EBC-148	TIP-1	UNAP-2	CUR-3	TAP-6	TAP-12	TAP-3	TAP-10	AMAZ-11	AMAZ-14	LCT-37	LCT-46	CCN-51
LCT-368															
EBC-148		+													
TIP-1		+ (*)	+ (*)												
UNAP-2		+	+	*											
CUR-3		+ (*)	+ (*)	+ (*)	*										
TAP-6		+ (*)	+ (*)	+ (*)	+ (*)	-									
TAP-12		-	+	+ (*)	+	+ (*)	-								
TAP-3		+ (*)	+ (*)	+ (*)	+	+ (*)	-	+ (*)							
TAP-10		+	+	+ (*)	+	+	-	-	+						
AMA-11		+	+	+ (*)	+	+	*	+	+ (*)	+					
AMA-14		+	+	+ (*)	*	+ (-)	-	-	-	+	*				
LCT-37		-	*	-	*	-	-	-	*	*	*	*			
LCT-46		-	*	-	-	Inc.	*	-	-	*	*	*	-		
CCN-51		+	+	+ (*)	+	+ (*)	+ (*)	+	+	+	+	+	+	+	

Around 1300 hybrid plants from 13 progenies are developing in the nursery. Pods are developing to produce other families; these will be harvested within the next few weeks and months. Eight progenies totaling more than 400 hybrids plants were taken out to the field and placed in a cocoa "huerta" to measure their response to a high pressure disease environment. The same number will soon be subjected to the SAI to measure their reaction to artificial inoculation with witches broom.

Population C (Nacional Type). A total of 36 crosses are planned within this population. This plan has progressed some 70 %. Lack of flowering synchronization between the parent trees located in the Estación Pichilingue and the farms "La Gloria" and "Las Brisas" have slowed the progress of this activity. At the moment there are around 2000 seedlings from 20 crosses growing in the nursery. Five progenies totaling 250 plants

have been taken out to the field and placed in a cocoa “huerta” to measure their response to a high pressure disease environment. The same number are ready to undergo artificial inoculation through the SAI in the next days. See Table 9 and 10 for more information.

Table 9. Crosses performed within population C (Nacional type)

	EB-10-13	EB-22-37	CCAT-18-58	CCAT-46-88	SNA-0707	SNA-0708
Gloria-1	+	+*	+*	+*	+*	+*
Gloria-3	+*	*	*	+*	+	+*
Gloria-17	-	+*	+*	+*	*	*
Brisas-13	+	*	*	*	*	*
Brisas-16	-	+*	*_	*	*	*
Brisas-30	-	-	+	-	-	*

- * = Pods still growing at field.
- = Need new pollinations.
- + = Pods harvested.

Table 10. First progenies taken out for WB field evaluation and ready for early WB evaluation under laboratory conditions (SAI).

Treatments			
N°	Hybrids	N°	Hybrids
1	AMA - 11 X TAP - 10	21	CCN - 51 X AMA - 11
2	AMA - 11 X UNAP - 2	22	TAP - 10 X UNAP - 2
3	AMA - 11 X TAP - 12	23	BRISAS - 3 X CCAT - 1858
4	EET - 387 X D - 147	24	GLORIA - 3 X SNA - 0707
5	EET - 387 X B - 60	25	EET - 387 X 2057
6	CCN - 51 X TAP - 10	26	TAP - 10 X CUR - 3
7	CCN - 51 X LCT - 46	27	TAP - 10 X EBC - 148
8	CCN - 51 X B - 60	28	TAP - 12 X EBC - 148
9	AMA - 11 X EBC - 148	29	EBC - 148 X LCT - 368
10	CCN - 51 X D - 147	30	TAP - 10 X LCT - 368
11	EET - 58 X B - 60	31	CCN - 51 X TAP - 3
12	CCN - 51 X A - 645	32	TIP - 1 X LCT - 368
13	EET - 387 X A - 645	33	AMA - 14 X UNAP - 2
14	BRISAS - 13 X EB - 1013	34	TIP - 1 X EBC - 148
15	TAP - 3 X UNAP - 2	35	AMA - 11 X LCT - 368
16	AMA - 11 X CUR - 3	36	GLORIA - 1 X SNA - 0708
17	UNAP - 2 X EBC - 148	37	AMA - 14 X TIP - 1
18	CCN - 51 X EBC - 148	38	GLORIA - 1 X CCAT - 1858
19	TAP - 12 X UNAP - 2	39	AMA - 11 X TIP - 1
20	AMA - 11 X TAP - 3	40	TESTIGO

Land preparation for field planting of the progenies

Some 23.5 hectares of a shrubby pasture land were prepared. Two thirds of this surface have a flat topography and are being considered to plant the future trials. Half of it has already been planted with plantain to provide temporary shading. This is needed once the selected witches broom resistant plants coming out from the several tested cocoa progenies are ready to go out for field planting. Approximately 1.3 hectares of natural ponds have been conditioned as sources of water to provide irrigation to the cocoa plants during the dry part of the year (six months). A similar surface is available for future conditioning with the same purpose. Sloping areas are gradually being planted with timber species. It should be noted that some 4 hectares have already been planted to three cocoa trials (26 progenies created in the frame of the CFC /ICCO/IPGRI project that ended last year, 10 progenies created locally and also received from other American countries in the frame of a new CFC/ICCO/IPGRI project, and planting material from 10 clones to compare field performance of somatic embriogenic clones with those produced with other clonal propagation methods). Discussion is ongoing by the cocoa team members to turn the whole area into a agroturistic option to add value to the project through this type of alternative benefits (see photographs in the Annex for graphic illustrations).

Cocoa diseases studies

Pathogen population diversity

A field survey through several main cocoa growing areas (Provinces of Guayas, Los Rios, Esmeraldas, Manabí and Napo) allowed the sampling of diseased plant material to isolate strains of *C. pernicioso* and *M. Roreri*. DNA was extracted from 105 strains of both causal organisms. RAPDs were carried out at the Molecular Biology lab of CEPEC (Brasil). Figures 5 illustrate some of the results on the genetic diversity of these organisms. More detailed and complete information will be presented in the next progress report.

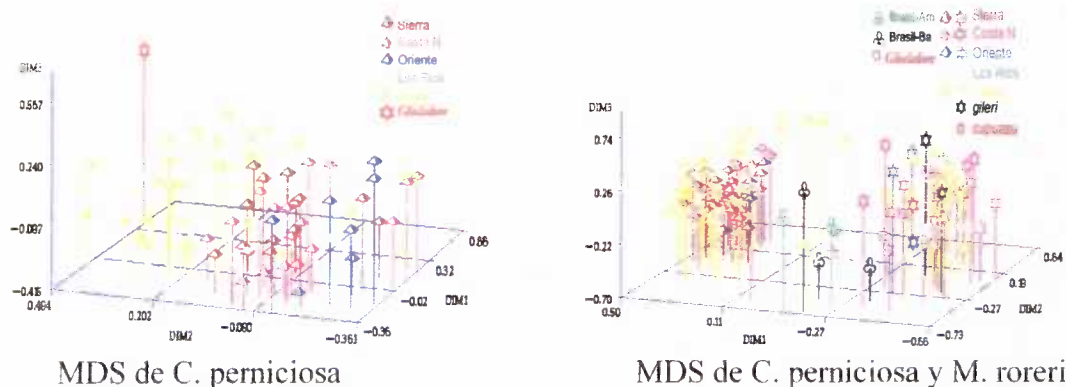


Fig. 5. Genetic variability results of *C. Pernicioso* and *M.Roreri* strains collected in main cocoa growin zones of Ecuador.

Disease Resistance Evaluation

A study was conducted in the lab to measure the reaction of Amazonian accessions from the Chalmer and Allen collection at Pichilingue to the inoculation with *Ceratocystis fimbriata*. The data produced were analysed with the assistance of Johnny Demey (a hired consultant). A dendrogram was originated based on the dissimilarity ranking matrix and UPGMA as the clustering method. Figure 6 shows the relationships among different cocoa accessions using the mycelium development and the perithecium formation variables. Three main group are distinguished. The first group is conformed by accessions that could be considered *Ceratocystis* resistant (including IMC 67), the second group is constituted by accessions that could be considered moderately susceptible to the disease caused by this organism and the third group by susceptible accessions.

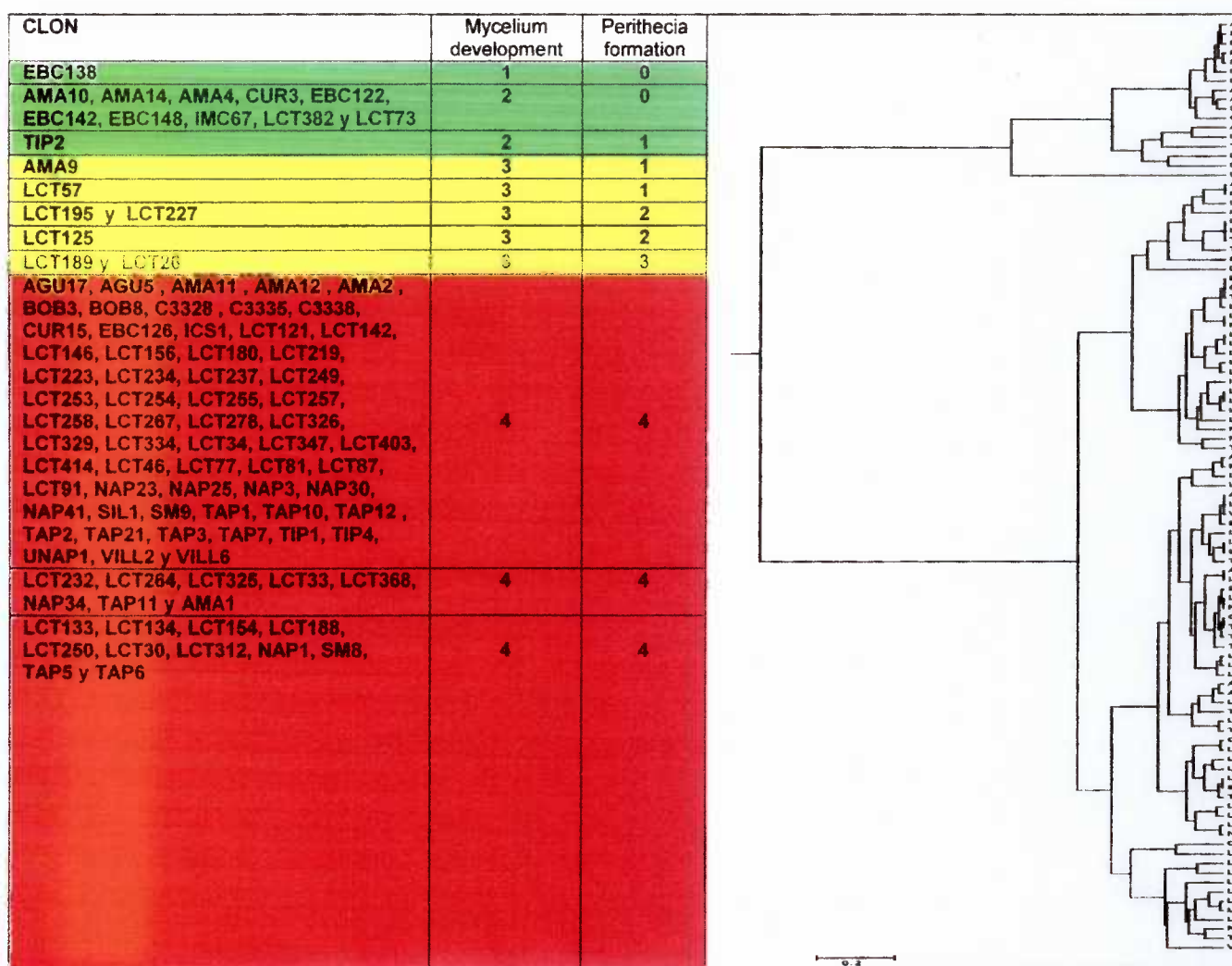


Fig. 6. Dendrogram of Chalmers and Allen germplasm based on dissimilarity ranking data and UPGMA as the clustering method. Groups of resistance to *Ceratocystis* are highlighted in different colors. The green color shows the group with the most resistance.

Frosty Pod Rot .- Around 500 flowers were hand-pollinated in 15 clones of the Chalmers collection. However weather conditions led to the rot of the pods by *Phytophthora sp.* This happened even though the pods were protected with plastic bags. Same test is planned to be carried out again during the dry part of the year.

Witches' broom.- A piece of research was formulated to compare the performance of 10 early screening methods for early evaluation of resistance to Witches' Broom. Treatments to be compared are: Test of Holliday, extract of young tissues, leaf disks, field young shoots, callus inoculation, somatic embryos inoculation, cotyledon inoculation and SAI. Work to produce enough spores of the causal agent of the disease is undergoing and inoculation will take place within the next weeks.

Publications

Loor, S. R. y Amores, F. 2003. Explorando la variabilidad del cacao tipo Nacional para identificar clones élite. Revista Sabor Arriba de la Asociación de Exportadores de cacao de Ecuador. (ANECACAO). Año 2, Nº 4. Pag. 14-15.

Loor, S. R. y Amores, F. 2003. Comparación de los niveles de homocigosis y heterocigosis entre cacaos (*Theobroma cacao* L.) del genotipo Nacional y otros existentes en Ecuador, mediante el uso del marcador molecular denominado microsátélites (SSRs)". Presented at the 14th International Cacao Conference in Ghana-Africa.

Delgado, R. 2003. Fuentes de resistencia al mal del machete en accesiones de cacao silvestre colectadas en la amazonia ecuatoriana. Presented in the XII Seminario Nacional de Sanidad Vegetal. Latacunga, Ecuador. November 19-21, 2003.

A inventory of the genetic material available in the different cocoa germplasm Collections present in Ecuador as well as the knowledge generated around is in progress. Over 6000 diferent accesions are being considered and publication of the inventory is expected to be made this year. It is strategic for the future development of cocoa research in Ecuador.

Personal hired by the project

Juan Agama (student), Dario Calderón (student), Patricio del Pozo (student), Ricardo Zapata (technitian) and Geover Peña (technitian).

Acknowledgments

Freddy Amores, Carmen Suarez and Gaston Loor, members of the cocoa team of INIAP, deeply acknowledge and thanks the support received by the project to attend the 14th international cocoa research conference which took place in Accra, Ghana, during the past October 2003.

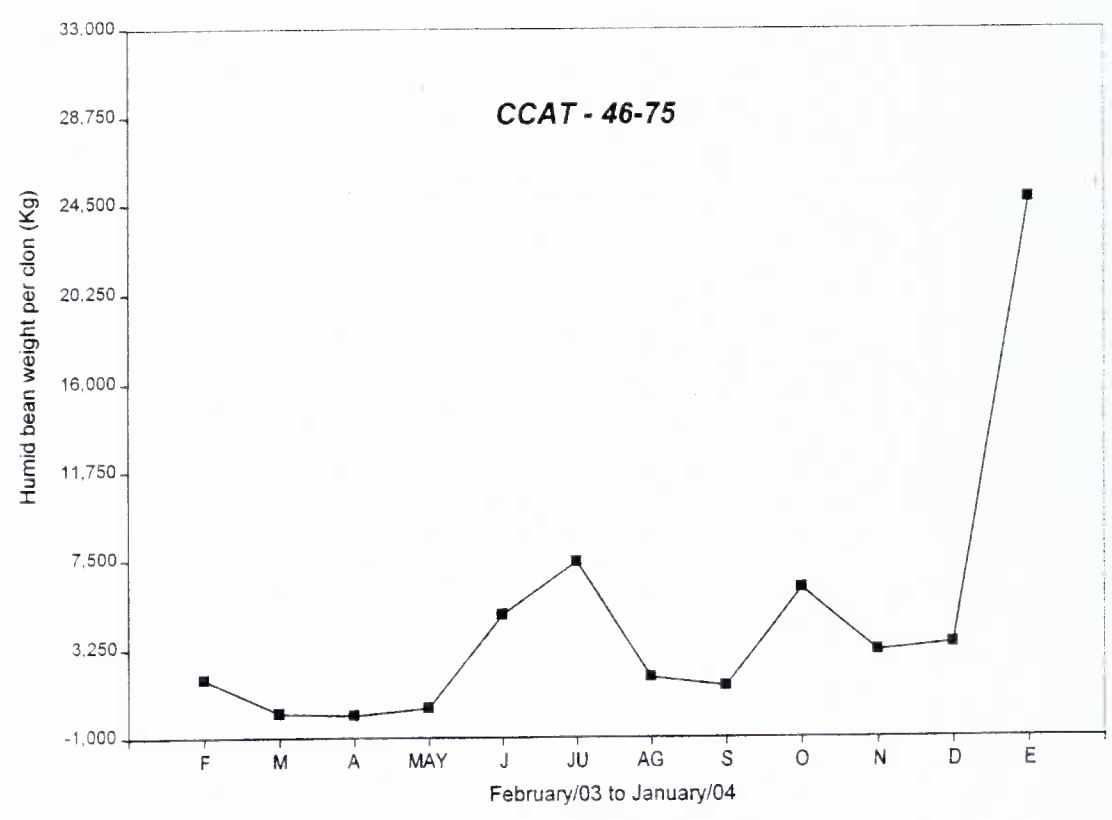
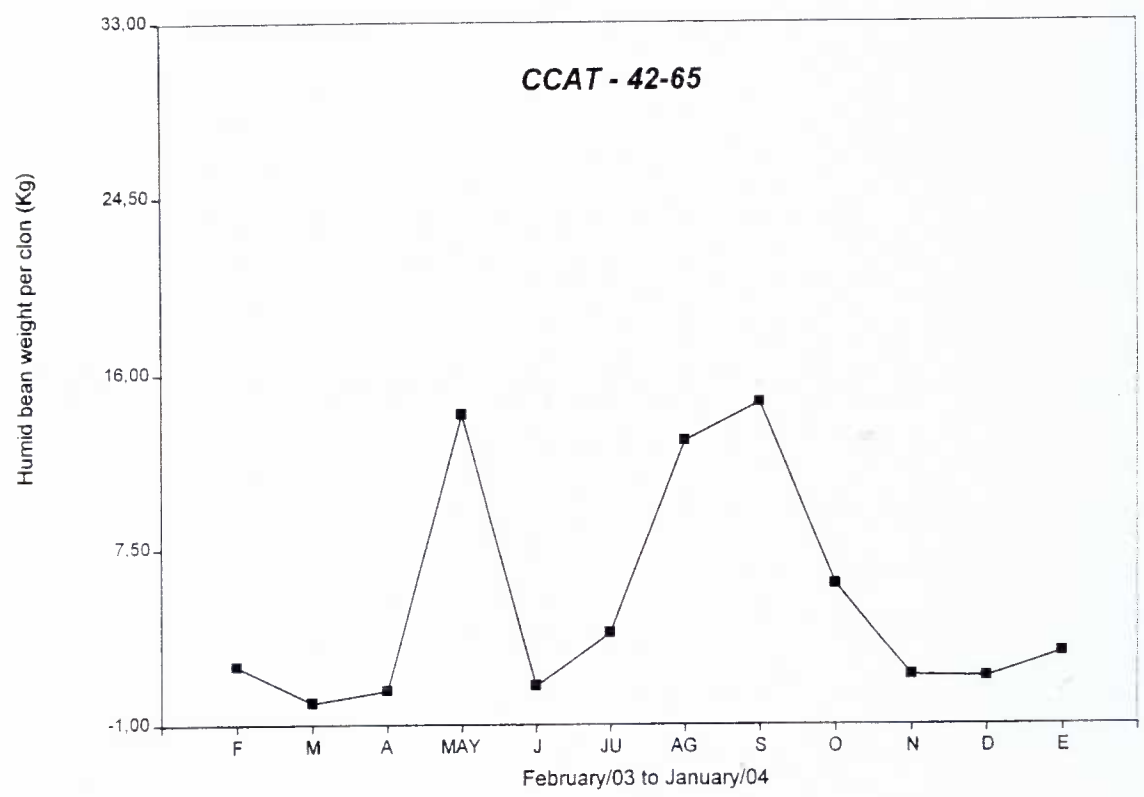
ANNEX

Annex 1. Number of accessions in the Collection of Nacional cocoa genotypes at Pichilingue.

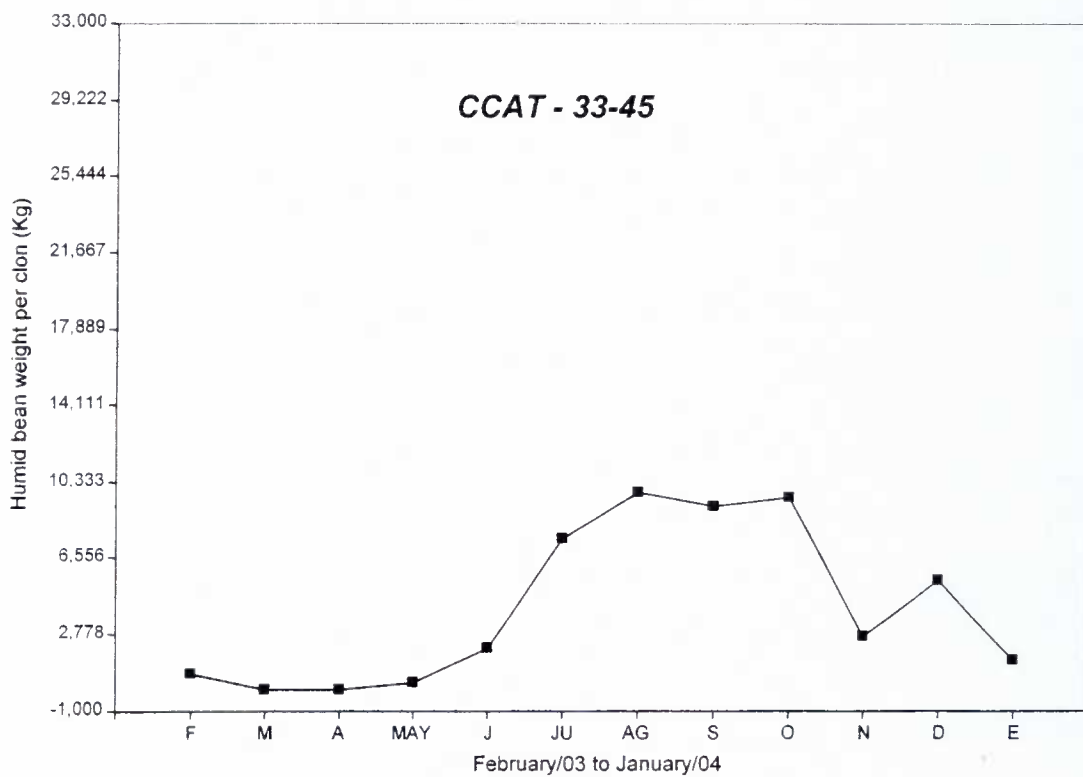
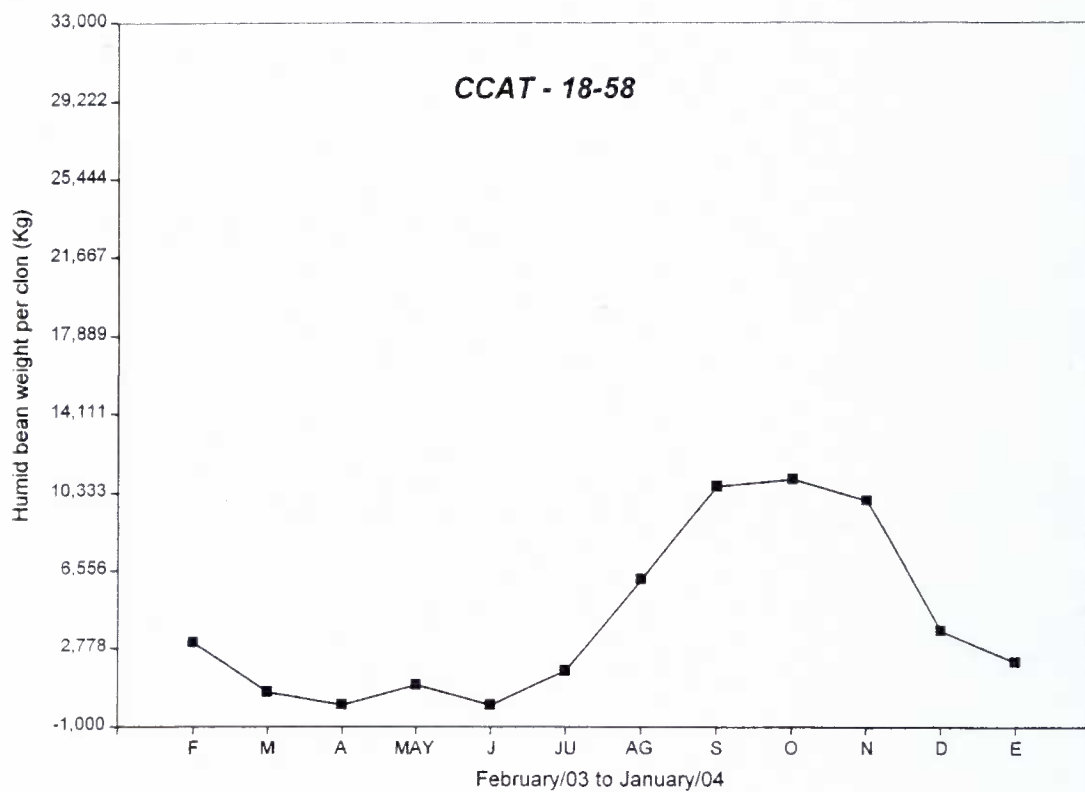
N°	Accession	Origin	N°	Accession	Origin	N°	Accession	Origin
1	CCAT 46-68	Tenguel	27	CCAT 42-65	Tenguel	53	CCAT 19-34	Tenguel
2	CCAT 45-83	Tenguel	28	EB 21-02	Mocache	54	CCAT 18-17	Tenguel
3	CCAT 49-98	Tenguel	29	CCAT 19-16	Tenguel	55	EB 22-29	Calceta
4	CCAT 26-64	Tenguel	30	CCAT 19-28	Tenguel	56	CCAT 33-45	Tenguel
5	CCAT 42-60	Tenguel	31	CCAT 18-58	Tenguel	57	EB 15-16	Pueblo Viejo
6	EB 10-13	Milagro	32	CCAT 54-77	Tenguel	58	EB 01-04	Machala
7	CCAT 22-40	Tenguel	33	CCAT 50-64	Tenguel	59	CCAT 46-75	Tenguel
8	EB 05-01	Chone	34	CCAT 32-60	Tenguel	60	EB 22-25	Camareta
9	EB 20-03	Zapotal	35	CCAT 52-12	Tenguel	61	CCAT 19-14	Tenguel
10	EB 22-37	Canuto	36	CCAT 30-61	Tenguel	62	CCAT 46-68	Tenguel
11	FIDENCIO	Zapotal	37	CCAT 19-30	Tenguel	63	EB 22-50	Río Santo
12	EB 12-03	El Triunfo	38	BETANIA	Zapotal	64	CCAT 19-15	Tenguel
13	EB 10-11	Milagro	39	CCAT 21-43	Tenguel	65	CCAT 23-63	Tenguel
14	CCAT 45-84	Tenguel	40	CCAT 23-49	Tenguel	66	CCAT 46-50	Tenguel
15	CCAT 52-06	Tenguel	41	CCAT 43-64	Tenguel	67	CCAT 05	Tenguel
16	EB 19-15	Vinces	42	CCAT 51-36	Tenguel	68	CCAT 01	Tenguel
17	EB 10-10	R. Astudillo	43	CCAT 34-07	Tenguel	69	CCAT 52-12	Tenguel
18	CCAT 11-19	Tenguel	44	EB 20-09	Zapotal	70	CCAT 30-50	Tenguel
19	CCAT 23-41	Tenguel	45	SA 8	Fío Chone	71	SIN PLACA	
20	CCAT 18-58	Tenguel	46	BCH 9	Balao Chico	72	EET 387	Pichilingue
21	CCAT 46-88	Tenguel	47	EB 22-22	Camareta	73	SIN PLACA	
22	CCAT 25-64	Tenguel	48	BCH 14	Balao Chico	74	EET 233	Pichilingue
23	CCAT 12-01	Tenguel	49	EB 22-36	Canuto	75	SIN PLACA	
24	EB 04-02	Chontillal	50	EB 22-33	Canuto	76	CCAT 2	Tenguel
25	EB 04-01	Chontillal	51	EB 16-17	Guare	77	SIN PLACA	
26	CCAT 30-50	Tenguel	52	EB 19-22	Vinces			

Annex 2.

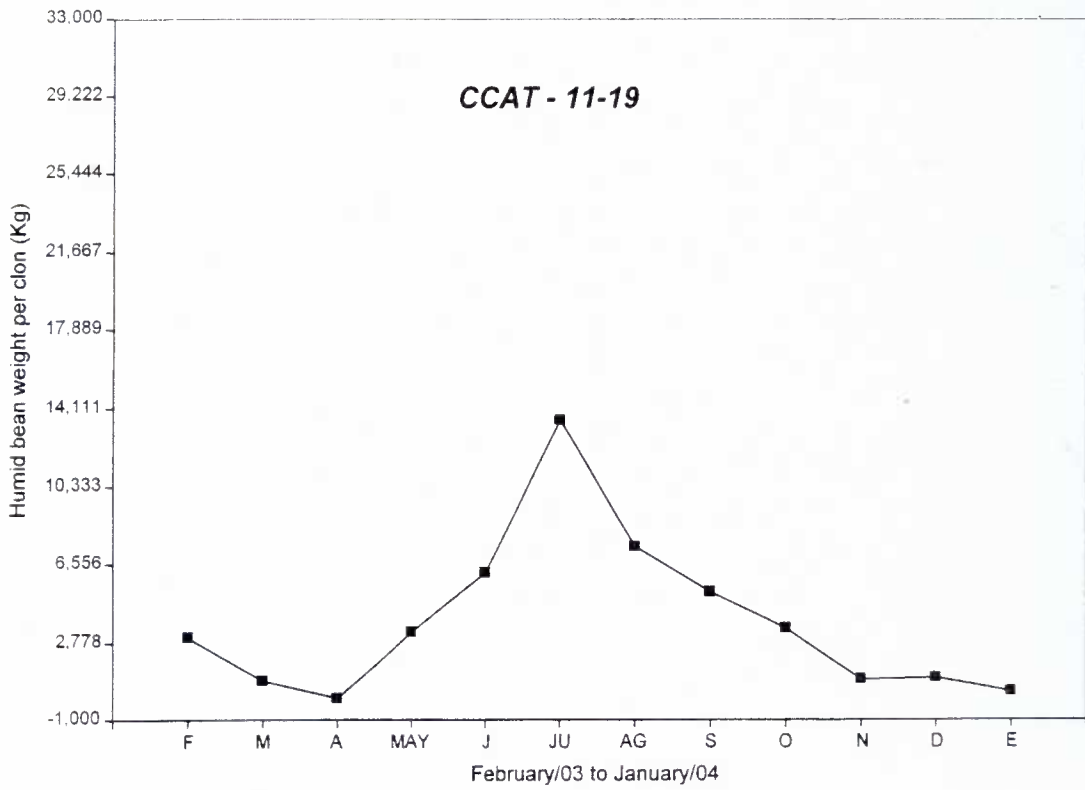
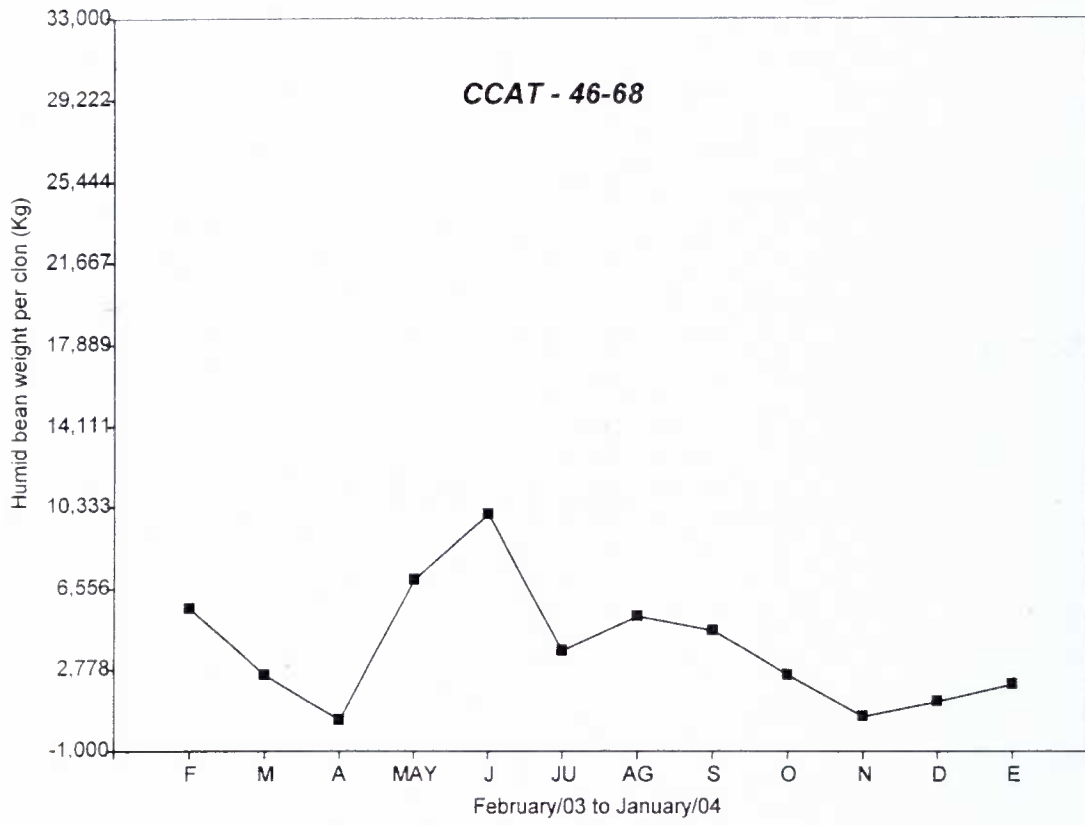
Harvest distribution of the 10 clones identified as high yielding in the CGCN Collection at Pichilingue, during February/2003 to January/2004



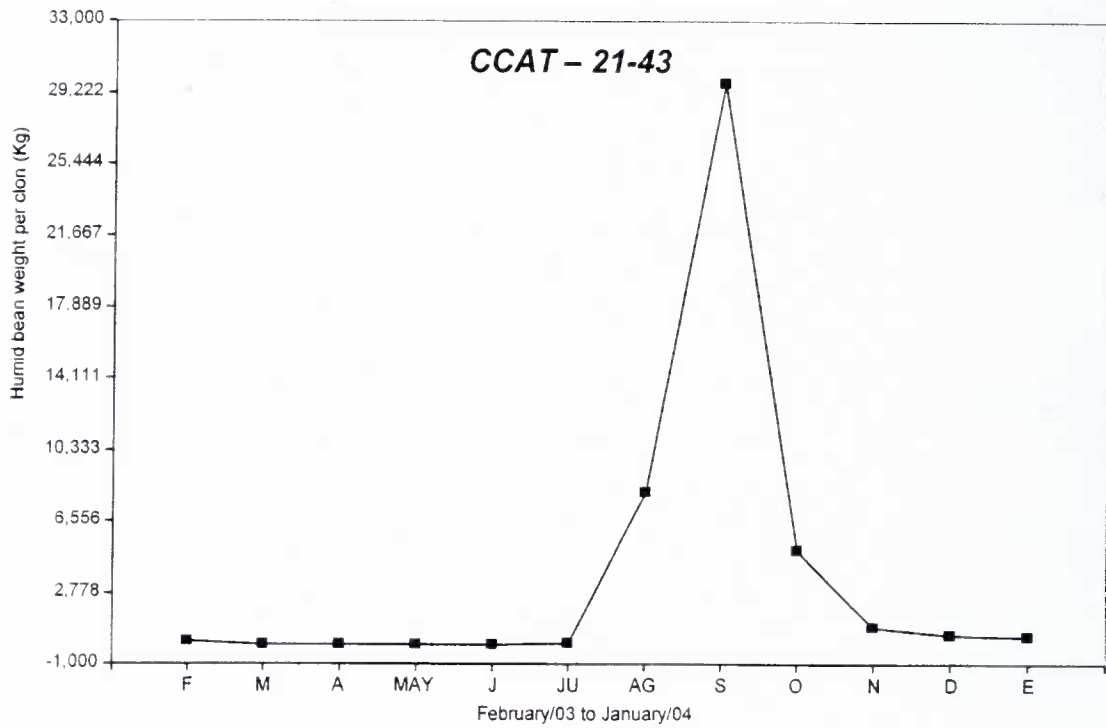
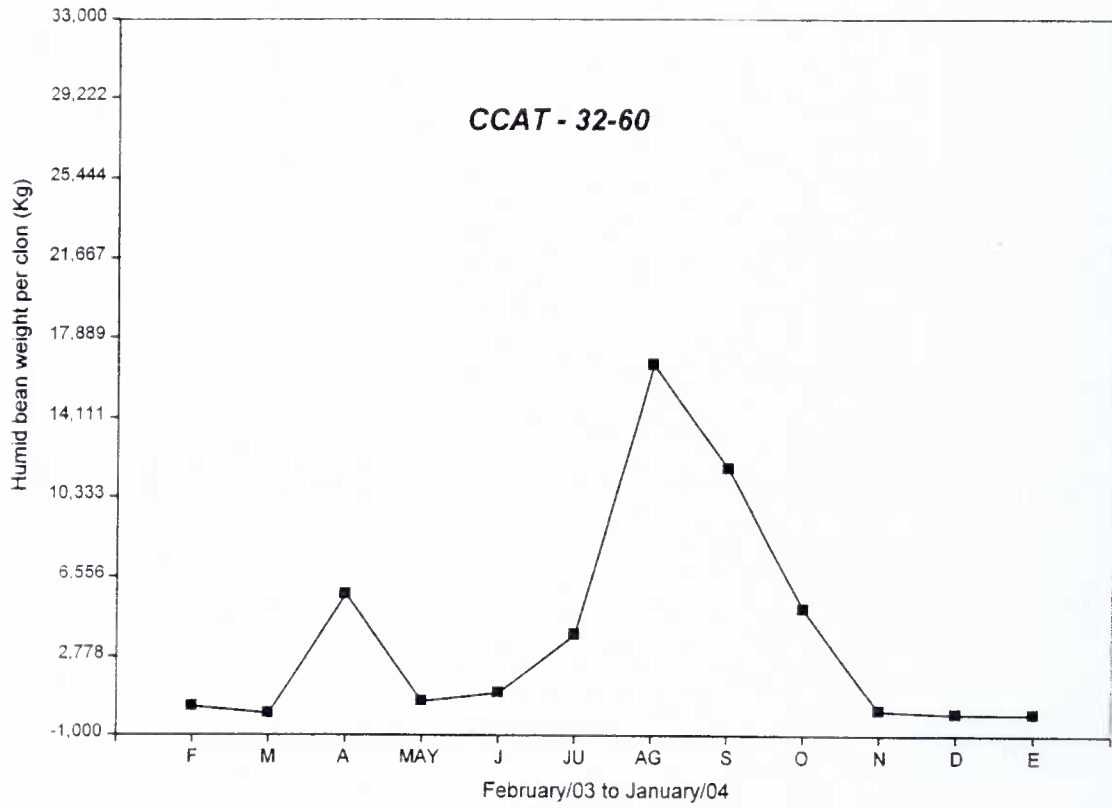
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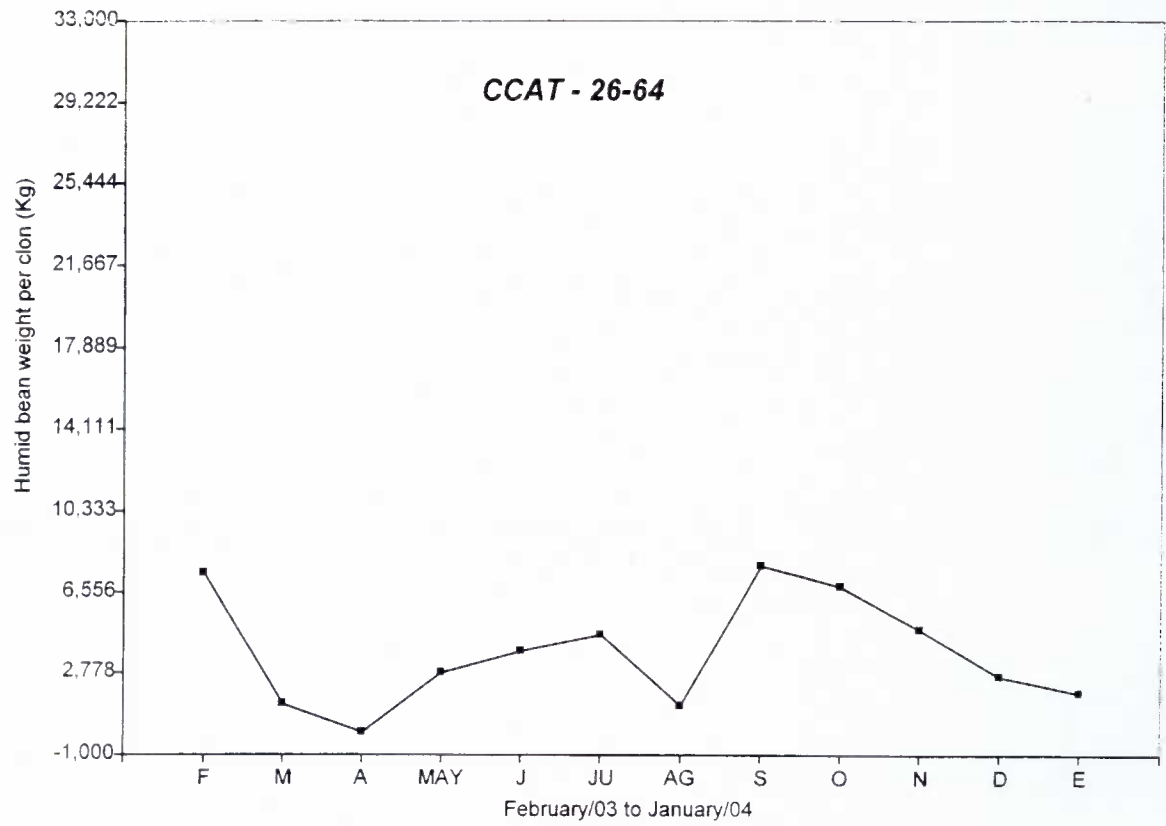
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CI/ON	N° trees	HEALTHY PODS					TOTAL	DISEASED PODS					TOTAL	HUMID BEAN WEIGHT (KG)					TOTAL			
		J	A	S	C	N		D	J	A	S	C		N	D	J	A	S		C	N	D
SNA 0428	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0417	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0421	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0404	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0423	5	0	0	0	1	1	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0392	5	0	0	0	4	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0808	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0503	4	0	0	1	10	6	1	18	0	0	0	1	0	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.450
SNA 0437	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0204	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0103	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0102	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0101	4	0	0	0	0	1	0	1	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 1002	5	0	0	0	0	0	0	0	1	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 1009	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0907	4	2	0	0	0	1	0	3	0	0	0	0	0	0	0.300	0.000	0.255	0.000	0.100	0.000	0.000	0.655
SNA 0431	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0433	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0205	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0203	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0202	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0201	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0107	3	0	0	0	1	0	1	2	0	0	0	0	0	0	0.000	0.000	0.000	0.150	0.000	0.100	0.000	0.250
SNA 0106	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0105	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0412	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIN PLACA1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIN PLACA	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0424	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0427	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIN PLA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0435	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0414	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIN	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0403	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.150	0.000	0.000	0.000	0.150
SIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0430	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SNA 0111	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Continue Annex 3 (b)

CLON	N° trees	HEALTHY PODS				TOTAL	DISEASED PODS				TOTAL	HUMID BEAN WEIGHT (Kg)					TOTAL
		E	F	M	A		E	F	M	A		E	F	M	A		
SNA 0503	4	15	13	10	7	45	1	1	2	3	7	0,043	1,140	0,534	0,454	2,170	
SNA 0437	4	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0204	5	0	0	30	11	41	0	0	12	2	14	0,000	0,000	0,890	0,757	1,647	
SNA 0103	3	0	0	0	0	0	2	0	0	2	2	0,000	0,000	0,000	0,000	0,000	
SNA 0102	5	0	0	0	2	2	0	0	0	1	1	0,000	0,000	0,000	0,000	0,000	
SNA 0101	4	0	0	0	1	1	0	0	0	5	5	0,000	0,000	0,000	0,000	0,000	
SNA 1002	5	0	0	0	7	7	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 1009	4	1	0	0	12	13	0	0	0	7	7	0,000	0,000	0,000	0,000	0,000	
SNA 0907	4	8	0	0	2	10	2	0	0	6	8	0,887	0,000	0,000	0,000	0,887	
SNA 0431	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0433	4	20	20	20	0	60	8	8	8	0	24	0,000	2,000	0,670	0,570	3,240	
SNA 0205	3	1	0	0	1	1	0	0	0	0	1	0,000	0,000	0,000	0,000	0,000	
SNA 0203	5	4	0	0	5	9	0	0	0	1	1	0,000	0,000	0,000	0,000	0,000	
SNA 0202	1	0	0	0	1	1	2	0	0	0	2	0,000	0,000	0,000	0,000	0,000	
SNA 0201	1	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0107	3	3	0	0	1	4	2	0	0	2	4	0,085	0,000	0,000	0,000	0,085	
SNA 0106	2	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0105	2	0	0	0	1	1	0	0	0	1	1	0,000	0,000	0,000	0,000	0,000	
SNA 0412	3	3	0	0	15	18	0	0	0	4	4	0,000	0,000	0,000	0,000	0,000	
SNA 0416	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SIN PLACA1	2	2	0	0	1	3	3	0	0	3	6	0,000	0,000	0,000	0,000	0,000	
SIN PLACA	4	0	0	0	0	0	0	0	0	7	7	0,000	0,000	0,000	0,000	0,000	
SNA 0424	1	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0427	1	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SIN PLA	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SIN	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SIN	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SIN	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0435	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0414	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SIN	4	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0403	4	2	0	0	2	4	0	0	0	2	2	0,000	0,000	0,000	0,000	0,000	
SIN	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0430	4	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SIN	0	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	
SNA 0111	1	0	0	0	0	0	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	

Annex 4. Characterization results for the germplasm available in the Chalmer's Collection at Pichilingue.

ACCESSIONS	Healthy pods (wed season)	Healthy pods (dry season)	Diseased pods (wed season)	Diseased pods (dry season)	Production per clone (wed season)	Production per clone (dry season)	Number of cushion brooms	Number of vegetative brooms	Number of chirimola	Number of canker	Total production
AGU-17	72.33	64.17	41.17	36.50	73.06	77.78	105.94	150.61	87.00	132.11	58.00
AGU-5	138.38	173.00	153.88	118.75	135.25	174.88	136.50	221.63	121.25	200.63	168.25
AMA-1	131.45	54.70	150.10	146.85	124.30	57.55	133.25	144.80	110.30	44.05	78.95
AMA-10	209.06	186.69	129.50	138.75	206.13	179.13	196.56	152.63	177.19	131.06	192.44
AMA-12	95.75	143.10	172.20	211.10	97.60	151.90	189.90	126.00	188.30	88.00	121.55
AMA-14	101.90	139.80	179.75	237.85	101.00	149.30	203.35	188.30	206.25	195.90	117.60
AMA-2	162.67	156.83	58.33	154.00	178.17	152.33	173.67	149.17	164.00	140.83	159.00
AMA-4	225.64	176.07	137.43	140.79	214.86	162.29	130.29	140.50	165.50	166.50	187.29
AMA-9	167.38	154.63	176.25	237.00	126.88	128.50	266.50	207.50	243.50	102.50	113.25
AMA-11	170.45	239.20	230.00	265.25	183.05	243.10	214.35	167.85	199.80	112.50	235.10
BOB-3	204.00	173.20	178.80	175.50	217.20	199.80	137.00	242.10	118.30	195.80	211.90
BOB-8	171.86	111.14	167.93	204.93	209.00	126.86	108.50	200.64	120.29	205.07	163.36
COC-3328	66.30	32.50	108.30	70.00	89.40	39.80	93.30	186.70	87.00	180.50	48.20
COC-3335	172.63	52.88	196.13	54.13	196.38	59.63	75.00	162.88	87.00	133.38	119.75
COC-3338	114.00	107.58	93.67	57.00	104.17	107.33	94.83	189.25	111.33	210.00	87.25
CUR-15	146.25	96.75	224.00	82.50	155.00	84.25	75.00	239.00	87.00	261.50	121.25
CUR-3	213.89	122.50	222.72	167.28	221.56	131.89	159.56	128.61	171.00	130.44	180.39
NAP-23	116.70	80.30	68.90	76.40	117.90	84.70	93.30	165.00	110.10	190.00	92.10
NAP-25	148.67	158.67	122.83	128.83	165.00	178.33	196.67	247.50	157.50	238.83	173.00
NAP-3	233.14	95.36	156.14	174.00	208.29	93.71	209.36	232.79	185.64	93.79	142.36
NAP-30	90.75	111.25	73.88	81.50	98.88	118.88	97.88	132.75	111.00	108.63	103.88
NAP-34	186.50	213.50	253.25	244.25	181.00	239.25	239.00	247.75	246.75	207.00	232.25
NAP-41	53.90	113.00	123.70	89.50	61.20	103.70	126.50	175.20	150.70	173.40	71.50
NAP-1	81.71	144.00	71.93	103.79	98.36	135.57	138.57	213.71	132.86	143.93	119.57
SIL-1	19.50	44.50	21.50	156.00	20.00	33.50	75.00	81.50	87.00	29.50	9.00
SM-9	188.43	218.00	168.71	148.93	166.79	217.07	236.93	253.36	241.93	222.64	211.36
SM-8	96.50	60.07	97.21	76.57	102.86	58.14	187.00	185.93	180.43	169.93	62.43
TAP-1	160.58	154.75	185.92	173.50	159.75	146.58	90.25	106.83	87.00	138.33	147.00
TAP-10	141.05	214.15	129.00	117.45	124.75	207.60	102.45	61.20	96.60	86.75	183.25
TAP-11	93.50	166.50	92.39	99.83	83.94	158.33	95.33	39.11	116.00	142.33	129.17
TAP-12	78.90	168.95	112.75	125.45	72.50	163.85	93.30	29.50	96.60	113.85	121.70
TAP-2	130.55	115.25	148.95	118.00	136.05	102.70	126.45	82.05	124.70	79.00	113.05
TAP-21	116.83	79.33	34.50	45.33	119.67	86.83	75.00	151.50	87.00	193.17	86.50
TAP-3	205.15	204.05	171.15	147.15	207.50	201.65	106.70	101.65	124.10	186.55	212.50
TAP-5	201.31	232.56	175.38	206.38	184.06	221.44	132.50	83.75	160.44	144.25	218.44
TAP-7	164.60	165.70	129.50	160.50	149.80	149.30	93.30	53.90	116.20	121.00	143.00
TAP-6	184.45	130.95	137.00	126.90	168.90	132.45	75.00	40.15	87.00	121.25	139.60
TIP-1	145.13	29.50	132.00	105.50	121.88	29.25	75.00	54.13	87.00	65.75	59.13
TIP-2	269.25	183.38	93.75	176.88	270.50	194.63	161.25	188.25	188.13	136.25	242.00
TIP-4	80.44	44.94	124.06	60.17	106.39	42.11	89.89	63.89	99.83	58.61	56.22
UNAP-1	124.56	244.06	181.50	240.88	117.31	240.81	251.00	158.69	222.13	135.75	232.75
UNAP-2	70.50	258.88	79.63	154.38	81.50	260.88	217.63	234.25	175.50	252.63	238.13
VILL-2	38.50	67.75	41.00	96.50	47.75	84.25	75.00	144.50	87.00	95.50	49.75
VILL-6	86.29	68.57	167.29	76.14	99.43	69.07	140.79	150.14	109.36	188.57	64.57

Annex 4. Characterization results for the germplasm available in the Chalmer's Collection at Pichilingue.

ACCESSIONS	Healthy pods (wed season)	Healthy pods (dry season)	Diseased pods (wed season)	Diseased pods (dry season)	Production per clone (wed season)	Production per clone (dry season)	Number of cushion brooms	Number of vegetative brooms	Number of chirimola	Number of canker	Total production
AGU-17	72.33	64.17	41.17	36.50	73.06	77.78	105.94	150.61	87.00	132.11	58.00
AGU-5	138.38	173.00	153.88	118.75	135.25	174.88	136.50	221.63	121.25	200.63	168.25
AMA-1	131.45	54.70	150.10	146.85	124.30	57.55	133.25	144.80	110.30	44.05	78.95
AMA-10	209.06	186.69	129.50	138.75	206.13	179.13	196.56	152.63	177.19	131.06	192.44
AMA-12	95.75	143.10	172.20	211.10	97.60	151.90	189.90	126.00	188.30	88.00	121.55
AMA-14	101.90	139.80	179.75	237.85	101.00	149.30	203.35	188.30	206.25	195.90	117.60
AMA-2	162.67	156.83	58.33	154.00	178.17	152.33	173.67	149.17	164.00	140.83	159.00
AMA-4	225.64	176.07	137.43	140.79	214.86	162.29	130.29	140.50	165.50	166.50	187.29
AMA-9	167.38	154.63	176.25	237.00	126.88	128.50	266.50	207.50	243.50	102.50	113.25
AMA-11	170.45	239.20	230.00	265.25	183.05	243.10	214.35	167.85	199.80	112.50	235.10
BOB-3	204.00	173.20	178.80	175.50	217.20	199.80	137.00	242.10	118.30	195.80	211.90
BOB-8	171.86	111.14	167.93	204.93	209.00	126.86	108.50	200.64	120.29	205.07	163.36
COC-3328	66.30	32.50	108.30	70.00	89.40	39.80	93.30	186.70	87.00	180.50	48.20
COC-3335	172.63	52.88	196.13	54.13	196.38	59.63	75.00	162.88	87.00	133.38	119.75
COC-3338	114.00	107.58	93.67	57.00	104.17	107.33	94.83	189.25	111.33	210.00	87.25
CUR-15	146.25	96.75	224.00	82.50	155.00	84.25	75.00	239.00	87.00	261.50	121.25
CUR-3	213.89	122.50	222.72	167.28	221.56	131.89	159.56	128.61	171.00	130.44	180.39
NAP-23	116.70	80.30	68.90	76.40	117.90	84.70	93.30	165.00	110.10	190.00	92.10
NAP-25	148.67	158.67	122.83	128.83	165.00	178.33	196.67	247.50	157.50	238.83	173.00
NAP-3	233.14	95.36	156.14	174.00	208.29	93.71	209.36	232.79	185.64	93.79	142.36
NAP-30	90.75	111.25	73.88	81.50	98.88	118.88	97.88	132.75	111.00	108.63	103.88
NAP-34	186.50	213.50	253.25	244.25	181.00	239.25	239.00	247.75	246.75	207.00	232.25
NAP-41	53.90	113.00	123.70	89.50	61.20	103.70	126.50	175.20	150.70	173.40	71.50
NAP-1	81.71	144.00	71.93	103.79	98.36	135.57	138.57	213.71	132.86	143.93	119.57
SIL-1	19.50	44.50	21.50	156.00	20.00	33.50	75.00	81.50	87.00	29.50	9.00
SM-9	188.43	218.00	168.71	148.93	166.79	217.07	236.93	253.36	241.93	222.64	211.36
SM-8	96.50	60.07	97.21	76.57	102.86	58.14	187.00	185.93	180.43	169.93	62.43
TAP-1	160.58	154.75	185.92	173.50	159.75	146.58	90.25	106.83	87.00	138.33	147.00
TAP-10	141.05	214.15	129.00	117.45	124.75	207.60	102.45	61.20	96.60	86.75	183.25
TAP-11	93.50	166.50	92.39	99.83	83.94	158.33	95.33	39.11	116.00	142.33	129.17
TAP-12	78.90	168.95	112.75	125.45	72.50	163.85	93.30	29.50	96.60	113.85	121.70
TAP-2	130.55	115.25	148.95	118.00	136.05	102.70	126.45	82.05	124.70	79.00	113.05
TAP-21	116.83	79.33	34.50	45.33	119.67	86.83	75.00	151.50	87.00	193.17	86.50
TAP-3	205.15	204.05	171.15	147.15	207.50	201.65	106.70	101.65	124.10	186.55	212.50
TAP-5	201.31	232.56	175.38	206.38	184.06	221.44	132.50	83.75	160.44	144.25	218.44
TAP-7	164.60	165.70	129.50	160.50	149.80	149.30	93.30	53.90	116.20	121.00	143.00
TAP-6	184.45	130.95	137.00	126.90	168.90	132.45	75.00	40.15	87.00	121.25	139.60
TIP-1	145.13	29.50	132.00	105.50	121.88	29.25	75.00	54.13	87.00	65.75	59.13
TIP-2	269.25	183.38	93.75	176.88	270.50	194.63	161.25	188.25	188.13	136.25	242.00
TIP-4	80.44	44.94	124.06	60.17	106.39	42.11	89.89	63.89	99.83	58.61	56.22
UNAP-1	124.56	244.06	181.50	240.88	117.31	240.81	251.00	158.69	222.13	135.75	232.75
UNAP-2	70.50	258.88	79.63	154.38	81.50	260.88	217.63	234.25	175.50	252.63	238.13
VILL-2	38.50	67.75	41.00	96.50	47.75	84.25	75.00	144.50	87.00	95.50	49.75
VILL-6	86.29	68.57	167.29	76.14	99.43	69.07	140.79	150.14	109.36	188.57	64.57

Annex 5 (a). Results on healthy pods, diseased pods and fresh weight obtained for the amazonian germplasm in the Allen's Collection at Pichilingue.

Clone	Accumulated healthy pods	Accumulated diseased pods	Accumulated Cherelles	Accumulated fresh bean weight	Number of trees under evaluation
LCT - 253	7	7	38	0.7	3
LCT - 73	10	1	15	1.2	2
EBC - 122	1	2	7	0.1	2
LCT - 250	19	7	29	1.7	3
LCT - 146	68	10	495	4.0	3
LCT - 334	3	5	8	0.5	2
LCT - 81	25	43	84	3.3	5
LCT - 257	9	28	8	2.3	4
LCT - 77	84	29	114	11.2	3
LCT - 121	87	69	52	8.4	5
LCT - 255	46	65	10	6.6	4
LCT - 219	5	16	10	0.3	2
LCT - 254	15	11	12	1.7	4
LCT - 325	16	26	48	2.1	2
LCT - 329	48	13	25	6.5	4
LCT - 249	26	306	14	2.8	4
LCT - 142	20	6	45	2.3	3
LCT - 156	13	13	31	0.8	2
LCT - 237	23	43	45	3.1	5
LCT - 180	47	38	18	3.9	4
LCT - 223	2	2	1	0.3	1

Continue Annex 5 (a)

Clone	Accumulated healthy pods	Accumulated diseased pods	Accumulated Cherelles	Accumulated freash bean weight	Number of trees under evaluation
LCT - 125	1	1	2	0.1	2
EBC - 138	96	27	79	9.5	5
LCT - 232	22	22	29	2.8	3
LCT - 368	67	32	15	3.7	4
LCT - 227	12	6	44	1.6	2
LCT - 278	40	19	60	5.2	2
LCT - 347	103	54	109	12.5	5
EBC - 142	116	78	56	15.5	3
LCT - 154	67	133	50	7.7	3
LCT - 87	22	14	42	2.9	2
EBC - 148	95	66	146	11.1	4
LCT - 30	88	29	32	9.6	2
LCT - 326	20	8	23	1.9	1
LCT - 312	0	0	4	0.0	1
EBC - 126	21	4	10	2.1	1
LCT - 134	0	0	1	0	2
TOTAL	1344	1226	1797	151.0	109

Annex 5 (b) Results on witches broom evaluation (2002 and 2003) on the germplasm available in the Allen's Collection at Pichilingue.

CLONE	First evaluation/2002				Second evaluation/2003				Weight Gr
	Broom	Cushion Brooms	CHIRM	Canker	Broom	Cushion Brooms	CHIRM	Canker	
LCTEEN - 253	52	0	0	48	53	0	0	8	335
LCTEEN - 91	2	0	0	8	0	0	0	0	0
LCTEEN - 73	3	0	0	4	3	0	0	2	25
LCTEEN - 258	3	0	0	6	7	0	0	0	55
LCTEEN - 264	0	0	0	1	0	0	0	0	0
EBC - 122	10	0	0	11	11	0	0	1	55
LCTEEN - 312	21	0	0	21	21	0	0	2	125
LCTEEN - 33	1	0	0	2	0	0	0	0	0
LCTEEN - 134	22	0	0	40	38	0	0	1	150
EBC - 126	4	0	0	19	9	0	0	4	40
LCTEEN - 250	60	5	0	24	83	0	0	4	1150
LCTEEN - 146	23	11	0	28	12	0	0	4	30
LCTEEN - 334	23	0	0	24	22	0	0	1	200
LCTEEN - 234	17	0	0	11	4	0	0	0	30
LCTEEN - 81	13	0	0	8	4	1	0	3	25
LCTEEN - 257	22	0	0	14	10	0	0	2	105
LCTEEN - 77	77	17	5	44	133	1	0	22	2725
LCTEEN - 121	38	3	4	53	36	1	0	19	70
LCTEEN - 255	42	0	0	44	111	1	0	6	500
LCTEEN - 219	44	0	0	22	55	0	0	9	310
LCTEEN - 325	77	0	0	36	79	3	6	2	1075
LCTEEN - 329	94	1	0	57	61	0	0	12	605
LCTEEN - 142	51	3	11	31	95	1	0	0	1700
LCTEEN - 156	1	0	0	3	7	0	0	5	45
LCTEEN - 237	83	20	21	28	104	28	31	0	2975
LCTEEN - 180	32	0	0	22	40	19	17	0	860
LCTEEN - 125	21	0	0	8	16	0	0	0	225
EBC - 138	56	3	4	69	28	2	7	10	75
LCTEEN - 232	23	0	0	34	13	3	6	1	135
LCTEEN - 368	34	3	3	19	35	0	0	0	1235
LCTEEN - 227	19	1	12	14	41	2	0	0	535
LCTEEN - 278	22	12	2	35	63	6	1	5	1125
LCTEEN - 223	7	0	0	5	3	0	0	1	25
LCTEEN - 347	126	5	19	39	204	19	25	26	3000
EBC - 142	37	0	0	25	23	0	0	5	275
LCTEEN - 154	56	10	1	61	32	3	3	6	275
LCTEEN - 87	35	3	0	11	28	28	26	3	1375
EBC - 148	20	3	2	75	7	4	0	0	50
LCTEEN - 30	10	2	0	12	18	1	0	2	80
LCTEEN - 326	16	0	0	15	26	0	0	0	120
LCTEEN - 403	3	0	0	7	0	0	0	0	0
LCTEEN - 364	0	0	0	0	7	0	0	0	25
LCTEEN - 241	0	0	0	0	0	0	0	0	0
LCTEEN - 282	0	0	0	0	0	0	0	1	0
LCTEEN - 133	0	0	0	0	5	0	0	0	10
LCTEEN - 312	21	0	0	21	21	0	0	2	125

Continue Annex 5 (b)

CLONE	First evaluation/2002				Second evaluation/2003				Weight
	Broom	Cushion Brooms	CHIRM	Canker	Broom	Cushion Brooms	CHIRM	Canker	Gr
LCTEEN - 282	0	0	0	0	0	0	0	1	0
LCTEEN - 133	0	0	0	0	5	0	0	0	10
LCTEEN - 312	21	0	0	21	21	0	0	2	125
LCTEEN - 195	1	0	0	2	7	0	0	1	90
LCTEEN - 46	4	0	0	2	2	0	0	0	25
LCTEEN - 411	0	0	0	0	1	0	0	0	5
LCTEEN - 65	0	0	0	0	1	0	0	0	10
LCTEEN - 249	2	0	0	8	1	0	0	0	5
LCTEEN - 254	5	0	0	9	0	0	0	0	0
LCTEEN - 188	2	0	0	0	20	0	0	3	52
LCTEEN - 52	0	0	0	0	1	0	0	0	30
LCTEEN - 73	0	0	0	0	3	0	0	2	25
LCTEEN - 91	0	0	0	0	4	0	0	0	20
LCTEEN - 193	0	0	0	0	0	0	0	0	0
LCTEEN - 414	0	0	0	0	0	0	0	0	0
LCTEEN - 267	1	0	0	2	1	0	0	1	2
LCTEEN - 57	6	0	0	10	10	0	0	2	50
LCTEEN - 432	0	0	0	0	0	0	0	0	0
LCTEEN - 259	0	0	0	0	0	0	0	0	0
LCTEEN - 449	0	0	0	0	0	0	0	0	0
LCTEEN - 36	4	0	0	1	0	0	0	0	0
LCTEEN - 141	0	0	0	0	0	0	0	0	0
LCTEEN - 156	1	0	0	3	7	0	0	5	45

ANNEX 6:

PLOT HYBRID PROGENIES POPULATION "2 A"

2773	2777	2725	2724			2629	2628			2053	2054	2101	2102	2144	2145	2197	2198			2246	2297	2297	2341	2342	2389	2390	2437	2438	2485	2486
2774	2771	2726	2723			2630	2627	2579		2054	2055	2100	2103	2148	2151	2196	2199				2297	2295	2340	2343	2388	2391	2438	2439	2484	2487
2775	2770	2727	2722			2631	2626			2051	2056	2099	2104	2147	2152	2195	2200				2297	2296	2339	2344	2387	2392	2435	2440	2483	2488
2776	2769	2728	2721			2632	2625			2050	2057	2098	2105	2146	2153	2194	2201				2297	2297	2338	2345	2386	2393	2434	2441	2482	2489
2777	2768	2729	2720			2633	2624			2049	2058	2097	2106	2145	2154	2193	2202				2297	2297	2337	2346	2385	2394	2433	2442	2481	2490
2778	2767	2730	2719			2634	2623			2048	2059	2096	2107	2144	2155	2192	2203				2297	2299	2336	2347	2384	2395	2432	2443	2480	2491
2779	2766	2731	2718			2635	2622			2047	2060	2095	2108	2143	2156	2191	2204				2297	2296	2335	2348	2383	2396	2431	2444	2479	2492
2780	2765	2732	2717			2636	2621			2046	2061	2094	2109	2142	2157	2190	2205				2286	2301	2334	2349	2382	2397	2430	2445	2478	2493
2781	2764	2733	2716	2685		2637	2620			2045	2062	2093	2110	2141	2158	2189	2206				2285	2292	2333	2350	2381	2398	2429	2446	2477	2494
2782	2763	2734	2715			2638	2619			2044	2063	2092	2111	2140	2159	2188	2207				2284	2291	2332	2351	2380	2399	2428	2447	2476	2495
2783	2762	2735	2714	2687	2666	2639	2618			2043	2064	2091	2112	2139	2160	2187	2208				2283	2294	2331	2352	2379	2400	2427	2448	2475	2496
2784	2761	2736	2713	2688		2640	2617			2042	2065	2090	2113	2138	2161	2186	2209				2282	2293	2330	2353	2378	2401	2426	2449	2474	2497
2785	2760	2737	2712	2689		2641	2616	2568		2041	2066	2089	2114	2137	2162	2185	2210				2281	2290	2329	2354	2377	2402	2425	2450	2473	2498
2786	2759	2738	2711	2690		2642	2615			2040	2067	2088	2115	2136	2163	2184	2211				2280	2291	2328	2355	2376	2403	2424	2451	2472	2499
2787	2758	2739	2710	2691		2643	2614			2039	2068	2087	2116	2135	2164	2183	2212				2279	2292	2327	2356	2375	2404	2423	2452	2471	2500
2788	2740	2709	2692			2644	2613			2038	2069	2086	2117	2134	2165	2182	2213				2278	2309	2326	2357	2374	2405	2422	2453	2470	2501
2789	2741	2708	2693	2660		2645	2612			2037	2070	2085	2118	2133	2166	2181	2214				2277	2310	2325	2358	2373	2406	2421	2454	2469	2502
2790	2742	2707	2694			2646	2611			2036	2071	2084	2119	2132	2167	2180	2215				2276	2311	2324	2359	2372	2407	2420	2455	2468	2503
2791	2743	2706	2695			2647	2610			2035	2072	2083	2120	2131	2168	2179	2216				2275	2312	2323	2360	2371	2408	2419	2456	2467	2504
2792	2744	2705	2696			2648	2609			2034	2073	2082	2121	2130	2169	2178	2217				2274	2313	2322	2361	2370	2409	2418	2457	2466	2505
2793	2745	2704	2697			2649	2608			2033	2074	2081	2122	2129	2170	2177	2218				2273	2314	2321	2362	2369	2410	2417	2458	2465	2506
2794	2746	2703	2698	2655		2650	2607			2032	2075	2080	2123	2128	2171	2176	2219				2272	2315	2320	2363	2368	2411	2416	2459	2464	2507
2795	2747	2702	2699			2651	2606			2031	2076	2079	2124	2127	2172	2175	2220				2271	2316	2319	2364	2367	2412	2415	2460	2463	2508
2796	2748	2701	2700			2652	2604			2030	2077	2078	2125	2126	2173	2174	2221				2270	2317	2318	2365	2366	2413	2414	2461	2462	2509

Camino a Herrera

Materiales Existentes

CAMINO A PALMA DE CHAVES

No	PROGENIE	INTERVALO ENTRE PLANTAS	No	PROGENIE	INTERVALO ENTRE PLANTAS
1	** EET313 X SCA12	2509-2499	14	** EET48 X EET195	2127-2098
2	** EET262 X EET166	2498-2470	15	** EET61 X EET166	2097-2091
3	** EET224 X EET174	2469-2422	16	** EET192 X EET237	2090-2071
4	** EET161 X EET166	2421-2391	17	** EPC X EET196	2070-2042
5	** EET6 X EET6	2390-2363	18	** SCA12 X EET1	2039-2030
6	** H-89 X EET166	2362-2329	19	** EET250 X EET11	2029-2556
7	** EET6 X SCA 12	2328-2311	20	** EET250 X EET110	2557-2601
8	** EET6 X EET174	2310-2287	21	** EET252 X EET174	2602-2639
9	** EET166 X EET184	2286-2266	22	** EET252 X EET252	2640-2646
10	** EET156 X EET166	2265-2237	23	** EET260 X EET110	2647-2686
11	** EET166 X EET184	2236-2220	24	** EET1 X EET11	2687-2718
12	** EET238 X EET196	2219-2195	25	** EET280 X EET274	2719-2746
13	** EET238 X SCA 12	2194-2128	26	** DESCONOCIDO	2747-2787
			27	EET-48 x EET-332	Resiembra

Plot Hybrid progenies Population "2A"

Planting year: 1952-1953

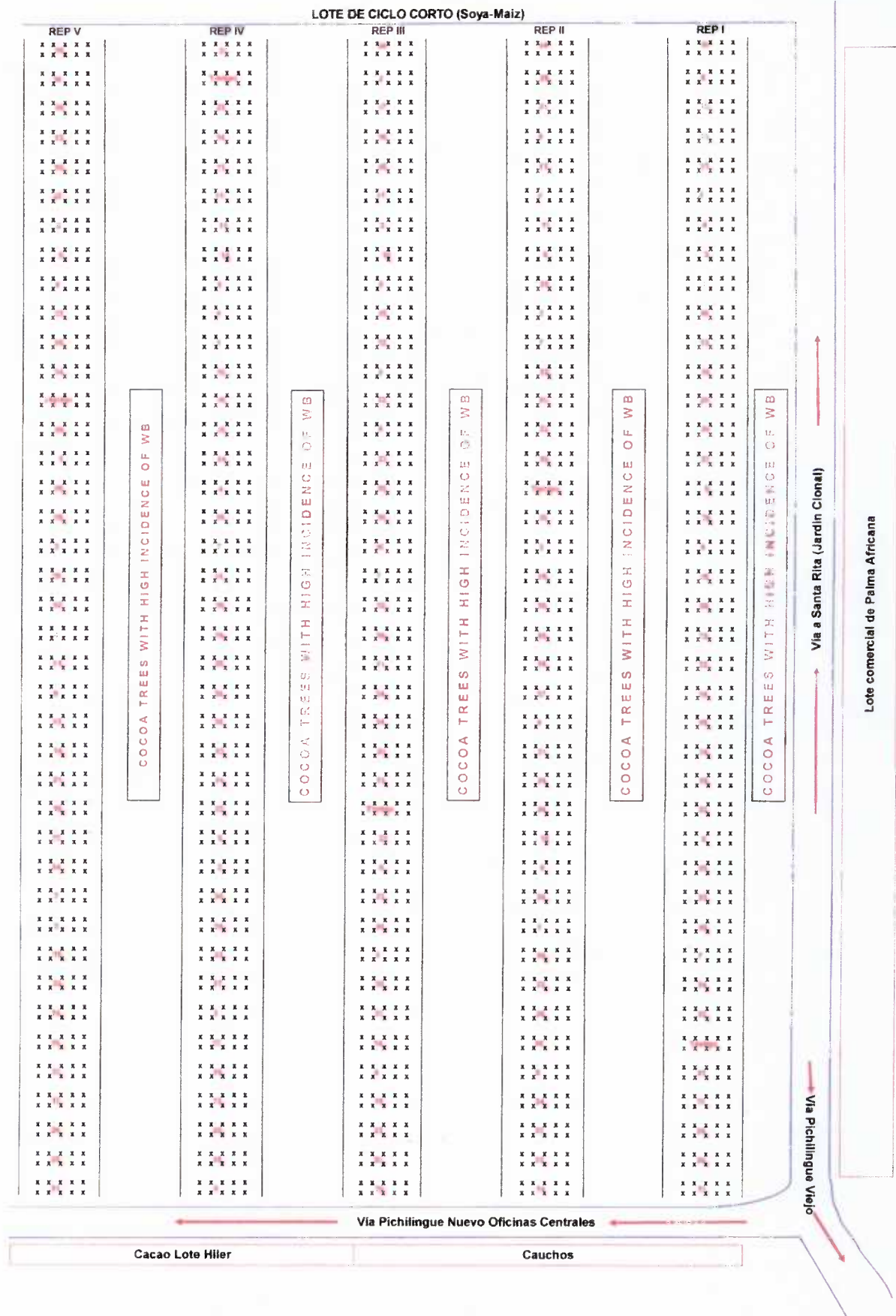
Planting distance: 5mx 4m

Total area: 14 920 m

Replantings: 1990

Annex 7.

Distribution of plants in the field trail about natural infection with WB
(Plot Abejon)



ANNEX PHOTOS



Members of ICCO staff visiting some of the selected cocoa trees in Lote "2A"



Selected cocoa tree that set most of its pods during the dry part of the year.



Sequence of photographs showing the process of pollinations to obtain the crosses and hybrid progenies planned within the project.



Sequence of photographs showing the process of preparing the land, sources of water for irrigation and temporary shading for the future planting of cocoa progenies generated by the project.



Sequence of photographs showing the process of growing the progenies in the nursery, the high pressure disease environment, and placing the seedlings in the middle of a adult cocoa "huerta" highly infected with witches broom to measure their resistance under field conditions.



Seedlings in the greenhouse ready to undergo artificial witches broom inoculation in the SAI to produce data which will be compared to the response of the same plants in the field.



Part of the cocoa team (researchers and students) at the E. Pichilingue going over the places where the progenies will be placed to undergo natural witches broom inoculation and later on field planted.



Photographs showing work being made to improve the facilities (escobero) to produce spores of the causal agent for witches broom. These will be used to carry out the artificial inoculation trials with the SA.



A high yielding tree selection made after analyzing the historical data records of the old cocoa progenies present in the Lote "7A".