Conservation of cacao in field genebanks (CATIE)

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Abstract

An important activity at CATIE, related to the center's role in conservation and management for development of natural resources, is the conservation and utilization of genetic resources of cacao.

These activities have been supported by the American Cocoa Research Institute (ACRI), and recently by the U.S. Agency for International Development (USAID) Regional Office for Central America (ROCAP) through the PROCACAO regional network. These activities are also supported by the CATIE Plant Genetic Resources Area, whose strategy is based on the conservation and appropriate use of genetic resources, with the following detailed objectives: to promote the unrestricted use of germplasm as a legacy for mankind; to increase the collections; to select superior genotypes in support of national plant genetic improvement programs; and to improve characterization and conservation methods for germplasm at CATIE.

The cacao germplasm collection at CATIE comprises almost 749 accessions, mostly consisting of elite selections from the main cocoa research stations of Latin America and including the main cultivated varieties of Tropical America.

From our cacao collections, CATIE personnel have produced planting material (clones and hybrids) with high yields, good size of beans and fruits, and resistance to

Phytophthora palmivora (black pod disease), Moniliophthora roreri (Moniliasis) and Ceratocystis fimbriata (Ceratocystis wilt).

Detailed information is given on plant management, and soil and climatic data at CATIE, Turrialba to allow comparison with information from other localities.

I. CATIE's action in protecting cacao genetic resources

CATIE is a regional institution whose efforts are devoted to research and education for sustainable agricultural production and the integrated management of natural resources. Cacao (Theobroma cacao) is one of the many crops domesticated in Mesoamerica. Although before the arrival of Europeans the tree grew wild throughout the New World tropics, the art of cultivating it was known only in Mexico and Central America.

Over the past forty years increasing attention has been devoted to conservation of cacao genotypes, as it became increasingly obvious that many genetic resources were disappearing rapidly, never to be replaced.

The risk of future loss of plant genetic resources is greatest in countries where agriculture has not yet been modernized. Central America is the center of genetic diversity of cacao and presently it is the only region in the world where a great diversity of high-quality genotypes still exist outside experiment stations. Therefore, there is an urgent need to explore, collect and assess these materials before they disappear.

At its headquarters in Turrialba, Costa Rica, CATIE has one of the most complete collections of genotypes of Theobroma in the world. The collection includes much material with disease resistance and high yields. Its origin dates to 1948 when the former Inter American Institute of Agricultural Sciences (now IICA) received a series of cacao

accessions including commercial cultivars (UF clones) from the Banana United Fruit Company collections for germplasm evaluation in the lowland tropics of Costa Rica (actually "La Lola" Experimental Station, now part of CATIE). Already a that time, the Program's research activities placed some emphasis on selection of germplasm, particularly within the UF clones, adapted to different environmental conditions.

By 1978, in view of serious moniliasis disease problems, it was recognized that the genetic base of the cacao collection needed to be broadened considerably. Thus, taking into consideration that Tropical America is the major center of diversity of most of the cacao germplasm, several explorations/introductions were undertaken between 1980 and 1991 throughout the USDA Miami Quarantine Station.

Consequently, the CATIE collection of cacao germplasm increased from 350 accessions at the end of 1979 to 749 accessions at the end of 1992. The collection activities in 1988-1992 were financed by the AID/ROCAP, PROCACAO network.

In 1988 the objectives of the CATIE cacao breeding program were re-defined to emphasize the development of germplasm-based technology for increasing cacao production in the different areas of the under-utilized forested regions of Central America. With the subsequent reorganization of the cacao program and in recognition of the need to explore the range of as yet under-exploited, potentially valuable criollo cacao germplasm, an aggressive program of plant introduction was re-initiated. Assisted by the Plan Genetic Resources Area, this program assumed responsability for the collection, introduction, maintenance, characterization and documentation of cacao germplasm.

Some of the accessions in the cacao collection are the result of genetic improvement work carried out at CATIE.

From some of the accessions, superior materials have been selected and distributed to interested national

institutions and farmers. Selection for high yield, high quality and disease resistance must be continued at CATIE so that distribution and evaluation of promising materials throughout the region may be maintained.

II. Protecting Mesoamerica cacao diversity

a. Germplasm conservation

The importance of Mesoamerica as a center of genetic diversity in both cultivated and wild plant species is generally accepted.

Interest in the cacao genetic resources of Mesoamerica extends far beyond the political and geographical boundaries of the region. Conservation of cacao genetic material and distribution of representative samples throughout the world, is of fundamental importance to cacao breeders worldwide.

The interdependence of all cacao-growing countries for the testing and utilization of cacao genetic resources makes their efficient preservation a matter of global importance. This interdependence is particularly evident in the need for planting materials with resistance to the different pests and diseases peculiar to the different cacao-growing regions.

CATIE has gained a reputation over the years for its outstanding work in cacao and coffee, two major export crops of the region. At present, no other institution in the region plays such an important role in the conservation and improvement of these crops, each of which is faced with severe disease and other production problems.

The Plant Genetic Resources Area at CATIE has the responsibility for conserving, rejuvenating, characterizing and evaluating cacao genotypes as well as supporting their utilization. The main target groups are the national programs and other potential users of the available genetic resources. Since the value of any conserved germplasm will

be greatly determined by the information available on it, high priority is given to systematic characterization of the collection.

The collection of cacao clones at CATIE occupies some 14 hectares. This existing collection is presently being expanded and rejuvenated to accommodate new material gathered in Mesoamerica, especially criollo types.

Only ten percent of the total collection consists of criollo wild types. This low proportion reflects the fact that the regions so far explored for cacao germplasm lack criollo germplasm that can be considered promising.

The main objective of the collection and exploration activities is to provide the CATIE breeding program as well as collaborating national institutions, mainly in Central America, with germplasm for cultivar development; thus the cacao collection is an active working collection with a continuous flow of material into the program's germplasm screening and characterization scheme.

b. Genetic improvement

Research emphasis is currently on the self-compatible cacao clones. In many national programs, CATIE cacao germplasm is in advanced stages of evaluation in clonal gardens; some hybrids have been developed and released as commercial cultivars in the past.

CATIE's cacao breeding program is very interested in intensifying germplasm exchange with other regional institutions, and a list of the cacao collection is available. In order to obtain clonal material of uniform age for the purpose of distribution, in early 1990 a clonal rejuvenation process was initiated within some of the major cacao groups such as the clones designated CC, UF, EET, ICS, SGU, RIM, SIC, SIAL, and criollo clones.

Future plans include cacao criollo collecting, in collaboration with the respective national programs, in those areas of Central America and the Caribbean Islands which so far have either not been prospected sufficiently, or not at all, such as Central America and México.

According to CATIE's collecting experience, in the case of criollo germplasm there is increasing evidence of genetic erosion due to increasing expansion and development of agriculture throughout the region; thus, worldwide IBPGR-coordinated actions to collect criollo germplasm of cacao are urgently needed.

If within any eventual global strategy such actions materialize, the activities centering on the CATIE cacao collection, which up to the present time have aimed principally at cultivar development, should consequently expand towards germplasm conservation.

c. Germplasm characterization and improvement

The cacao collection has been characterized (Engels, 1981; Soria and Enríquez, 1981), and useful data obtained for practical plant breeding. The CATIE cacao descriptor list (Engels *et al.*, 1980) was used in description of the collection, with 63 characters being assessed. The catalogues developed (Engels, 1981; Soria and Enríquez, 1981; Morera *et al.*, 1991) have been an attempt to distribute such information, accumulated during many years, and to assist potential users in obtaining the germplasm they need.

Since 1988 the cacao genetic improvement program at CATIE has been developing clonal selections and hybrids with desirable combinations of characters. The cacao program also emphasizes study of disease resistance in the cacao collection. In the future it is intended to include further genetic data which may be valuable in broadening the range

of germplasm by selecting promising trees or crossing distantly related parents.

It is quite likely that through hybridization of existing clones in the collection, improved levels of disease resistance and useful combination of resistances to different diseases (eg. moniliasis and black pod) may be obtained. The contribution of such work to cacao production needs to be emphasized.

Because of disease susceptibility, compatibility problems, low prices, and other natural hazards farmers are declining to maintain traditional cultivars. Improved cultivars of cacao are desperately needed, and it is expected that CATIE will play an important role in the replacement or traditional cultivars with improved planting material in the future.

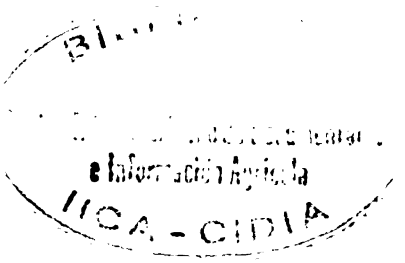

Table 1. Inventory of the cacao collection conserved at CATIE, Costa Rica. September, 1992

Identified and collected accessions		Total number of accessions
A C T	42, 215, 216	3
Amanaven		1
APA	4, 5	2
Arbol Estéril		1
ARF	1, 2, 3, 4, 5, 6, 7, 9, 10, 11 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38 39, 41, 42, 43, 44	41
BE	2, 3, 4, 5, 8, 10	6
BS	2	1
Cacao enano		1
Catongo		1
CATIE 1000		1
Carmelo		1
CAS	1, 3	2
CAAG		1
CC	9, 10, 17, 18, 27, 30, 33, 34, 35, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 52, 54, 67, 69, 71, 74, 79, 83, 99, 100, 103, 106, 107, 120, 121, 124, 132, 137, 138, 139, 143, 144, 152, 158, 169, 173, 182, 200, 201, 210, 211, 212, 213, 214, 215, 220, 221, 222, 223, 224, 225, 226, 228, 231, 232, 234, 235, 236, 237, 240, 241, 243, 244, 245, 246, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267,	96
CCN	10, 16, 51	3
CHUAO	24, 120	2
CNS	22, 23	2
Común Típico		1

México	1 (1, 2, 3, 4, 5) 2 (1, 2, 3, 4, 5) 3 (1, 2, 3) 4 (1, 2, 3, 4, 5, 6) 5 (1, 2, 3, 4, 5, 6, 7) 7 (1, 2, 3, 4, 5, 6, 7, 8) 10 (1, 2, 3, 4, 5, 6, 7) 11 (1, 2, 3, 4, 5) 12 (1, 2, 3, 4, 5, 6) 14 (1, 2, 3, 4, 5, 6) 19 (1, 2, 3, 4, 5)..... 63
ML	4, 22, 75, 102, 103, 105, 106, Nativo, Medio peso..... 9
Mocorongo	 1
MT 1	 1
Mutación Upala	 1
NA 34	 1
NAL	1A (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15) 2A (16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33) 3A (34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47) 4A (48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62) 62
OC	61, 77..... 2
P	8, 10, 11, 15, 16, 19, 20, 22, 23, 43..... 10
PA	13, 16, 19, 71, 81, 121, 150, 169, 303, 310..... 10
Papayo	 1
Para	 1
Pentagona	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 17, 18..... 15
PMCT	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101 88
PMCT 49	1, 2, 3, 4..... 4
PMCT 50	1, 2, 3, 4..... 4

PMCT 51	1, 2, 3, 4, 5, 6, 7, 8, 9	9
PMCT 52	1, 2, 3, 4, 5	5
PMCT 53	1, 2, 3, 4	4
PMCT 54	1, 2, 3, 4, 5, 6, 7, 8	8
Porcelana 3		1
Pound	7, 12	2
PV	2 (1, 2, 3, 4, 5) 4 (1, 2, 3, 4, 5) 5 (1, 2) 6 (1, 2, 3) 7 (1, 2, 3)	18
RB	29, 37, 39, 41, 43, 46, 47, 49	8
RIM	2, 6, 8, 9, 10, 13, 15, 19, 21, 23, 24, 30, 34, 39, 41, 43, 44, 48, 52, 56, 68, 71, 75, 76, 78, 88, 100, 101, 105, 106, 113, 117, 189,	33
SC	5, 6, 13, 24, 49	5
SCA	6, 9, 12	3
SCR	2, 4, 5	3
SGU	2, 3, 4, 20, 32, 43, 50, 53, 54, 60, 63, 67, 71, 72, 73, 74, 75, 82, 83, 84, 85, 86, 87, 88, 89, 90, 93, 94, 104	29
SIAL	8, 56, 70, 93, 98, 163, 169, 242, 244, 325, 339, 407	12
SIC	1, 2, 6, 7, 28, 256, 329, 433, 802, 806, 813	11
SM 2		1
SNK 12		1
SPA	4, 5, 7, 9, 10, 11, 12, 17	8
Sta. Clara	3	1
STICA 100		1
TJ 1		1
TSH	565, 644, 792, 812, 1112	5
UF	4, 10, 11, 12, 20, 29, 36, 38, 93, 122, 168, 210, 221, 242, 273, 296, 601, 602, 613, 650, 654, 666,	

667, 668, 672, 676, 677, 700, 701, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717 ..... **44**

Vere 1

Yamada M (A, B, C, D, E, F, H, I, K) 9

269 H 1

154, 200 L 2

N 123, 125, 128, 133, 147, 151, 166, 168, 171, 207, 237, 255, 271, 314, 324, 355, 349 17

1A (23-28-03)
2B (23-66-32)
3C (25-14-15)
4D (30-14-16)
5E (30-60-16)
6F (18-15-27)
7G (39-22-29) 7

Cacao Wild relatives

Theobroma angustifolia
Theobroma bicolor
Theobroma mammosum
Theobroma subincanum
Theobroma simiarum
Theobroma microcarpum
Theobroma grandiflora
Theobroma speciosum
Theobroma gileri 9

Herrania purpurea
Herrania balaoensis
Herrania nítida
Herrania umbrática
Herrania cuatrecasana
Herrania albiflora
Herrania nycterodendrum 7

TOTAL **879**