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The International Exchange and Testing
of

CASSAVA GERM PLASM



Proceedings of an interdisciplinary workshop
held at CIAT, Palmira, Colombia
4-6 February 1975

Editors: Barry Nestel and Reginald MacIntyre

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Cassava Germ Plasm Collection and Advanced Genetic Material at CIAT

Kazuo Kawano

CASSAVA originated in the American tropics. There is no evidence of this crop being transported to Asia or Africa before the age of the conquistadores, so we assume the majority of varietal diversification occurred in Latin America. The physiological features of cassava would indicate that cultivation originated in the marginal area between the tropical rain forest and the savanna. No edible cassava is found in the wild, and little modern technology has been applied to its genetic improvement. Thus the existing cassava germ plasm represents an intensive human intervention, without significant scientific methods, for the evolution of crop species.

Collection

Systematic collection of cassava germ plasm was already underway when CIAT's cassava research program started. Approximately 2700 clones of cultivated cassava were collected from Colombia, Venezuela, Ecuador, Mexico, Panama, Puerto Rico, Brazil, and Peru.

Most of the Peruvian collection was eliminated because of the presence of the Brazilian mosaic virus. A significant portion of the collections from Colombia, Panama, and Puerto Rico were lost because of salt spots in the field and an outbreak of bacterial blight (CBB) during the maintenance period. The total number of entries now maintained is a little more than 2200 (Table 1).

The number of Brazilian collections is small considering the expected great variability of cassava in this country. This deficiency occurs because of plant quarantine regulations. However, a continuous effort is made to introduce more genetic variation from Brazil in the form of true seeds. Nevertheless, the phenotypic variability in the CIAT germ plasm field is vast.

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The collection was made right in the centre of origin and diversification of the species. Cassava is highly heterozygous, and nobody has fully exploited the existing genetic variability of the species. We believe the CIAT cassava germ plasm is a highly promising source of genetic variation with which to start a breeding program. We do not intend to include wild species in our breeding work until we study a major part of genetic variability within the species. Wild species will only be used when we are certain that they have useful characters.

TABLE 1. Entries of cultivated cassava collection in the CIAT collection.

Country of origin	No. of clones maintained at present
Colombia	1682
Venezuela	266
Ecuador	133
Mexico	66
Panama	21
Brazil	17
Costa Rica	16
Puerto Rico	15
Perú	2
Total:	2218

Evaluation

Agronomic evaluation of approximately 2000 collections has just been completed at CIAT, which has highly fertile soil. The agronomic traits observed in the evaluation are listed in Table 2. Throughout the evaluation period there was no prolonged dry season, no heavy rainfall, or extreme temperature for normal cassava growth. The CIAT farm is kept free of two of the most destructive diseases, CBB and superelongation. Thus, yield data from the evalua-

tion may well represent yielding ability of each genotype under nearly ideal growing conditions for cassava.

TABLE 2. List of characteristics recorded in germ plasm evaluation.

Growing period (months)	Agronomic characteristics
0-3	Germination, vegetative vigour, flowering
4-6	Thrips, flowering
6	Root yield, top weight, harvest index, height, No. of total and commercial roots, root specific gravity
6-10	Branching habit, leaf size, leaf retention, flowering
10	Root yield, top weight, harvest index, height, No. of total and commercial roots, root specific gravity, ease of harvest, root length, root stalk length, HCN and N content, root perishability

A great genetic variability was observed in nearly all the traits evaluated. A summary of the evaluation is presented in the 1974 Annual Report of CIAT. Two hundred and thirty collections were selected on the basis of harvest index, root yield, and total plant weight, with an additional effort to include as much genetic diversity as possible. These are being further evaluated in advanced yield trial at CIAT and in observational yield trials at Carimagua, Llanos Orientales, and Caribia, Costa Atlántica. The trial in Carimagua is expected to give selection opportunity for poor acid soils with a prolonged dry season, and the other, in Caribia, a selection under high temperatures. These collections form the basis for obtaining higher-yielding capacity with wide adaptability.

Advanced Material

The present objective of hybridization is to upgrade primarily the harvest index of populations without losing overall heterozygosity since the inheritance of harvest index is largely controlled by the additive gene effect. Hybridization of cassava by hand pollination is easy. During 1974, approximately 35,000 F_1 seeds of about 250 cross-combinations were obtained out of about 30,000 female flowers by hand-pollination by three field labourers. These crosses were done mainly among the selected

genotypes for higher-yielding capacity. Sources of resistance to CBB, superelongation disease, *Phoma* leaf spot, and *Cercospora* leaf spot were found by the pathology group. Genes for resistance to important diseases are being added gradually. Characteristics of some frequently used genotypes in hybridization and their results are presented in CIAT's 1974 Annual Report.

Since cassava is a highly heterozygous plant, we need to produce a large number of F_1 seeds per cross combination. Yet we sometimes produce more than 1000 F_1 seeds in a single cross. The number of F_1 seeds per cross and total number of F_1 seeds being produced is too large for evaluation by CIAT.

An example is a cross between M Colombia 113 and M Mexico 55, of which we have obtained more than 1500 F_1 seeds. M Colombia 113 is a vigorous-growing type adapted to the relatively high land of Colombia with an excellent leaf area retention after 6 months of planting. M Mexico 55 comes from lowland Mexico and has high harvest index. We are looking for a new type that yields well not only on the CIAT farm but also in Costa Atlántica and Llanos Orientales of Colombia and outside Colombia. We hope to be able to produce a large quantity of F_1 seeds that can be distributed to workers interested in testing in their own environment.

A brief summary of our recent hybridization work is presented in the 1974 Annual Report of CIAT.

Material Exchange

The CIAT cassava breeding program is ready to send various types of genetic materials to cassava breeders outside CIAT upon request. Material exchange in the form of stakes is risky and bulky, so we prefer to exchange true seeds.

Since proper evaluation of large amounts of germ plasm requires considerable work, we have so far only sent general germ plasm material to other international programs. Approximately 15,000 open-pollinated seeds from 203 germ plasm collections were sent to the IITA program in Nigeria. Of course other cassava breeders in Africa may request general germ plasm material from IITA.

So far we have distributed some 5000 F_1 seeds, from such crosses as M Colombia 113 \times M Mex 55, M Colombia 22 \times M Colombia 647, and M Colombia 22 \times M Venezuela 318, to 12 interested breeder-agronomists in Brazil and IITA and to a CIAT trainee from Africa. How

significantly better these materials are than indigenous materials or simple open-pollinated progenies of germ plasm is a matter of hope rather than a scientific fact at present. Nevertheless, the level of our advanced material will be improved year by year. We hope that some of the recipients of these materials will do a proper evaluation on the materials and send us their best selection or information. We believe this is the best way to obtain wide adaptability.

Handling Genetic Material

Some of the recent findings on the genetic nature of cassava plants are: 1) highly heterozygous; 2) high occurrence of self-pollination; 3) extreme degree of inbreeding depression; 4) highly heritable nature of harvest index; and 5) high correlation between yield data with seedling plants and those with stake-planted plants.

The high occurrence of self-pollination and sensitiveness to inbreeding of cassava should be taken into consideration when exchange of

seeds is planned. Any open-pollinated seed collected in pure stand is almost certainly a result of self-pollination. Even in a genetically mixed population, outcrossing of profusely flowering type seldom exceeds 50%. The plants from self-pollination are unlikely to grow normally and hence fail to produce flowers necessary to ensure further hybridization with other genotypes. Thus in preparing seeds for exchange, special care should be taken so as to decrease the proportion of self-pollination.

The very high correlation between seedling and stake-planted performances eliminates the long period necessary for each seedling plant to produce enough stakes to be planted for proper field evaluation. This is especially true when the seedlings are given enough space for maximum yield without significant intergenotypic competition. Breeders are, therefore, able to save considerable time and space, and evaluate large numbers of genotypes. A detailed description can be found in the 1974 Annual Report of CIAT.