Hybrid selections were continued at CIAT-Palmira, Caribia and Carimagua. Because of the importance of the Caribia and Carimagua environment, the relative importance of selection programs there was increased. Since considerable progress has been made in yielding ability and disease resistance through single-trait selection for harvest index, branching type, or CBB and superelongation resistance, selection emphasis has gradually shifted towards overall performance over several years at each selection site. Production of hybrid seeds by controlled pollination was quadrupled after critical pest problems were overcome.

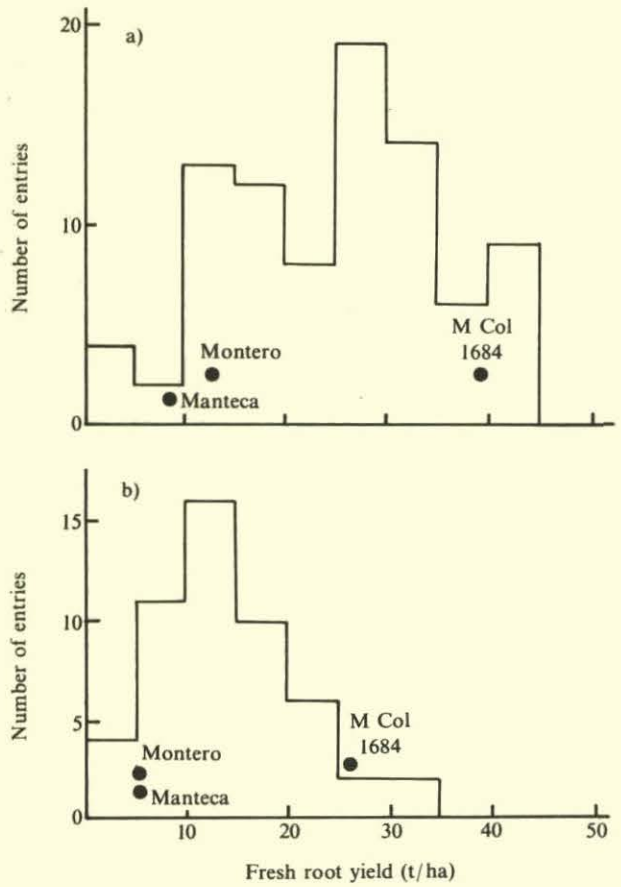

Figure 1. *Frequency distribution of CIAT cassava lines at different yield levels in replicated yield trials at Caribia, 1980. a) July and February plantings; b) May planting.*

Selection at Caribia

CIAT hybrid selections and an outstanding germplasm accession, M Col 1684, continued to show good yielding ability (Fig. 1). One of the replicated yield trials (planted in May and harvested in February), planted on a poor soil spot without irrigation, suffered severely from drought and consequently yielded low. Yet, the superiority of CIAT selections over local cultivars (Montero and Manteca) persisted. However, only few CIAT lines exceeded the best

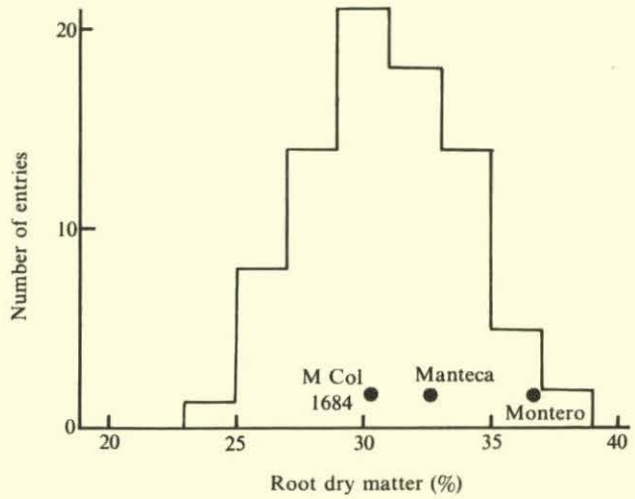

Figure 2. *Frequency distribution of CIAT cassava lines at different root dry matter contents in replicated yield trials at Caribia, 1980. (Average of three trials and including values only for higher yielding lines in terms of root production.)*

local cultivar in root dry matter content (Fig. 2). More selection efforts shall be directed to a good combination of high root dry matter content with high yielding ability.

Three new hybrid selections which seem to combine reasonably high yield with high root dry matter content and lodging resistance, were passed to the Agronomy section for evaluation in regional trials in the hot tropics.

Selection at Carimagua

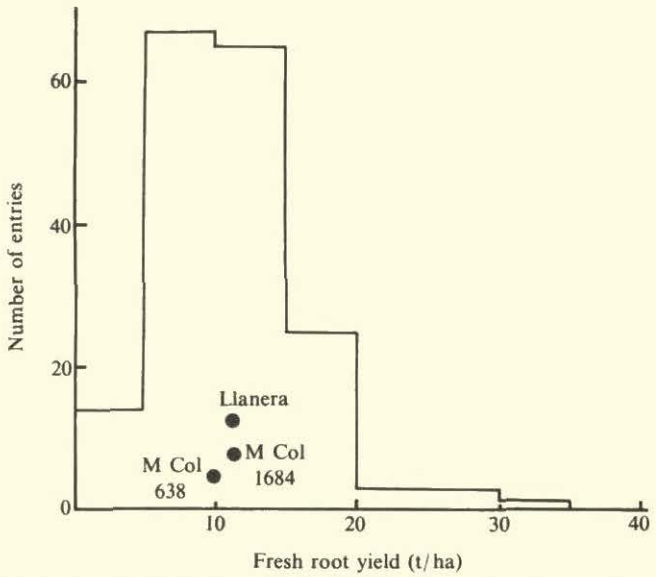

Figure 3. *Frequency distribution of CIAT cassava lines at different yield levels in replicated trials at Carimagua, 1980. (Average of two trials planted in May and October.)*

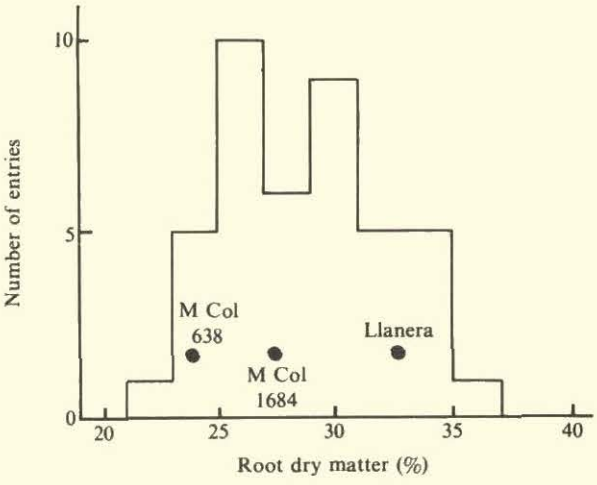

Figure 4. *Frequency distribution of CIAT cassava lines at different root dry matter contents in replicated yield trials at Carimagua, 1980. (Average of two trials and including values only for higher root yielding lines.*

Many CIAT lines outyielded local cultivars (Llanera and M Col 638) and M Col 1604 but yields were generally low (Fig. 3). All trials received a modest fertilizer application. The root dry matter content was generally very low but several lines, such as CM 523-7 and CM 723-3, consistently showed high root dry matter content (Fig. 4). Many new lines had good resistance to CBB and superelongation. Selection emphasis continues to be for a good combination of stable yield with high root dry matter content and disease and insect resistance.

Six new selections were passed to the Agronomy section for regional trials evaluations in tropical savanna conditions.

Selection at CIAT-Palmira

Many CIAT lines continued to show excellent yield and root dry matter content (Figs. 5 and 6). A good example is a new selection CM 849-1 which gave a root yield of 71 t/ha/year with 39% root dry matter content.

Twelve selections which seemed to combine high yield with high root dry matter content and high harvest index (thus lodging resistance) were passed to the Agronomy section. Many of these are expected to be adapted to the hot lowland tropics, thus, all of these are intensively evaluated at the Caribia station also. Ten selections which showed exceptionally high-yielding ability were also passed to the Agronomy section. These are the selections to be adapted to high-yielding environments.

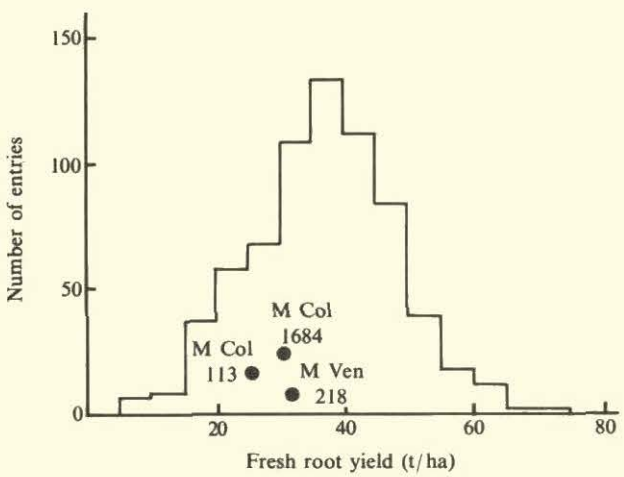

Figure 5. *Frequency distribution of CIAT cassava lines at different yield levels in replicated trials at CIAT-Palmira, 1980. (Average of three trials.)*

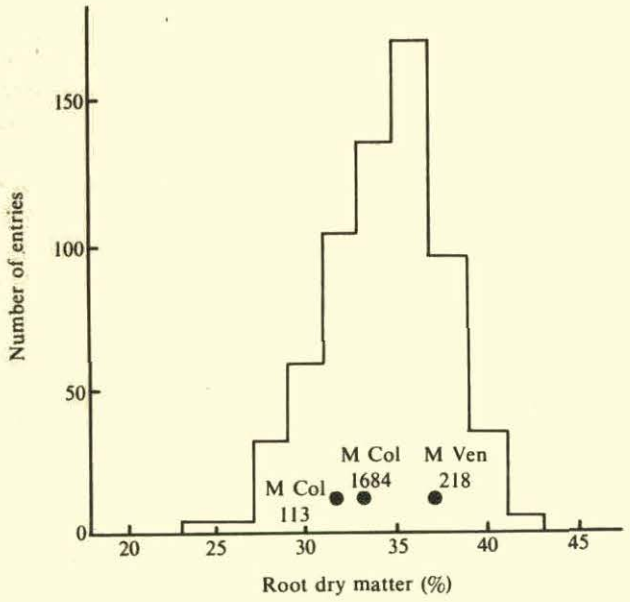

Figure 6. *Frequency distribution of CIAT cassava lines at different root dry matter contents in replicated yield trials at CIAT-Palmira, 1980. (Average of three trials.)*

Yielding Stability

Emphasis on varietal selection has shifted from absolute high yield to reasonably high yield that is stable over years and seasons in each representative enviroment. Treatment of selection fields is adjusted to realistic farm situations by eliminating heavy fertilizer applications, irrigation, and pesticides. Several factors affecting yield stability have been identified (see Agronomy-Regional Trials section). Thus, breeding for disease and insect resistance, good germination ability, and lodging resistance are among the important selection criteria. The final selection criterion in the Varietal Improvement section is stable yield over years and seasons. Yield stability over different sites within each macro-region is evaluated with a smaller number of promising materials in the regional trials. Numbers of new selections are evaluated in repeated seasons at each selection site.

A good example of high and stable yield was obtained with CM 342-170 at Caribia and CM 516-7 at CIAT (Fig. 7). At Carimagua, the number of abiotic and biotic factors which adversely affect cassava yield is much higher, so obtaining a stable yield is more difficult. Yet, CIAT lines such as CM 517-1 and CM 523-7 seem to show some promise.

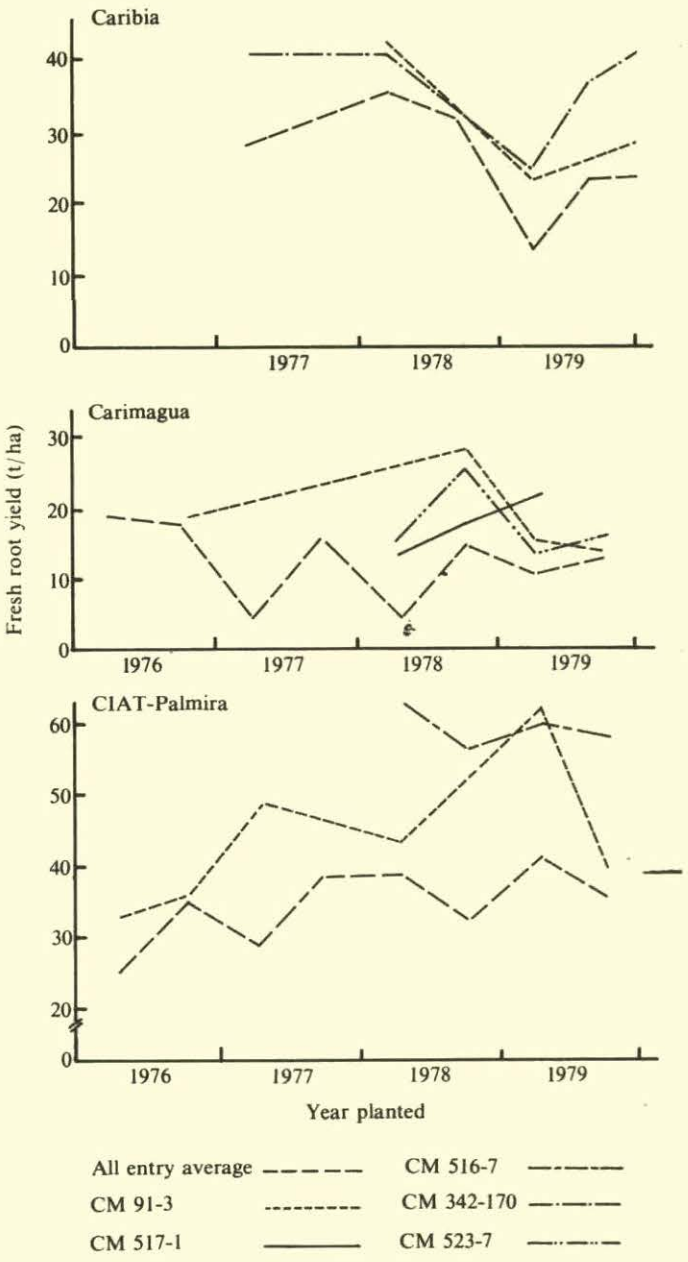

Figure 7. *Yield stability in selected cassava lines grown in three locations.*

Varietal Adaptation and Production of Planting Stakes

Production of good planting stakes is difficult under high-stress conditions such as those at Carimagua. CBB infection significantly reduces the root yield of susceptible cassava lines, particularly when early infection is produced

from CBB-infested cuttings (CIAT Cassava Prog. 1979 Ann. Rept.). Furthermore, CBB infection drastically reduced the quantity of planting stakes on susceptible lines. Unavailability of non-infested planting stakes is, therefore, a more acute factor than the reduced root yield in susceptible cultivars planted with uninfested stakes. This is especially critical when continuous cassava production has to be done using stakes produced locally.

Primary superelongation infection (self-infection within the same planting stake), which may cause complete crop failure, can be easily distinguished from ordinary or secondary infection coming from other plants. Primary infection is proportional to the superelongation infection in the previous planting from which the planting stakes were taken (Fig. 8). There are many more abiotic and biotic factors which should affect quantity and quality of planting stakes.

CIAT-Palmira is regarded as a low stress environment relatively free from disease problems for cassava production. Caribia is regarded as a medium stress environment where the dry season is long and CBB is always present during the rainy season and causes significant yield reductions occasionally. Caribia is, however, relatively free from other disease and insect problems. To compare the quality of locally produced planting stakes with those from CIAT-Palmira, several cassava lines have been planted in replicated yield trials with stakes from CIAT-Palmira and from Caribia and Carimagua.

At Caribia, both local and CIAT-Palmira stakes germinated well. Local stakes tended to yield slightly better but differences were generally not statistically significant. However, looking at individual lines, M Col 22 was a good yielder when planted with locally produced planting stakes but it was difficult to obtain a high yield using CIAT-produced stakes (Table 1). The same tendency was observed with CM 342-170, but M Col 1684 showed no clear tendency. There was no sign that stakes from Caribia were inferior to CIAT-produced stakes. There was, however, some delay in planting stakes from Palmira in Caribia due to transport problems. Nevertheless, CIAT-produced stakes were treated with fungicides to offset this effect while Caribia stakes were untreated.

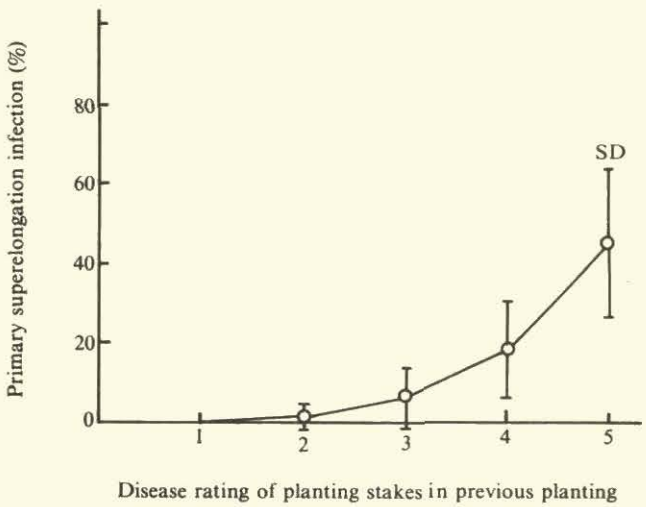

Figure 8. *Effect of superelongation infection in a previous planting on primary superelongation infection (May plantings in Carimagua)*
Superelongation rating: 1 = no symptoms; 2 = symptoms only on leaves; 3 = symptoms on leaves of all plants and occasional stem elongation; 4 = 50% of plants show stem elongation; 5 = leaves dying of disease infection.

Table 1. Yield comparisons for three cassava lines planted at Caribia, in relation to the source of planting stakes.

Cassava line	Source of planting stakes	Fresh root yield (t/ha) for crops planted in:				
		May 1978	May 1979	October 1979	February 1980	Average
M Col 22	Caribia	44.2	22.2	48.6	34.4	37.4
	CIAT-Palmira	20.0	16.1	29.2	15.0	20.1
CM 342-170	Caribia	51.4	25.2	-	41.9	39.5
	CIAT-Palmira	31.2	21.1	36.7	33.3	28.5
M Col 1684	Caribia	-	16.1	32.5	39.4	29.3
	CIAT-Palmira	50.8	25.6	56.9	27.2	36.6

At Carimagua, local planting stakes generally germinated poorly and yielded significantly lower. Yield differences between Carimagua and CIAT-Palmira stakes were greater in earlier days (1978 plantings); however, as selection intensified, differences narrowed to a negligible level (October 1979 planting). For those lines which gave reasonably high yields by planting Carimagua stakes, the yield difference between Carimagua and CIAT-grown stakes disappeared (Table 2).

Table 2. Yield comparisons for selected cassava lines planted in Carimagua, in relation to the source of planting stakes (for planting of October 1979).

Lines	Fresh root yield, Carimagua stakes (t/ha)	Fresh root yield, CIAT-Palmira stakes (t/ha)
New selections:		
CM 946-2	31.3	34.7
CM 996-6	29.9	23.6
CM 983-5	22.9	not planted
CM 951-6	20.8	29.2
CM 976-2	19.4	9.7
CM 854-21	18.8	19.4
CM 1012-2	18.1	13.2
CM 840-323	18.1	16.7
CM 869-4	18.1	12.5
CM 840-324	17.4	20.1
Average	21.3	19.9
Older selections:		
CM 430-37	18.2	13.9
CM 723-3	15.7	14.6
CM 523-7	15.3	12.5
CM 91-3	14.3	11.5
M Ven 77	11.9	7.7
Average	15.1	12.0

In older selections, whose adaptation to Carimagua has been well-confirmed, yield with Carimagua stakes tended to exceed that with CIAT stakes.

We can conclude that production of good quality planting stakes is difficult under high stress conditions. However, if the cassava genotypes are truly adapted locally, the quality of planting stakes produced is as good as or even better than stakes produced in other environments with less stress.

Hybrid Seed Production

As cassava breeding programs in certain key countries such as Brazil and Thailand gained strength, and the importance of decentralized varietal selection was widely recognized, demand for F_1 hybrid seeds has increased. Hybrid seeds had been produced at CIAT-Palmira with reasonably high efficiency (around 0.7 seed per each female flower pollinated) between 1974 and 1977. However, the efficiency dropped notably in 1978 and in 1979 when only an average of 0.28 seed per female flower was obtained. In 1979, the number of pollinations doubled but the actual hybrid seeds obtained decreased.

The primary cause of decreased seed production has been the increasing buildup of the cassava fruit fly (*Anastrepha* sp.), which feeds on developing seeds. In January 1980, biweekly applications of the systemic insecticide fenthion were begun. These treatments have not only effectively controlled *Anastrepha* sp., but also several other insect pests of cassava. A high efficiency of hybridization (0.82 seed per flower) has been restored and, because of the effective control of thrips, pollen and flower production has been improved. This has enabled massive pollinations to be made with such lines as M Ven 77 and M Pan 12B, which are known to be well adapted to the Carimagua environment.

Errata

Page	Columm	Element	Printed:	Should be:
6	1	Figure 2	M Col 59	M Mex 59
6	2	Figure 3	M Col 59	M Mex 59
6	2	Figure 3	LSD (P<0.05)	LSD (P<0.05)
7	1	Figure 4	M Col 59	M Mex 59
60	2	Second para., line 8	more to growth	more top growth
61	2	Line 1	and K contents	and K concentrations
20	1	Figure 1	I - Tolerant III - Tolerant V - Tolerant	I - Intermediate-resistant III - Intermediate-resistant V - Intermediate-resistant
62	1	Figure 3	Stems □	Stems △
64	1	Figure 5	5.0 4.0 % N	5.0 4.0 % N 3.0
66	1	Figure 8	Figure 44	Figure 8
93	2	Footnote	*Left during 1979.	*Left during 1980.