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MANAUS/AMAZONAS

1992

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1992 FL-FOL5342

CPAA-11039-1

FOL
5342

OIL PALM BREEDING PROGRAM AT EMBRAPA/BRAZIL

Edson Barcelos¹
 Philippe Amblard²

INTRODUCTION

The story of the introduction of oil palm breeding material in Brazil goes back to 1963, when two similar collections of crosses selected by IRHO were sent to Brazil in order to develop a program aimed to produce seeds under local conditions. The first IRHO set of crosses was introduced in the State of Bahia by CEPLAC ("Comissão Executiva do Plano da Lavoura Cacaueira"), and planted at the Una Research Station in 1966. The second set of crosses was established between 1964 and 1965 at CPATU ("Centro de Pesquisa Agropecuária do Trópico Umido"), State of Pará. These genetic resources consisted in Deli Duras Dabou, plus L2T Selfed, L2T x L5T and L5T x L7T as La Mé source of Pisiferas, and S7T Selfed, S10T x S7T, and S17T x S9T as Yangambi Pisiferas. CEPLAC has been employing the best Dura palm progenies for the production of seeds for smallholders. The material introduced to CPATU was abandoned and suffered severe disease problems.

¹Oil palm breeder - EMBRAPA/CPAA/Manaus/Brazil.

²Oil palm breeder - CIRAD/IRHO - Based at EMBRAPA/CPAA/Manaus/Brazil.

Other introductions of advanced breeding material in Brazil occurred in the seventies, with the introductions of MARDI (Malaysian Agricultural and Development Institute of Malaysia) lines in Bahia State (in exchange with cocoa germplasm from CEPLAC) and the bulk introductions made by IRHO in Manaus, through a cooperative program with EMBRAPA ("Empresa Brasileira de Pesquisa Agropecuária"). Details of these programs are as follows:

1. CEPLAC, STATE OF BAHIA

In 1976, MARDI sent 10 crosses (5 T x T and 5 D x D) to CEPLAC. Only 80 plants of the five D x D crosses survived. This material was planted mixed in a single observation plot at the Lemos Maia Experimental Station in Una, Bahia. The ancestry of the 5 crosses mixed are as follows:

1)	0.102/8428	x	0.102/8539
2)	0.82 /2258	x	0.34 /73
3)	0.82 /2159	x	0.34 /55
4)	0.82 /2029	x	0.102/2054
5)	0.82 /2029	x	0.102/2054

A second introduction of MARDI material occurred in 1977. Of the 8 D x D crosses introduced, 5 crosses survived and were planted in single observation plots. These Dx D crosses were:

0.85 /4251 x 47/114
0.105/8914 x JL 18024
0.105/8949 x JL 18152
0.107/1681 x 47/94
0.105/8914 x 47/146

Finally, in 1978 a set of 26 crosses, 11 of which were T x T's SP540 derivatives and 15 D x D's Deli and Deli Dumpy.

2. EMBRAPA

EMBRAPA is a national organization with research activities all over Brazil. EMBRAPA's oil palm breeding program is conducted by the Agro-Forestry Research Center (Centro de Pesquisa Agroflorestal da Amazônia Ocidental, CPAA), located at Manaus, Amazonas State. This Center has 5,000 ha of land at its Urubu River Oil Palm Research Station (Estação Experimental do Rio Urubu-EERU), located 140 km from Manaus, of which 400 ha were planted with breeding and agronomy experiments (Table 1). In this area the rain is relatively well distributed throughout the year, with an average total rain ranging from 2,040 to 2,749 mm per year with mild annual water deficits of 4 to 215 mm (Table 2). EERU is located on clayey textured weathered soil with a low organic matter content, strongly acid and low fertility (low phosphorus & exchangeable bases contents).

Table 1. Research conducted at Rio Urubu Experimental
Station - EERU - EMBRAPA/Manaus.

Research	Lines	Number of Trials	Planted Area-ha
Breeding	259	22	212
Agronomy	-	4	48
Germplasm ¹	521	8	48
Seed Production ²	215	9	92
TOTAL	995	43	400

1. 245 accessions collected in sub-spontaneous oil palm in Bahia/Brazil.
50 accessions introduced from Africa/IRHO
226 accessions E. oleifera collected in the Amazonian Region
2. 156 Dura lines
55 Tenera/pisifera lines.

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Table 2. Rainfall, water deficit and temperature at EERU, EMBRAPA-CPAA, Brazil.

MONTH	1984	1985	1986	1987	1988	1989	1990	1991	AVERAGE
Jan	-	268.8	177.4	314.0	242.8	324.4	133.8	311.8	221.6
Feb	-	196.7	240.8	266.0	307.2	254.4	192.4	146.2	200.5
Mar	-	244.4	226.8	375.4	174.8	310.6	467.1	327.3	265.8
Apr	-	162.4	332.6	353.6	328.8	307.0	308.6	318.8	264.0
May	-	226.2	183.0	236.0	442.4	405.0	303.4	345.0	267.6
Jun	64.6	212.9	160.8	68.1	260.6	217.8	76.0	192.0	156.6
Jul	150.4	136.8	151.6	60.6	179.8	204.0	117.6	116.8	139.7
Aug	59.8	123.4	29.8	141.0	52.2	64.4	49.0	91.0	76.3
Sep	218.2	129.2	49.8	79.8	150.4	42.0	85.4	85.4	105.0
Oct	179.0	280.8	171.2	47.2	166.8	115.8	49.8	78.2	136.1
Nov	87.7	94.2	236.8	76.0	220.6	213.2	124.4	29.2	135.3
Dec	229.8	298.0	158.7	221.7	222.6	173.4	133.0	68.2	188.2
TOTAL	-	2373.8	2119.3	2239.4	2749.0	2632.0	2040.5	2109.9	2,323.4
Water Deficit(mm)	-	4	87	164	21	67	192	215	107
Ligth Hours	-	2032	1952	2030	1787	1824	2019	2016	1925
Days with rain	-	177	173	146	177	177	-	185	-
Temperature Max	32.2	32.9	33.0	32.2	32.0	32.7	31.8	34.0	32.0
Min	20.4	21.1	21.2	21.4	21.4	21.7	21.8	19.7	21.1

Source: EMBRAPA-CPAA, Manaus (1992)

EERU's guineensis breeding program is composed mainly by IRHO materials introduced since 1983. Table 3 presents a summary of the Progenies Test by parental line planted at EERU during 1983-88.

The progenies test presented in Table 3 originated from Deli Dura parental lines mated to classical IRHO sources of pisifera, namely La Mé and Yangambi (Table 4). The ascendance of these male parents which were introduced to Brazil as selfingsis described in Figure 1. The Deli Dura lines (Table 5), include parents from the well known Sumatra-Dabou and Medan Ara (Indonesia)-Johore Labis (Malaysia, Socfinco) populations as shown in Figure 2.

The parental lines shown in Table 3 correspond to the first selection cycle of the IRHO program, and were extensively tested in various locations in Africa and Asia (GASCON, 1981; JACQUEMARD, 1981; and NOUY, et al., 1991). Several related DxP and DxT crosses of the second cycle were introduced for testing at Brazil-EERU. However, no conclusive results have been recorded yet.

Table 3. Number of progenies test between parental lines at
EMBRAPA's Rio Urubu research station in Manaus.

Deli Dura Female Lines	Male Lines				Total
	L2T SELF	L10T SELF	L10Tx L312P	L431Tx L319P	
D5D x D3D	11	9	11	13	44
L404 x D3D	6	9	13	13	41
L404D x D10D	10	11	10	10	41
D115D x L269D	9	11	6	10	36
D8D x D115D	5	7	9	16	37
D8D X D118D	6	7	8	8	29
TOTAL	47	54	57	70	228

5 crosses (D5D x D3D) x (L5T x L10T)
 5 crosses (D5D x D3D) x (L5T x L2T)
 4 crosses (D5D x D3D) x (L2T x L10T)
 3 crosses ASD
 7 crosses MARDI-CEPLAC x L2T AF
 6 crosses IRHO-CEPLAC x MARDI-CEPLAC
 1 cross Control L2T x D10D

Table 4. Tenera/pisifera lines in EERU.

Original Cross	Number of Lines
L2T SELF	7
L2T SELF x (L10T x L312P)	6
L10T SELF	5
L2T SELF x (L431T x L319P)	6
L2T SELF x L10T SELF	2
L2T SELF x L2T SELF	3
(L5T x L2T) x L10T SELF	1
(L431P x L319P) SELF	11
(L10T x L312P) SELF	6
(L2T x L10T) SELF	2
(L5T x L2T) SELF	1
L2T SELF x (L5T x L2T)	3
L10T SELF x (L2T x L10T)	1
CHE 131 SIB	1
L5T SELF x (L11T x L2T)	1
HC 129 SIB	2
CAM 236 x CAM 244	1
17	59

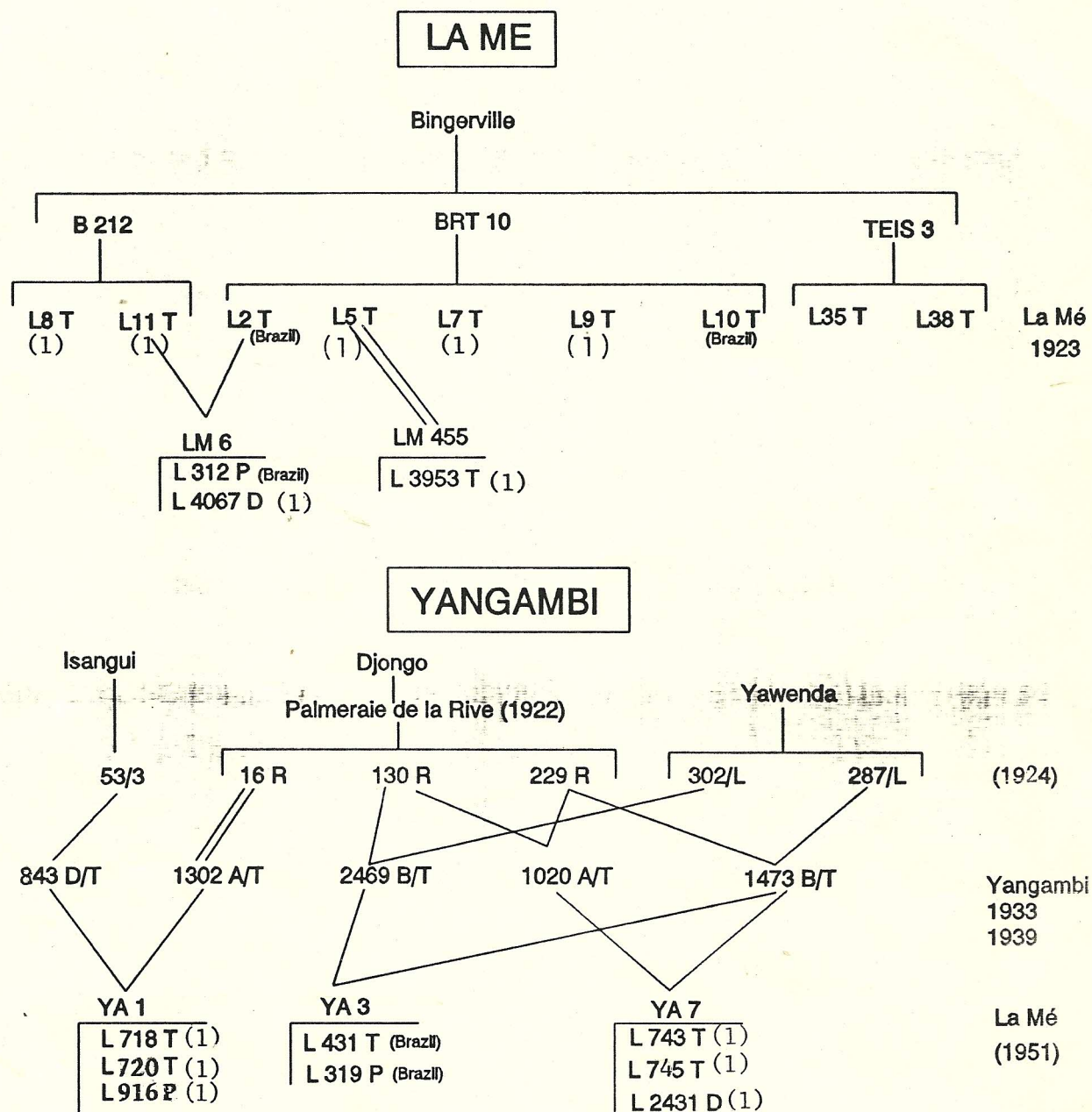


Fig 1. Ancestry of Lame and Yangambi male parents used at EERU program in Brazil.

(1) Also introduced to EERU

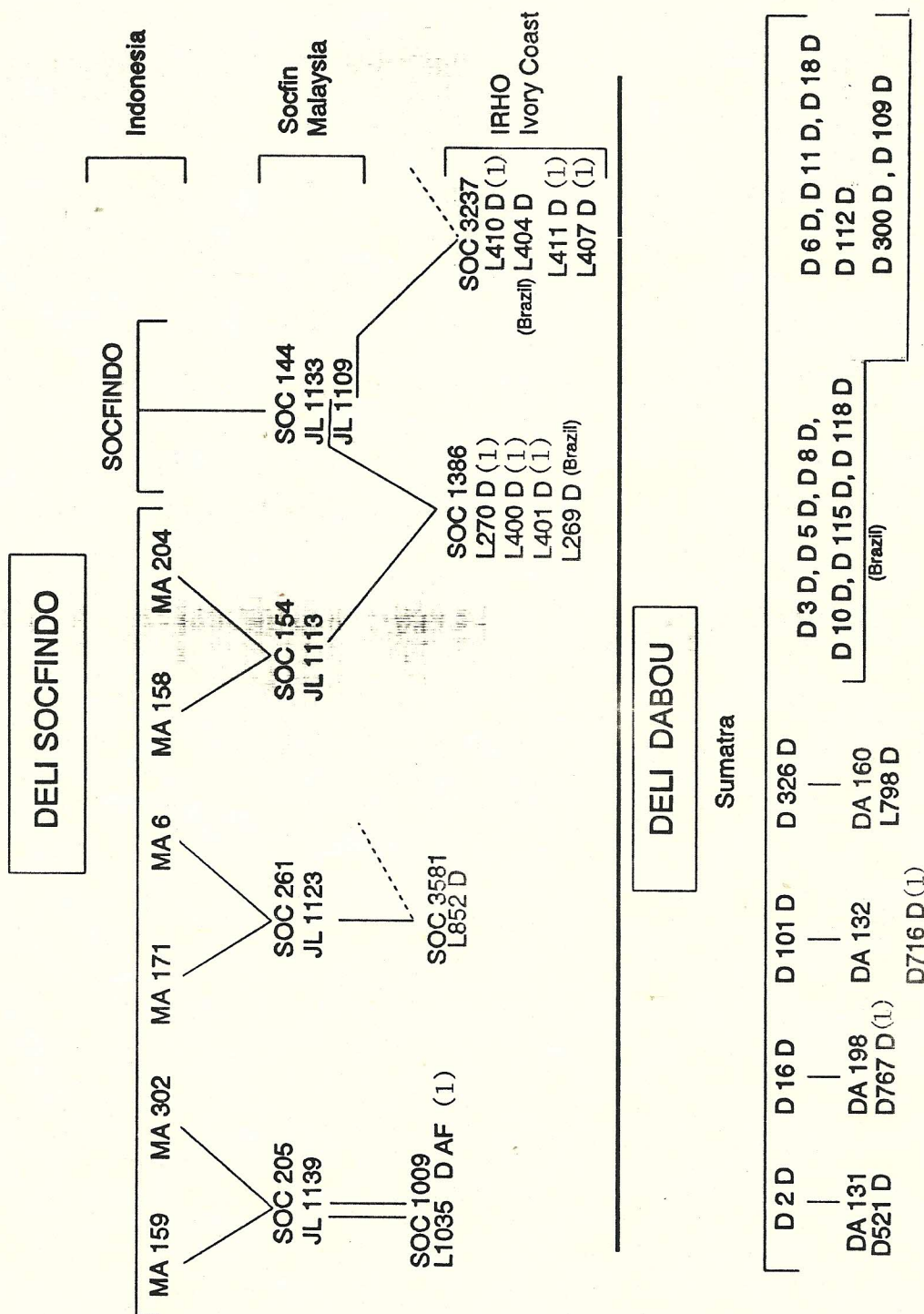


Fig 2. Genealogy of IRHO Deli Dura parents introduced to EERU program in Brazil .

(1) Also introduced to EERU .

Table 5. Dura lines in EERU.

Original Cross			Number of Lines
(D5D	x D3D)	SELF	17
(D115D	x L269D)	SELF	14
(L404D	x D3D)	SELF	15
(L404	x D10D)	SELF	18
(D8D	x D118D)	SELF	10
(D8D	x D115D)	SELF	10
(D5D	x D3D)	SIB	5
(L404D	x D10D)	SIB	4
(D8D	x D118D)	SIB	3
(D5D	x D3D)	x (L404D x D3D)	2
(D8D	x D118D)	x (D115D x L269D)	3
(L404D	x D3D)	x (L404D x D10D)	2
(D8D	x D115D)	x (L404D x D10D)	3
(D5D	x D3D)	x (D8D x D118D)	3
(D8D	x D118D)	x (L404D x D10D)	4
(D8D	x D115D)	SIB	4
(D8D	x D118D)	x (D8D x D115D)	4
(L404D	x D3D)	SIB	5
(D115D	x L269D)	SIB	5
(L404D	x D3D)	x (D115D x L269D)	4
(D5D	x D3D)	x (D115D x L269D)	3
(D5D	x D3D)	x (L404D x D10D)	2
(L404D	x D3D)	x (D8D x D118D)	2
(L404D	x D10D)	x (D115D x L269D)	1
(D8D	x D115D)	x (L404D x D3D)	2
(D5D	x D3D)	x (D8D x D115D)	2
(D8D	x D115D)	x (D115D x L269D)	2
CHE 135	x HC 132		1
HC 133	x HC 132		1
HC 132	x HC 136		1
CHE 135	x HC 136		1
(D118D	x D10D)	x (D22 x D5D)*	1
(D22D	x D5D)	x (D102D) x D3D)*	1
(P519D	x P511D)	x (D118D x D10D)*	1
34			156

* CPATU

In addition, 3 clone evaluation trials were planted at EERU, since 1988, involving a total of 23 IRHO's clones. These trials are part of an international network for evaluation of the genetic x environment interaction. Vegetative observations show a good conformity in the first planted trails.

A trial of commercial seeds with different origins, was also planted in 1985, involving material from 6 origins:

- IRHO (2)
- OPALMA (2)
- PALMOL (2)
- ASD (1)
- H&C (1)
- UNILEVER/ZAIRE (7)

Unfortunately, no conclusive results are available.

Additional germplasm has been introduced from IRHO to enrich the gene pool of EERU since 1984 (Table 6).

Table 6. Germplasm accessions introduced in Brazil by IRHO since 1984.

ACCESSION	NUMBER OF LINES PER YEAR OF INTRODUCTION					
	1984	1985	1986	1987	1988	Total
<u>DURA</u>						
Dabou Deli	4	4				8
Johore Labis Deli	1	3		3		7
Layang Layang Deli		1			1	2
Deli "Dumpy" Serdang		3				3
<u>TENERA/PISIFERA</u>						
Bingerville	1	4				5
Yocoboue		1				1
"Porto Novo" Pobe		1		1		2
Yangambi INEAC	1	1	3			5
"Sibiti" La Rive					2	2
Lobe		1			1	2
Widikoum, Cameroon		2				2
Aba, Calabar (Nigeria)			1	2		3
Salazar, Novo Redondo	3					3
Short Stem (Pobe)		5				5

In addition to the oil palm advanced breeding material and germplasm introduced by IRHO, Embrapa also obtained 246 introductions of identified open-pollinated seeds sampled from sub-spontaneous oil palm groves of the Brazilian State of Bahia, which were planted at EERU during 1984-86. These sub-spontaneous populations developed from the seeds brought by the African slaves, and dispersed along the coast, from the State of Rio de Janeiro in the south towards the State of Ceara in the North. However, the greatest concentration of groves occurs in the southern coast of Bahia State, close to Valença, Taperoá and Nazaré districts. OOI, et al. (1982), collected 31 open-pollinated bunches at different processing plants in Bahia, and planted the material in a replicated trial at EERU. In 1984, MELO (1985) carried out a prospection in 6 districts of Bahia State. From these collections, EMBRAPA introduced 215 entries, identifying the different materials by geographic origin and planting the accessions in a bunch-to-row trial for evaluation. According to MELO (1985), most of the bunches collected were Dura, only a frequency of 4.9% of Pisiferas were found in the prospection. The same author, indicates that the low presence of Pisiferas can be explained by the fact that the first African slaves could not have brought other, than Dura seeds. Similar low Pisifera frequencies were also found in prospectations in Africa by RAJAINNADU and MEUNIER cited by MELO (1985). A summary of the characteristics of the germplasm collected by MELO (1985) is presented in Table 7. The importance of this material can be seen as a new source of genetic material for breeding better locally adapted oil palm types, especially seeking resistance to major oil palm diseases present in South America.

Table 7. Bunch characteristics of the sub-spontaneous material
prospected by Melo (1985) in Bahia, Brazil.

Characteristic	Number of Observations	Mean	Rance	C.V. (%)
Bunch weight(kg)	329	17.3	3.3 -65.4	52.6
Fruit to Bunch (%)	329	72.3	27.1 - 87.4	11.9
Average Fruit Wight (g)	329	5.5	4.9 - 49.9	33.0
Mesocarp to Fruit (%)	328	51.1	34.6 - 76.5	10.7
Shell to Fruit (%)	327	38.9	13.9 - 49.2	11.7
Oil to Fresh Mesocarp (%)	255	45.9	11.0 - 60.6	16.7

In the *E. guineensis* breeding program is planed the utilization of the material prospected at Bahia and also the utilization of the material available at the germplasm colection. For this once evaluated, these material will go into the reciprocal recurrent selection design.

With the trial results of Rio Urubu and other IRHO's stations, where the same breeding material has been tested, the third cycle of RRS will be conducted.

The utilization of tissue culture in collaboration with IRHO will allow exploitation of the outstanding individuals in the trials.

Besides the breeding program, the EERU is producing commercial seeds. A total of 4 million seeds is the anual production potential of the station.

Germplasm of *Elaeis oleifera* and its hybrids.

The *E. oleifera* germplasm collection, collected in the Brazilian Amazon, includes 226 open pollinated lines, collected from 15 localities in the region, representing 26 ha of planted area and 3.726 individuals (Table 8). The collected material shows interesting genetic variability (GHESQUIERE, 1987), very promising for the hybridization program with *E. guineensis*. The interespecific hybrids program is also being conducted, with some progenies already in the field (Table 9).

Due to the great importance of "spear rot" in the Latin American oilpalm cultivation, this program must be enforced by the production of a considerable amount of hybrids and back crosses, in view to selecting outstanding individuals to be multiplied by tissue culture and be evaluated in high "spear rot" incidence areas (LE GUEN, et al. 1991).

Table 8. Germplasm of *E. oleifera* collected in Brazil.

Location	Number of acces/year of planting			
	1984	1985	1987	Total
Careiro	11	28	-	39
Manicoré	29	42	-	71
Novo Aripuanã	-	12	-	12
Anatari	-	13	-	13
Autazes	-	12	-	12
Maués	-	11	4	15
BR 174	2	14	-	16
Perimetral Norte	-	8	-	8
Acajatuba	-	9	1	10
Tefé	-	6	-	6
Anori	-	5	-	5
Moura	-	12	-	12
Tonantins	3	1	-	4
Benjamin Constant	1	-	-	1
Barcelos	2	-	-	2
15	48	173	5	226
Number of palms	645	3.015	66	3.726

Table 9. Interspecific oil palm breeding program.

Hybrids	1985	1986	1991	1992	1993*	Total
<i>E. oleifera</i> x <i>E. guineensis</i>	17	12	62	5		96
Back cross BC 1		3	6	10	11	30
BC 2				4	14	18
F2			1			1

* in the nursery

CONCLUSION

In spite of the national and regional importance and scientific value of the Rio Urubu Station, lack of financial and human resources are major constraints to its immediate survival. In this context EMBRAPA is looking for partners and other collaborators.

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